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The effectiveness of FFAs in hedging freight rate risk in the Dry Cargo Panamax Sector

By

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Abstract

The shipping industry is subject to a unique demand and supply mechanism that makes the market very volatile and exposes ship owners and shippers to a number of risks, one of which is freight rate risk. Owners naturally aim to control freight risk in an effort to secure constant earnings from a vessel.

One method to reduce freight risk exposure is to take opposite positions in a corresponding paper trade. This is known as derivative hedging and features the ship owner placing a bet on the downside of the market; i.e. falling freight rates. That way one hopes to mitigate the losses incurred in the physical market (spot) with the gains made on the hedge. The hedging tools analyzed in this study are future contracts, namely forward freight agreements (FFA). They are priced through an index reflecting future prices of the underlying market to be hedged and can be short sold, because they are cash settled.

The downfall of BIFFEX contracts has shown that the effectiveness of FFAs as hedging tools depends on how well the indicating chart reflects the physical market. Indices are often composites of a number of routes or ship segments and eventually lack representing accuracy. For modern Panamax FFA contracts the relationship between spot and future prices is tested statistically using regression analysis. The results show high correlation between the plotted variables, suggesting that much of the variance in the physical segment can be explained by developments on the future market as well; hence there is high potential for hedges to be effective. The issue of effectiveness is elaborated further, also with respect to other factors, such as counter party risk and a lack of liquidity in a market. The latter of which is an issue in today's shipping environment, which experiences a reduction in the number of people willing and able to trade FFAs. No matter how well the index represents the market, there always has to be somebody acting as counter party. Nevertheless, although liquidity risk may arise from the quality of a FFA, it may have other origins and may not be used to judge hedging effectiveness as such.

The overall opinion is that for the sector handled (Panamax) and for the viewed route composition, FFAs appear to be very effective risk minimizers. But ship segments are much diversified and may not all show similar hedging results. Further, the spot rates are averages received from routes between world regions that consider a range of ports on either side. Therefore, the true effectiveness for individual routes (port-to-port) may only be assessed by further refinement of sailing distances.

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Glossary *(Taken from the Clarksons Glossary of Shipping Terms 2011)*

BDI – Dry Bulk Index; Composite Freight

BFI – Dry Bulk Index; Composite Freight ; renamed BDI after the introduction of tanker derivatives

BIFFEX – Baltic International Freight Futures Exchange

BPI – Baltic Panamax Index, Composite Freight

Capesize. A drybulk carrier with a cargo-carrying capacity exceeding 100,000 dwt. These vessels generally operate along long-haul iron ore and coal trade routes

Charter. The hire of a vessel for the transportation of a cargo. The contract for a charter is commonly called a "charterparty".

Charterer. The party that hires a vessel under the charterparty*.*

Deadweight ton or "dwt." A unit of a vessel's carrying capacity, including cargo, fuel, oil, water, stores and crew; measured in metric tons of 1,000 kilograms.

Drybulk carriers. Vessels designed and built to carry large volume bulk cargo.

Drybulk. Non-liquid cargoes of commodities shipped in an unpackaged state, such as coal, iron ore and grain, etc. that is loaded in bulk and not in bags, packages or containers.

Fixture. A shipping industry term used to denote the agreement of a new charter.

Freight. A sum of money paid to the shipowner by the charterer under a voyage charter, usually calculated either per ton loaded or as a lump-sum amount.

Handysize. Handysize (drybulk) vessels have a cargo carrying capacity of approximately 10,000 to 39,999 dwt. These vessels carry generally minor bulk cargo. Handysize vessels are well suited for small ports with length and draft restrictions that may lack the infrastructure for cargo loading and unloading.

IMAREX – International Maritime Exchange

Lay up: Temporary cessation of trading of a ship by a shipowner, usually during a period when there is a surplus of ships in relation to the level of available cargoes.

LIFFE – London International Freight Futures Exchange

Panamax (Drybulk). Panamax vessels have a cargo carrying capacity of approximately 60,000 to 99,999 dwt, and do not exceed the maximum length, depth and draft capable of passing fully loaded through the Panama Canal. Panamax drybulk carriers carry coal, grains, and, to a lesser extent, minor bulks, including steel products, forest products and fertilizers.

Spot charter. Generally refers to a voyage charter or a trip charter (see separate definitions), which generally last from 10 days to three months. Under both types of spot charters, the shipowner would pay for vessel operating expenses, which include crew costs, provisions, deck and engine stores, lubricating oil, insurance, maintenance and repairs, and for commissions on gross revenues. The shipowner would also be responsible for each vessel's intermediate and special survey costs.

Spot market. The market for a vessel for single voyages.

Supramax – Dry Bulk vessel class <55,000 mt dwt

Time charter equivalent rate ("TCE"). A shipping industry performance measure used primarily to compare daily earnings generated by vessels on time charters with daily earnings generated by vessels on voyage charters, because charter hire rates for vessels on voyage charters are generally not expressed in per day amounts while charter hire rates for vessels on time charters generally are expressed in such amounts. TCE is expressed as per ship per day rate and is calculated as voyage and time charter revenues less voyage expenses during a period divided by the number of our operating days during the period, which is consistent with industry standards

Time charter. A charter under which the vessel owner is paid charter hire on a per-day basis for a specified period of time. Typically, the shipowner receives semi-monthly charter hire payments on a U.S. dollar per day basis and is responsible for providing the crew and paying vessel operating expenses while the charterer is responsible for paying the voyage expenses and additional voyage insurance. Under time charters, including trip time charters, the charterer pays voyage expenses such as port, canal and fuel costs and bunkers.

Voyage charter. A voyage charter involves the carriage of a specific amount and type of cargo on a load port-to-discharge port basis, subject to various cargo handling terms. Most of these charters are of a single voyage nature, as trading patterns do not encourage round voyage trading. The owner of the vessel receives one payment derived by multiplying the tonnage of cargo loaded on board by the agreed upon freight rate expressed on a U.S. dollar per ton basis. The owner is responsible for the payment of all voyage and operating expenses, as well as the capital costs of the vessel.

1. Introduction

Ships naturally are very expensive and complex pieces of equipment. This asset intensity and the high volatility in trade volumes and ocean transportation make the shipping industry risky. One of the many risks participants have to bear is freight rate risk; i.e. the income a vessel receives and the hire/freight a charterer has to pay. Over the centuries, both ship owners and charterers have been aiming to minimize this risk through good market anticipation, experience, expertise and hedging. In basic there are two ways to hedge freight rate risk: "physical" and derivative hedging. From the position of a ship owner, the former tool could include methods such as fleet diversification so that falling freight rates in one ship segment may be bolstered by rises in another. This is one of the oldest and most basic ways of hedging, but involves greater expertise in a wider business area, which on the other hand bares risks in itself. Further, the demand for more ship segments may be derived from the same or similar trade. For example, iron ore, steel coils and cars are all carried in different vessels, but may actually be interdependent, because they form a production chain. I.e.: if fewer cars are produced, this may as well reduce the demand for steel coils and iron ore and hence, diversifying one's fleet towards car carriers, bulkers and heavy-lifters may not actually help reduce freight rate risk, but increase exposure.
A much more modern invention is financial hedging, where one takes a position in a virtual and paper trade that is exactly opposite to the one held in the physical market. Meaning: As a ship owner one fears falling freight rates and thus places a preventive bet on the market downside in the paper trade. If real rates do drop, the ship owner makes money on his paper bet instead; gains that can help offset (insure/hedge against) the physical loss.
The financial instruments used for paper hedging are known as derivatives. Stulz (2005) quotes the Merriam-Webster Dictionary that a chemical derivative is "a substance that can be made from another substance". He claims those principles also apply to financial derivatives, because their gains and losses are essentially derived from the value of a so-called underling (Stulz, 2005). Those underlings can be stocks, grains, weather, etc. and also freight rates. In the derivative trades "one party's loss is always another party's gain" and their "main purpose […] is to transfer risk" to any counter party willing to bear it (FFA presentation, author and date unknown). Derivatives have the advantage of being non-asset bets on market movement with very low transactions costs. These market movements are only anticipated and therefore subject to speculation and the quality of information available. Altogether, derivatives form a parallel and virtual market that provides relatively cheap and asset-free hedging possibilities. The performance can then be plotted on an index.
Nevertheless, the virtual character also holds drawbacks: bets are based on assumed development that might not actually reflect the real market most accurately. In that case real and virtual freight rates would behave differently, real and paper positions held not be exactly opposite and the hedge not really offset one another's losses. Therefore it is very important for a successful hedging strategy that paper trade and underling correlate. In maritime transport however, issues arise with the variety of different trades and the subsequent division into often totally independent sub-segments. Whilst raw materials, such as crude oil only exist as a handful of different, but chemically distinguishable grades, ships can be both,

specialized for a single cargo or generalized for more. This has to do with all the different trade patterns, characterized not only by demand and supply, but cargo type, handling requirements and equipment, port accessibility and many more. Raw materials, such as crude oil and iron ore are transported in bulk and not containers. Hence, these cargoes require different ships, often too big to access all canals and ports. Further, very large vessel may not be efficient in transporting goods that are demanded in smaller consignments or in smaller ports and vice versa for smaller ships. Although cargo flexibility seems to increase with smaller capacity, vessels are often forced into certain trades. These factors determine the type and length of a voyage and therefore the freight rate. Because of the variety within trade and shipping, a corresponding paper trade should not be derived from the industry as a whole. Neither should a performance index generalize too much regarding ship classes and routes for similar cargoes, if used for hedging purposes. The less an index has in common with the actual risk to be hedged, the less effective the hedge is, too.
There is a variety of derivative instruments, namely Forwards, Futures, Options and Swaps, all of which will be explained in detail later on. Using empirical evidence and correlation theory, this paper aims to outline and *analyze the use and effectiveness of future contracts to hedge freight risk; i.e. how well are they suited to minimize freight rate risk?*

2. Background

Notable authors such as Nimikos, Alizadeh and Kavussanos have bundled much of their shipping and derivative knowledge in compact Handbooks, such as the one by the Grammenos Library and published by Lloyd's List (2010) or another by Alizadeh and Nomikos themselves (2009). Both books constitute a number of peer reviewed essays that address much of the dynamics and functioning of shipping and freight derivative markets and therefore provide the theoretical basis for this study. Most of the journal articles addressing more specific information on freight futures were found in the endnotes of these two books. Although this may already raise limitations to this study in terms of being rather one sided, the derivative trade for non-storable commodities (such as freight) is as such a rather new invention and not many experts have touched this field yet.

2.1. Market Segmentation and the freight rate mechanism

To recall, the segmentation within the shipping industry is determined by the trade patterns for the goods that require ocean transport. In basic that is the type of and demand for a certain commodity and in detail which type of vessel the charterer chooses, considering three factors: commodity type, parcel size and port facilities (Alizadeh et al, 2009). The above points decide which ships carry what where and their freight rate. Strong economic growth in many Asian economies and their need for industrial raw materials led to an increase in the demand for Panamax and Capesize vessels and consequently of their freight rate. Smaller ship segments, on the other hand, such as the Handy- and Supramax classes are less suitable for the transport of large quantities of for instance coal, and therefore do not directly benefit from a rise in demand of the underlying commodity. However, economies of scale on one hand restrict port and canal accessibility on the other (draught vs. shallow water). Further, not every cargo is best shipped in very large consignments, either because simply not needed in such large quantities, but more frequently, because it perishes (e.g. grain) (Alizadeh et al., 2009). Larger vessels also tend to have no own handling equipment for which they require adequate load and discharge facilities at port. According to the specific requirements of cargo, routes and shippers, some main segments and many sub-segments have emerged in shipping. On top of the pyramid there is bulk and general cargo. The former is split into dry and wet bulk and the latter is mostly transported in containers and designated vessels. All segments further split up into numerous ship classes, assigned to meet the above mentioned trade requirements best. Examples in the dry bulk sector are Handysize, Supramax, Panamax and Capesize (ascending in size). The Panamax class is limited in length, width and draught to the size of locks used in the Panama Canal (vessels usually have a max capacity of 70,000 mt dwt). Capesize vessels on the other hand originate their name from being too big to pass through canals and therefore have to sail round the capes of Good Hope and Horn.

Because there are so many segments, some of which are very specialized, it may be very difficult for practitioners to hedge their physical positions effectively. As mentioned, the underlying index for the derivative hedge should match one's real asset. However, not every ship class has its own specifically designed derivative and indices are often composed of a few ship segments. The mismatch between future index and real market development bares an additional risk for hedgers. That risk is generally referred to as basis risk. I will explain the implications of basis risk later in this thesis.

2.2. Spot Freight rate formation

Following the previous section the shipping freight market is defined by the underlying functions of demand and supply. Demand and supply factors interact, just like in any other market and hence create an equilibrium at which the quantity (ship capacity, measured in ton-miles) and price (freight rate, $US) meet. In its nature as transportation service, the demand for shipping is derived from the demand for the goods traded via the sea. Factors are the world economy and international seaborne trade, as well as "seasonal and cyclical changes for different commodities transported […], and the distance between sources of production, and consumption of commodities" (Alizadeh et al., 2009). The supply curve of shipping however is slightly more complicated. Whilst in basic it reflects shipping capacity available, the formation of the curve very much depends on the global fleet size, its productivity and corresponding freight rate, as well as production and scrapping levels. Looking at Figure 1(LR supply and demand), we notice that the supply curve is convex shaped, ranging from very elastic to very inelastic with increasing freight rates. The reason behind that is that at any given point in time there may be supply limitations. Another is a certain inability of the market to respond to strong changes in demand immediately, because it costs time and money for tonnage to enter or leave the market. Only smaller fluctuations in demand can be mitigated through higher travel speed and port turnaround times in an upswing and slow-steaming and layup on the downside. In fact it may take one whole year until a new vessel is built and delivered and equally ships are usually depreciated over a long period of time (e.g. 30 years), which makes owners reluctant to scrapping before that age is met. In conclusion, the supply curve remains elastic, despite significant increases in demand, until capacity limits are reached, because owners apply short term measures; also the freight rate increases only marginally relative to the rise in demand. However, when all capacity is utilized to its maximum, freight rates experience a steep rise until new tonnage enters the market. If too many ships are ordered this results in overcapacity and consequently lower freight rates on a yet again elastic supply curve. This mechanism is widely known as the "shipping cycle" has received extensive analysis by Martin Stopford (Maritime Economics, 2009).

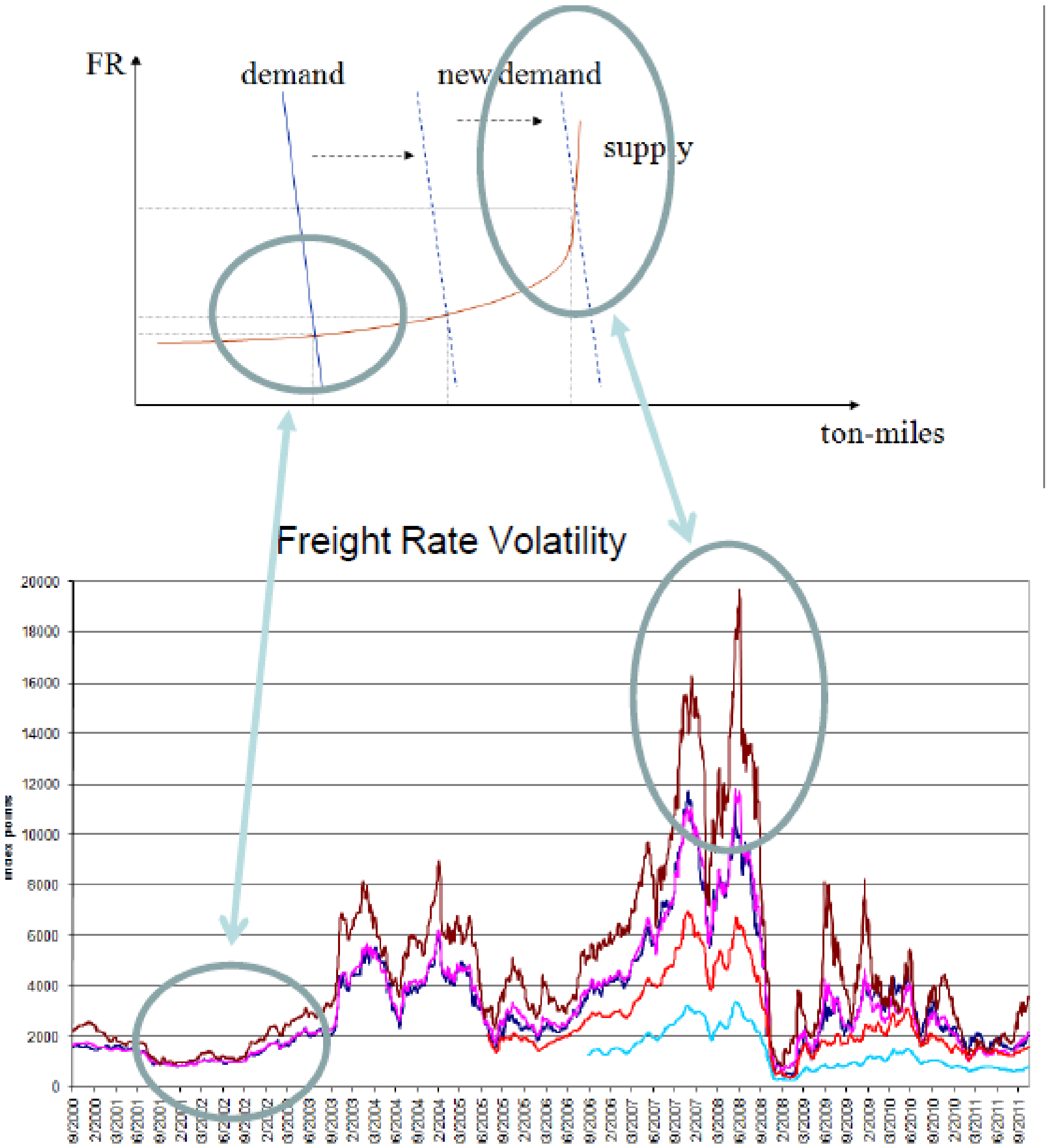


Figure 1 - Supply and Demand Framework in Freight Rate Determination; Source: Nomikos, 2012, Presentation, online

2.3. Risks

As Alizadeh puts it correctly, "these are interesting times for the shipping industry" (2009). After an extreme boom in freight rates between 2003 and 2008, presenting an increase of nearly 300 per cent, the world witnessed the arguably biggest slump in shipping history in the final quarter of 2008. The BDI fell by 95 per cent (Figure X),

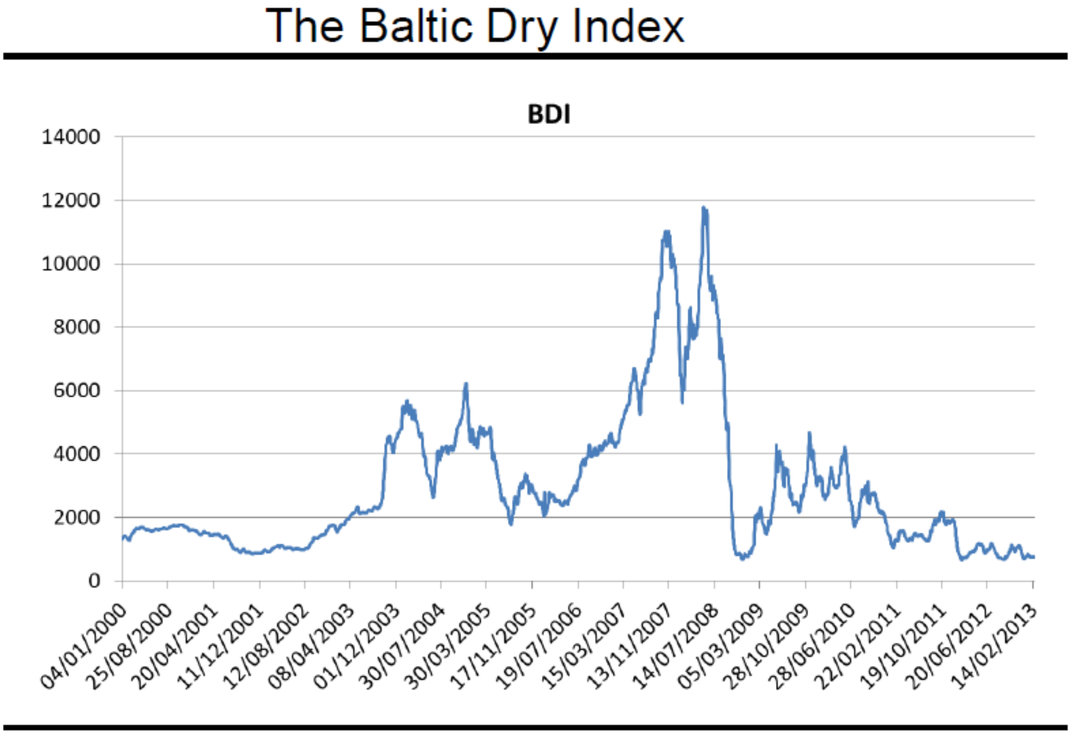


Figure 2 – Baltic Dry Index; Source: Duncan Dunn SSY; Presentation online, date unknown

which not only added to the already volatile character of the shipping industry, but might " have changed the way the industry views and manages its risk" (Alizadeh et al., 2009). Although not storable, freight rates have become tradable just like any other commodity. This process, described as "commoditization" (Alizadeh, 2009), allows all kind of market players to participate in the trade for shipping services, without actually being involved in the physical market. One of the main ideas behind and uses of freight derivatives however is to hedge positions held in the underlying tangible market, and on which this thesis will focus. As mentioned earlier, freight rates can be very volatile and therefore freight risk management is of great importance to market players, such as ship owners and shippers.

Managing this risk using forward contracts is discussed presenting their application in a number of hedging scenarios. Basis risk and settlement risk will be main topics addressed to elaborate the effective application of freight forward agreements (FFAs).

Freight rates essentially are what the vessel earns and thus it is obvious that their volatility presents a risk that has a direct impact on a company's cash flow and profitability. Following that Alizadeh points out that in fact every "factor that may have a negative impact on the expected net cash flow is identified as a risk" (Alizadeh et al, 2009).

But freight rates are by far not the only fluctuating factor in a ship owners spectrum, which is why I will briefly introduce the other risks faced by a shipping company. As mentioned, freight rate risk is the risk of change in price that a firm can demand for its transport services, which is generally termed as output price risk. But also input prices, the amounts payable by the firm for labor, raw materials etc, are changing and present a risk (Alizadeh et al.,, 2009). For a shipping company that is operating cost risk, concerned with the cost of manning and running a vessel, of which bunker fuel costs usually have the largest share with more than fifty per cent of total voyage

costs. Bunker prices, but also lube oils and other oil products onboard, are naturally related to crude oil prices and therefore also highly volatile. Labor regulations and wages, but also port and canal dues, as well as repairs and maintenance are just other examples of input prices.
There are two more price risks a shipping company has to cope with: interest rate risk and asset price risk. The former inherits its importance from the capital intensity of ocean transportation, which requires many vessels being financed through loans on a floating rate basis. If interest rates increase so will the capital costs payble to the bank. Interest rate risk naturally spins off into exchange rate risk; because the two are related (the cost of money in one country compared to the cost of money in another is the rate of exchange). Being an international business, shipping companies may sometimes have to convert voyage incomes received into a foreign currency and similarly fees or prices for spare parts. For instance, if a vessel has to be repaired in a Japanese dry dock, the bill is likely to be issued in Yen.
The ship is usually the major if not the only asset of a shipping company. Therefore asset price risk is an important factor, too. Thus on one hand asset price fluctuations have a strong impact on a company's balance sheet and on the other hand, similarly to interest rates, affect the ability to service debt obligations, because ships are often used as collateral against a loan. Mortgage agreements for ships usually include covenants that regulate the relation between asset value and loan amount. If asset values depreciate, the collateral may not cover the sum owed anymore, for which the ship owner would become liable for breach of contract.
Having presented the major components of price risk a shipping company has to face, I would also like to briefly introduce credit risk and pure risk. Credit risk may also be classified as "counter party risk" and describes the possibility of a business partner or debtor failing to honor the agreement made. This is particular relevant to shipping, because most deals are made between two parties and without insurance or clearing. Though, especially after the credit crunch export credit agencies have increasingly been insuring loans for new build vessels. Further, most of the trade in freight derivatives has moved away from the over-the-counter (OTC) market and to cleared exchanges (IMAREX) with higher security. In the case of default, the amount owed is paid by a clearing house. The function of those is explained further on.
Last, but not least and perhaps most easiest to understand is pure risk, which refers to asset value reduction through physical damage to the ship, its crew and environment due to things like human error, technical failure, force majeure etc.

3. Introduction to derivatives

Having introduced the different risks a shipping company faces in its day to day operation, I will now give insights to the different derivative contracts and their application, because they are also used to manage price risk.
In basic, derivatives are contracts on a transaction "whose value depends or derives from the values of other […] underlying variables" (Alizadeh et al, 2009). Underlying variables can be commodities or financial assets and virtual performance is presented in indices. The contract is usually concerned with "the terms of a transaction that will take place in the future" (Alizadeh et al, 2009).
Forwards, futures, swaps and options are therefore all derivative instruments and may be traded through an exchange or over-the-counter (OTC). The former features standardized versions with pre-defined characteristics termed by the exchange.

It really all started with the Chicago Board of Trade in 1848, where fixed quantities and qualities of grain could be traded between farmers and merchants, but soon also developed a so call to-arrive contract allowing agreements for the future delivery of grain.

Risk management is what derivatives were originally intended for. We know that already in the 1860s farmers were able to hedge their physical positions with derivative contracts. Essentially hedging describes taking a position opposite of those in the physical market, diminishing any losses, but also gains made there. “Hedgers are either short or long” (Alizadeh, 2009). A farmer would naturally be long on grain, because he produces it and aims to sell it for profit. Then farmers could enter into future contracts, selling (paper-) grain they did not yet harvest at the prevailing price; i.e. go short on the paper trade. If later the market softened and they would be forced to sell at a loss (grain is perishable), they would make a profit on the future position, buying the contract back at a price lower than originally shorted.

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

Hedging with derivatives implies transferring the risk to someone else that is willing to take it in return for a possible profit. Essentially the basis for derivatives trading then becomes speculation, because either one party has different expectations of future market developments. In fact, it appears that many more derivative contracts are traded for speculative reasons rather than risk management purposes. Alizadeh et al (2009) point out a number of characteristics that facilitate this speculation: 1. Very high liquidity, 2. Low transaction costs and 3. the possibility to forward (short) sell. This ensures that almost all sellers will find a buyer (liquidity), at a very low cost and even without having a position in the real market (shorting). With the use of put options and forward contracts as explained earlier, participants may much easier speculate on a falling market than otherwise possible in a physical market. In addition, selling future contracts on a cleared exchange (BIFFEX / IMAREX) only costs a fee, which is a mere proportion of what the position is actually worth. Over-the-counter agreements are personalized and may only cost brokerage or nothing at all. Both ways, low transaction costs also allow the application of leverage. Leverage is multiplying the initial investment without the necessary cash backing, but essentially borrowed money supplied through a broker or exchange. That way it increases the returns on investment, creating the possibility of very high profits (and of course losses) (Alizadeh et al, 2009).

High speculation may lead to the false conclusion that future prices lose their connection to the underlying asset. But if there were serious price discrepancies, it would allow traders to enter into multiple agreements and secure virtually risk- free profits, merely by capitalizing on these differences rather than real development. This process is known as arbitrage and the fact that enough people seeking it (called arbitrageurs) exist, brings the asset and contract back in line (however then leaving it to the composition of the index).

Through arbitration and in general, “derivatives markets provide a mechanism through which the supply and demand for an asset are brought into alignment” (Alizadeh et al, 2009). By sharing both, present and future (expected) spot prices, the derivatives markets have a price discovery role that adds to the overall

transparency. As already mentioned this helps towards a better allocation of resources facilitated by reduced search and transaction costs as well as additional guidance for production and consumption decisions.
From then futures exchanges have been created all around the world, beginning as open-entry trade floors and developing into electronic platforms automatically performing transactions though high-tech computer systems.
Over the counter contracts (OTC) on the other hand are traded in a network of agents and brokers, usually arranging via telephone or email. The main difference to the exchange platform based system is that agreements are not set by the standards of the exchange, but are tailor-made for the individual client. That way, terms such as expiry date and underlying commodity can be chosen freely. On the other hand they also lack the security provided be an exchange and therefore are subject to credit risk, as explained earlier.

3.1. Futures and Forwards

Now to the different derivative contracts that can be used to manage the above risks: As mentioned earlier there are forward contracts, futures contracts, swaps and options. The former two are virtually identical concerning their definition and functioning; for minor details see Table 1.
A very straight forward definition of a forward contract is:

- A forward contract is an agreement entered into today between two parties, A and B, according to which, Party B has the obligation of delivering at some fixed future date a given quantity of a clearly specified underlying asset, and Party B the obligation of paying at that date a fixed amount that is agreed today (at date zero), and that is called the forward price at date zero of the asset at date T, denotes as F(0,T)" (Alizadeh et al, 2009).

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

Table 1 – Differences between Futures and Forwards; Source: Alizadeh et al., 2009, p.11

Again, the underlying asset may be anything really, such as a financial asset, a commodity or of course freight. But settlement does not have to be made physically otherwise intangible assets such as freight would not be feasible for derivative trade. "Only in 1982 when cash settlement procedures were introduced for stock futures a valid alternative to physical delivery was created" (Grammenos, 2010).

3.2. Swaps

"A swap is an agreement between two or more parties to exchange a sequence of cash flows over a period of time, at specified intervals" (ALizadeh et al, 2009).
Such arrangements are very popular with interest rates, for instance in form of "fixed-for-floating" interest swaps, where Party A agrees on paying a fixed rate on a certain principle to Party B, each year until the contract matures (e.g. 5 years). Party B in turn pays a floating rate to Party A and the difference is then settled. The same can of course be done with currencies, where one interest rate is denominated in each and another currency. In general, all assets or indices thereof are suitable for swap arrangements, but will not be discussed in depth here.

3.3. Options

"Options are financial contracts, which give their holder flexibility; that is the right - but not the obligation – to either buy or sell an asset at a specific price if market conditions are favorable" (Alizadeh, et al, 2009).
Options are usually divided into "call" and "put" options, allowing buying or selling at an agreed price until a certain time in future. This right however, has to be purchased at a price, called a premium.

4. Implication and application of financial derivatives

4.1. Freight Market Information

To recall, shipping is a very volatile industry, which exposes participants to a significant amount of undesirable risk. One way to reduce those uncertainties is hedging by derivatives based on freight indices, some of which are published by the Baltic Exchange, the leading provider (Alizadeh et al., 2009). "The structure and composition of these indices give us insights on how freight derivatives can be used for the purposes of hedging" (Alizadeh et al., 2009).

4.1.1. The baltic freight index

Until 1985 the shipping industry did not have an „underlying commodity", which was stock-indicated to trade future contracts. Then however the Baltic Exchange in London created a freight index (BFI), which enabled an efficient paper trade for freight rates. Similarly the International Futures Exchange was established in Bermuda, but was soon abandoned. Unlike other commodities freight is non-storable and does not involve any physical goods or assets whatsoever. The BFI is essentially an average weighted index of underlying dry cargo freight rates, i.e. of the Capsize-, Panama- and Handy sectors and their respective trade routes. Those again refer to the different ship classes active in this market. Further, separate indices have been produced of each of those "classes" individually. E.g. the Baltic Panamax Index (BPI), which will be center to this thesis.

4.1.2. The Baltic Panamax Index (BPI)

Looking at table 2 constructed by Nomikos et al. (Grammenos, 2010), we see that the BPI published through the Baltic Exchange constitutes of four trip-charter routes. They also present the most important routes on which Panamax vessels trade and are all equally weighted with 25% each. "Skaw-Gibraltar" names a range of ports from Skaw, which is located in northern Denmark, all the way westward/southward along the European coast and down to Gibraltar on the southern tip of Spain. Skaw-Gibraltar therefore represents the whole Atlantic coast of Europe. Consequently, the two routes commencing from there, present Atlantic voyages. The third route sees a simple trans-pacific round voyage from and to North-East Asia and the fourth route includes a trans-pacific voyage to the west coasts of Canada and the USA, then a crossing of the central American isthmus at Panama, and finally to continental Europe along the aforementioned Skaw-Gibraltar range.

Route number	Description	Weighting
P1A_03	Delivery Skaw-Gibraltar range for a Trans-Atlantic round voyage (including ECSA), redelivering Skaw-Gibraltar range. Duration 45-60 days.	25%
P2A_03	Delivery Skaw-Gibraltar for a trip to the Far East, redelivery Taiwan-Japan range. Duration 60-65 days.	25%
P3A_03	Delivery Japan-South Korea for a trans-Pacific round voyage, either via Australia of NOPAC, redelivery Japan-South Korea range. Duration 35-50 days.	25%
P4_03	Delivery Japan-South Korea for a trip to the Continent (via US West Coast-British Columbia range), redelivery Skaw-Gibraltar range. Duration 50-60 days.	25%

Table 2 – BPI 4TCA Composition; Source: Nomikos et al; 2010, Grammenos p.749

The actual index used in this study is a variation of the BPI, the Baltic Panamax 4TCA (time charter average). This term may raise the question why I would use a time charter index to assess spot rate futures, but this is not actually the case.

4.1.3. Calculation of the Baltic Indices and the role of panelists

Although nominated this way, the index represents a composite of the four most important Panamax spot voyages, but as time charter equivalents (TCE). This has to do with the actual charter contracts. Voyage charters (spot) are usually paid in $US/ton (freight), whilst time chartered vessels receive a "hire" per day. Under a time charter the charterer has to come up for bunker (fuel) expenses and port/canal dues, but when employed spot the ship owner has to remit these positions (Alizadeh et al., 2009). TCE therefore presents the net earnings of the vessel. Having mentioned that bunkers are a volatile cost factor, dependent on the price of oil, this additional volatility could potentially bias the freight chart.

Spot (voyage) market	Time-charter market
Voyage Hire (in US$)	T/C Hire (in US$)
Less: Operating costs (in domestic currency, e.g. euro)	Less: operating costs (in domestic currency, e.g. euro)
Less: Voyage Costs	

=Operating Earnings	**=Operating Earnings**
Less: Capital costs (from loans)	Less: Capital costs (from loans)
Plus: Capital gain/loss from buying and selling vessel	**Plus: Capital gain/loss** from buying and selling the vessel
=Overall Cash Flow	**=Overall Cash Flow**

Notes:

(1) Operating costs include manning, repairs and maintenance, stores and lubes, insurance, administration.

(2) Voyage costs include broking commission, fuel costs, port charges, tugs, canal dues, etc. Fuel costs form the largest part of these, and are subject to the highest fluctuations.

(3) Capital costs refer to debt servicing through capital repayment

Table 3 – Ship owner's cash flow; Source: Kavussanos, 2010; Grammenos, p.710

The Baltic Exchange calculates its indices daily at 13.00 GMT, using data provided by a board of independent international shipbrokers, called the panel. For routes appointed by the Baltic Exchange these panelists report and assess the current market situation. Because this is done by personal professional judgment and because identical ships may not receive identical rates for the same job (e.g. due to personal favor, negotiation, individual ship condition, etc.), a Manual for Panelists, produced by the Exchange, encourages the panelists to apply and if necessary adjust the relevant information. Further this handbook intends to "assist in ensuring common practice amongst panelists when making their […] assessment" (Alizadeh et al., 2009). Equally, panelists are held to exercise special care in the final seven days of every month, because then numerous derivative contracts are settled and traders may try to influence the panel for more favorable FFA settlement rates; such actions could also have an impact on the physical market. Further, each individual fixture between owner and charterer may also be termed very individually and/or sometimes physical activity on a certain route is virtually non-existent, which makes it a complicated undertaking to produce an accurate market representation. "In these circumstances panelists exercise judgments which cannot be tested against current negotiations or fixtures" (Alizadeh et al., 2009).

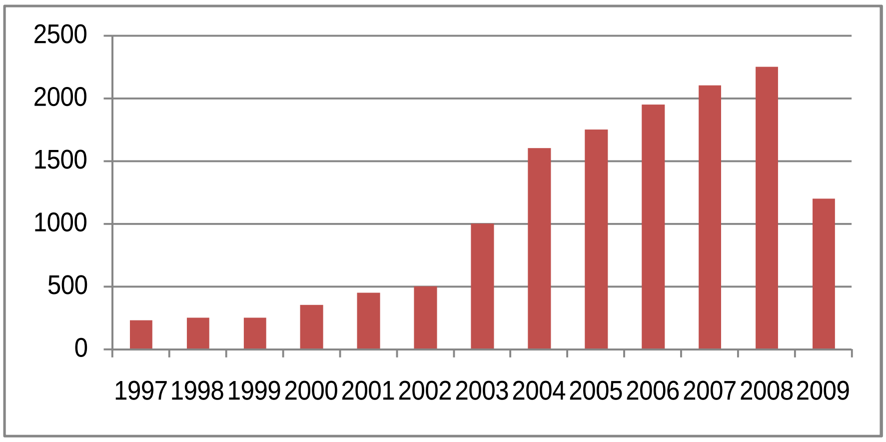
According to Alizadeh et al. the Baltic exchange applies three basic principles to compose their indices so to best reflect the prevailing situation and developments with regard to trade routes and their changing importance:

1. Since not every route can be taken into account, the component routes are chosen to achieve the highest market coverage by including principal voyages.
2. The liquidity of those principal routes should be sufficient with regard to the turnover and fixtures activity.
3. In order for the previous conditions to apply, sufficient amount of fixtures have to be reported accurately and transparent.

Following above procedure, the daily reported freight rate from each broker for each individual route is then averaged and multiplied by a constant figure to produce an index number. The constant multiplier is a component coefficient reflecting the importance of that particular route for the index, i.e. the weighting. That way the panel can also adjust the index to changes in the weighting or when routes are added or removed, without disturbing the continuity in the level of aggregation. In addition the multiplier shows by how much the index will change to each US$1/day change in freight.

5. Freight Futures

Freight futures are derivative contracts on spot freight rates; the termini, which have been explained before. They are based on the mentioned freight indices produced by the Baltic Exchange and settled between the buyer and seller upon maturity. In practice that is made over the difference "between the contracted price and the average freight on the indicated route over the last seven working days" of the contract period (Kavussanos, 2010, Grammenos). To avoid credit risk on behalf of the counter party, FFAs are often agreed on through a clearing house, which accounts for losses in the event of one party's deficiency (above). However, if both parties are willing to accept counter party risk and aim to avoid the fee usually associated with "clearing", they may also agree "over-the-counter" (OTC). Well known clearing houses are situated in London (LCH CLearnet), Oslo (NOS) and Singapore (Singapore Asia Clear). Further facilitated is the trade in freight derivatives by a number of intermediates, such as brokers and investment banks. Major trading platforms are the International Maritime Exchange (IMAREX) in Oslo and the New York Mercantile Exchange (NYMEX). Whereas open market traded and cleared derivatives are standardized, OTC agreements offer the benefit of being able to be adjusted precisely to what the individual parties require. Further, such transactions and their conditions are private and therefore may not be known to the public. If the market requirements changed, contracts may easily be updated to meet the new requirements. Whilst one-segment hedges, for instance in the dry bulk sectors Capesize, Panamax, Supramax, Handymax, are matched to cover spot rate risk, a "basket" of routes may also achieve that for the long term (time charters). Of course, then also, the daily average of the spot basket is settled against contract value. As demonstrated by Kavussanos (2010, Grammenos), the total value of contracts traded in the shipping derivatives market had not only grown substantially up to and including 2007 (Figure 3), but had actually surpassed the physical market in total value. As mentioned this has to do with speculators entering the paper trade, without being active in the underlying market.



Note: Each lot corresponds to either 1,000 tons of cargo or one day of TC hire.

Source: Freight Investor Services (FIS) and the Baltic Exchange. Reported figures are market es

Figure 3 – FFA Trade Volume development; Source: Nomikos et al., 2010; Grammenos, p.752

5.1. Historical Overview of the Freight Future Market

As mentioned earlier, transportation and the cost associated with it (freight) are not actually commodities that can be stored like any other, such as wheat or gold. Hence, it can neither be delivered as such upon expiry of the future contract. However, the benefits of hedging freight risk with futures traded in a specific market had already been recognized as early as the 1060s, but were then obstructed by the aforementioned characteristics of this "commodity". The first trading platform was opened in May 1985 in London featuring a Baltic Freight Index (BFI)-based dry bulk contract; the Baltic International Freight Futures Exchange (BIFFEX). The BFI started with 13 voyages for various dry bulk cargos and for ship sizes between 14 and 120 thousand metric tons and soon became the main and most widely accepted indicator for dry bulk freight rates. Over the next years more routes were added and variables and weighting were adjusted to match the developing market better. In 1999 another index was introduced with capsize activity separated from it and soon the Baltic Panamax Index (BPI) became the main underlying and most reliable index for BIFFEX contracts. Before the introduction of the BIFFEX contract, market players had no hedging tool to manage freight rate risk other than actual physical assets; e.g. fleet diversification etc. However, because the BFI consisted of a mix of vessel sizes and routes, the index did not necessarily reflect volatility on individual routes most accurately. Using such a tool to manage risk is considered cross hedging and does in fact bear risks and thus reduced the effectiveness of BIFFEX contracts. Cross hedging is the process whereby one takes a hedging position in a commodity like, but nowhere equal, but has similar price movements, such as oil and gas(Investopedia.com,2013).
In fact, BIFFEX studies made by Nomikos and Nomikos et al. (Grammenos, 2010 pp.747) have shown that actual hedging efficiency for individual routes ranged from only 19.2 to 4 per cent, as opposed to 70-99 per cent in other commodity and financial markets; the reason for which were cross-hedges caused by biased market reflection due to bad index composition. Despite further segmentation of the BFI (exclusion of Handy and Capesize) in 1999, efficiency did not improve. BIFFEX trade volumes continued to decline from 1995 on, until it eventually represented only 10 per cent of the physical market and in April 2002 BIFFEX was de-listed due to ceasing trade activity.

5.2. Forward Freight Agreements

After the aforementioned drawbacks of BIFFEX contracts, a new freight futures market came up from the early 1990s on. Forward freight agreements, a contract between two parties on freight on an agreed date in future for a specific dry bulk or tanker route, the quantity transported or the type of vessel sailing. Thereby hedgers hoped to find a more accurate tool considering their individual exposure to the real market. Again, the underlying asset to these agreements is produced by the Baltic Exchange in form of a number of indices representing specific routes or another basket thereof. However, they can also be based on any other reliable market information gathered by equally trustworthy institutions, e.g. Platts and Clarksons. The settlement rate for FFAs may equally to BIFFEX contracts be calculated over the average of the past 7 working days, but is usually done so over the settlement month. Nevertheless, both contracts are calculated over the average to ensure that settlement rates are not too sensible to strong amplitudes, either caused by natural market volatility or manipulation.
Like BIFFEX and any other futures contracts it is exercised on the cash value of the freight index upon settlement date.

Figure 4 shows the two ways in which FFAs can be traded; that is Over-the-Counter (OTC) or via an organized exchange, such as the International Maritime Exchange (IMAREX). Over the counter agreements may either be made the traditional way, through a broker and or cleared though one of the institutions mentioned earlier. The alternative to OTC broking is trading over a hybrid exchange like IMAREX. The platform provides standardized contracts, which are automatically cleared through NOS in Oslo (Alizadeh, 2009).

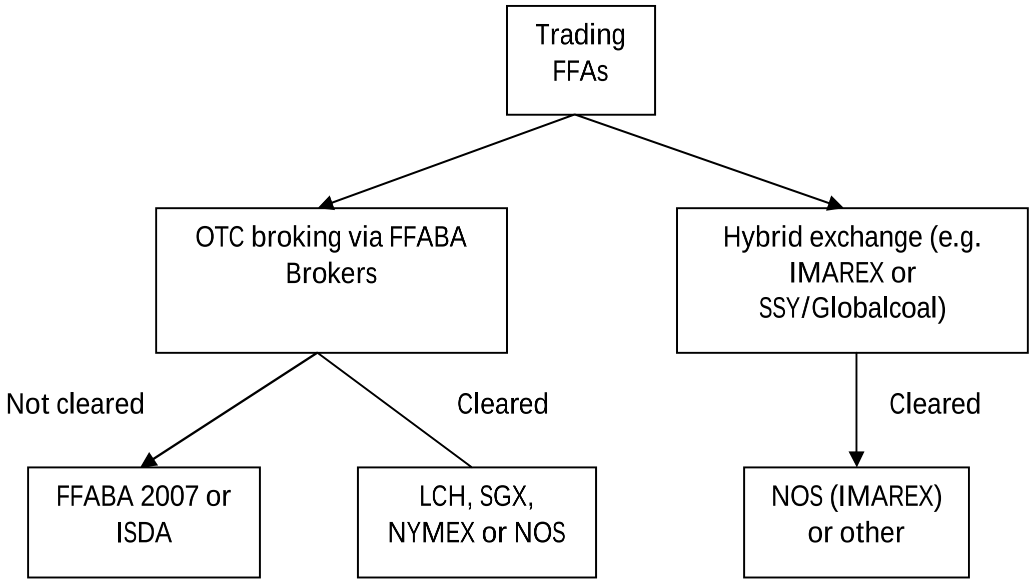


Figure 4 – FFA Market Structure; Source: Nomikos et al., 2010; Grammenos, p.753

6. Literature Review

There have been a number of studies conducted on the price discovery role of derivatives based on the causal relationship between freight futures and spot prices. Kavossanos and Nomikos (2003a) investigate the price discovery function of BIFFEX contracts and explain why the LIFFE exchange actually ceased trading them in 2002. They find that future prices discover spot price information more rapidly due to the limiting fundamentals of the spot market, such as the absence of short selling and higher transaction costs. New information flows therefore tend to prefer the futures markets. Kavussanos and Visvikis (2002) claim low transaction costs and flexibility to be the reason for information efficiency in the FFA market, also with respect to short selling and not actually having to own a vessel. Further, if a strong correlative long-run relationship between freight futures and spot prices exists, their application for short run forecasts is also justified. However the causal relationship discovered is rather one sided; i.e. future price information can effectively be used to forecast spot price developments, but not the other way around (Kavussanos and Nomikos, 2003a). They further find that price discovery improved with the refinement of the BFI (exclusion of Handymax vessels), because it added to the homogeneity of the index. Variety in ship segments and routes may reduce the usefulness for individual ship owners. Despite their efficiency in discovering spot prices, BIFFEX contracts were less effective freight hedging tools.

Two major reasons are brought forward here: a) significant fluctuations on individual routes within the composite index were not sufficiently covered and b), as a result many participants moved to the over-the-counter market (OTC), where they could obtain un-cleared, but personalized future contracts, avoiding the basis risk associated with composite indices such as the BIFFEX underlying Baltic Freight Index (BFI). OTC is an arrangement where two individuals agree privately, as opposed to contracts that are public exchange traded. Basis risk is the risk associated with the difference (basis) between index and real market. But not only using an average aggregate index reduced the hedging effectiveness for underlying routes, the move away from the exchange and to the OTC market drained necessary liquidity (Nomikos and Alizadeh, 2010, Grammenos Handbook). Liquidity however is probably most important to future markets. It allows market participants to enter and exit smoothly, at virtually no cost and without significantly influencing the price, all of which are fundamentals to the price discovery function again (Kavussanos and Nomikos, 1999b). Although indices are more refined nowadays, the example of BIFFEX contracts clearly demonstrates the dependencies of freight future contracts and hence their limited effectiveness.
Also Kavussanos and Visvikis investigate the causal relationship between spot and future prices with regard to a lead-lag relationship and find that freight derivatives (BPI) provide good information on the underlying spot market and faster; thus legitimating future market's discovery role. Thoung and Visscher (1990) elaborate the issue of index composition and find that introducing a risk minimizing hedge ratio through regression analysis between spot and future price volatility helps. The coefficient of determination (R^2) expresses the degree to which fluctuations in the dependent variable can be explained through regression; i.e. how much risk can be hedged; i.e. the effectiveness of future contracts. Building on aforementioned conclusions, they discover that, at the time, BIFFEX contracts were less effective, given rather low R^2 compared to future hedges performed in commodity markets. Similarly to Kavussanos and Nomikos, also they find the composition and weighting of the BFI (BIFFEX underlying index) to have major implications on how useful future contracts are for individual routes or segments. Haralambides (1993) practically analyzed the effectiveness of BIFFEX contracts via a 1 to 1 example, highlighting drawbacks of this strategy. He then, too, elaborates the usefulness of regression analysis to form a ratio that helps towards an "optimal hedge" with higher risk coverage than simple 1-to-1.
From the literature review I can conclude that valid peer-reviewed studies on the fundamentals, implication and effectiveness of freight futures exist. However, they only assess the somewhat "failed" effectiveness of BIFFEX contracts and give reasons why they were abandoned. After the obvious failure of BIFFEX contracts, the new version has received more care and refinement towards solving above mentioned issues of index composition, but is yet to be analyzed towards actual hedging effectiveness, like their predecessor. In addition, the recent financial crisis (2008) and consequent rate collapse in the shipping industry is assumed to have changed the conditions, also in respect to market liquidity. I therefore aim to continue the line of research in line with the ones made, but for IMAREX contracts.

From the literature review one can draw a research question in form of a null-hypothesis that requires quantitative and qualitative testing:

"The Baltic Panamax Index is an across-the-board composite index that does not reflect individual routes accurately enough and therefore cannot be used as underling in freight future hedges."
Can this statement be rejected and to what extent?

7. Methodology

Bunea-Bontas et al. (2009) outline methods to measure hedging effectiveness. Firstly, one should conduct both a prospective and retrospective test. They define a highly effective hedge as offsetting a minimum of 80 per cent of value change in the hedged item. The former is a forward-looking test incorporating the use of a scenario to analyze the appropriateness for future implementation and to find parameters on which to measure true effectiveness. The retrospective test on the other hand looks towards the past and effectiveness then. Next, Bunea-Bontas et al. suggest a statistical test, namely Regression Analysis, because it is the most widely used tool. In basic that is the measurement by how much the value of one variable depends on the change in another."Market practice agrees that the R^2 must be 80% or better to be considered highly effective" (Bunea-Bontas et al., 2009).
This paper aims to analyses the implementation and effectiveness of freight future contracts with hedging strategies to minimize freight rate risk. Hedging effectiveness was defined by Alizadeh et al (2009) "as the proportion of the risk in the unhedged position that is eliminated through hedging!"
After having explained the dynamics of the shipping market and the general risks associated with it, I outlined the financial derivatives available to market participants, such as forwards, swaps and options. From there I take future contracts as the tool to hedge against the risk of freight volatility, because that is their major purpose. How the hedging process is actually done is presented with practical one-to-one hedge examples that act as my prospective scenario test, as outlined above. This is done from the position of a Panamax owner active in the Pacific. He wishes to minimize the risk of financial exposure when freight rates fall. From there the limitations of this strategy (1-to-1) are addressed on principles of basis and credit risk. With the gained understanding of the market and the empirical evidence from the literature on BIFFEX contracts, I aim to find *eventual mismatches between an index and the underlying route/segment to be hedged*. The regression analysis then determines the effectiveness of FFAs.
The past has shown that shipping is a very volatile industry and that all participants, but especially ship owners are exposed to a number of risks (Stokes, 1997). Amongst those risks is freight rate risk. For the ship owner, freight rate or hire are what his asset earns and therefore a major source of income. To the charterer they present the cost of transporting a cargo as proportion of the total sales price. Both parties would like to reduce their exposure to this risk and hedge (evade) themselves against losses associated with changing freight rates; i.e. freight rate volatility.
This thesis examines *the effectiveness of freight derivative contracts as hedging tool for ship owners against freight rate volatility.* FFA (Forward Freight Agreement) contracts, namely those traded on the IMAREX exchange, but also over-the-counter arrangements, are the derivatives in question. IMAREX contracts are also the most widely used form of freight derivatives traded in the shipping industry, today (Bloomberg, 2012). Nevertheless, the actual effectiveness of hedging with exchange traded freight futures has been questioned in the literature (BIFFEX; Kavussanos et

al, Thoung et al, Haralambides).BIFFEX contracts are not traded anymore, because of a number of reasons, and similar issues may therefore also arise with the newer and more refined versions of freight derivatives (FFAs). One of the reasons mentioned earlier, was the index' inability to accurately present and forecast freight rate performance for individual segments/routes. This and others will be elaborated in more depth later on.

The shipping industry in general is a very specialized business and freight derivatives seem to be so in particular, because there have not been a lot of up-to date studies assessing the effectiveness of FFAs as freight rate hedging tools. However, there are extensive data sets on historical freight rates (spot and time charter) and corresponding future prices. To pick up on one issue that caused the trade in BIFFEX to cease action in 1999, IMAREX futures should also be tested on their correlative strength between future and spot prices. Shipping segments and also trade routes are actually diversified in terms of their freight performance and volatility. To recall, then BIFFEX contracts were taken off the market, because the future index was a composite of different ship sizes and routes. Therefore it did not reflect freight rate changes of individual underlying voyages well enough; hence became ineffective in managing freight rate risk on these individual routes. Since it has been concluded that FFAs are only as effective as their commonalty with the real market that is to be hedged, the thesis aims to discover similarities or differences through a number of measures, qualitatively as well as quantitatively. Qualitatively the literature reviewed revealed a number of conclusions that emphasize the strength of future prices in discovering spot values. This has also been confirmed for the freight markets and already indicates a relatively good connectivity between the two variables. However, outcomes differ; i.e. some segments or routes may correlate with a particular future index better than others.

In that sense, the Panamax sector was chosen, because futures for that class are amongst the most traded and thus provide sufficient information for this undertaking. But derivatives in general are not solely for hedging purposes and are in fact subject to speculation. Speculation is a "one-sided hedge" and is not judged towards hedging effectiveness. Therefore, market activity alone may hold no clue on their actual hedging effectiveness. Panamax futures are priced on the Baltic Panamax Index (BPI) published by the Baltic Exchange in London.

The index used is a composite of the most important routes Panamax vessels trade on, and to test its relevance as a whole to individual freight rates in the real market, I will plot individual routes against it. Because hedging aims for risk reduction and volatility is a risk, a regression analysis was chosen to compare the two variances. For that purpose DataAnalysis of Excel is used to regress the future (BPI) and spot prices (individual routes). Thus, the effectiveness of a hedge is determined by the amount of variance reduction it can achieve in a portfolio or how much of the variance in the real market can be explained by the variance in the index. This is essentially the coefficient of determination, denoted R^2. To demonstrate the mechanics and effects of derivative hedging, I will use a realistic scenario outlining two hedging strategies from the perspective of a Panamax vessel owner. One hedge will see the vessel active in the spot market (individual round voyages) and another features employment under a time charter agreement. The scenarios will apply a naïve 1-to-1 hedge, which is covering every financial exposure in the physical market with the same amount in papers. Only if the regression analysis beforehand shows significant discrepancies, I will alter the scenario towards applying a hedge ratio based on the R^2 obtained. The ratio would be necessary to relativise the difference in variance. Finally I return to the other issues, despite index mismatch, that brought down BIFFEX contracts then, and assess those now for IMAREX, especially in the light of the global financial and shipping crisis. Another problem then, was the lack of liquidity in the market, as in the amount of people actually willing and able to buy or sell freight derivatives for whatever purpose. And a currently distressed market with freight rates may in fact also suggest significant shifts in demand and supply for the corresponding paper market. Based on newspaper articles (Bloomberg) and market reports I will analyze the actual impacts of those factors, today.

7.1. Data and Sources:

As mentioned, the data used consists of various sets of spot and future rates. That is monthly prices for the ten years between Jan' 03 and Dec 2012 provided by Clarksons, a major ship broker also active in the trade for freight derivatives. Much of the background knowledge on freight and future dynamics was provided by the Erasmus University Library in form of acknowledged handbooks, such as the one on "Maritime Economics and Business" published by Lloyd's List and another on "Shipping Derivatives and Risk Management" by two experts in this field, Alizadeh and Nomikos. The University Library also provided free online access to a number of peer reviewed journal articles through its search engine. Also the University of Plymouth (UK) was found to be useful in that respect.

7.2. Valuation

Generally it is assumed that the two data sets in question correlate quite well, because they consider the same ship type, but on different routes. Also it is expected that correlation was one issue successfully tackled by the Baltic Exchange after BIFFEX was replaced by IMAREX. As a recognized institution, the Baltic Exchange certainly has experience in the production of indices. The degree of correlative "wellness" however, is to be discovered here. Further, the severe drop (95%) of the Baltic Dry Index (BDI) in 2008, the big "brother" of the BPI, and real freight rates is expected to have made at least some impact. The extent to which those impacts should concern the effectiveness of FFA contracts is to be analyzed qualitatively. As mentioned trading volume, as a measure of liquidity, and counter party risk (the risk of contractors dishonoring their agreements) are issues here and require assessment. In conclusion, I aim to present an updated picture on the usefulness of freight derivative hedging in the Panamax sector, also in comparison to previous editions (BIFFEX) and through the right mix of qualitative and quantitative analysis.

8. Testing

As mentioned in the Methodology it is necessary to conduct a prospective, retrospective as well as correlation test. The retrospective test is already incorporated in the Literature Review, which shows the rise and fall of BIFFEX contracts and therefore judges the effectiveness of freight future hedges in the past. The prospective test was also partly made in previous literature by proving a causal relationship between future and spot prices and by giving futures a price discovery role. The literature justifies the use freight derivatives to some respect already and thus lays basis for further applicability and effectiveness test in a scenario.

8.1. Hedging Cases

In order to visualize the practical application of FFA contracts and to assess their actual effectiveness I implemented two cases that bring light to the trade from the view point of the ship owner.

Nomikos and Alizadeh (Grammenos Handbook, 2010) outline a very straight forward scenario:

A currently time chartered Panamax vessel of 65,000 tons is due for delivery again in mid of January the next year. It is the 10th of October 2005 and the vessel earns 22,000 $/day. Because the owner fears the market to decline when the vessel becomes idle, he aims to hedge this risk and lock in a suitable rate by short selling FFA lots. He does so for the first two quarters (6 month) of 2006 using the four TC average of the Baltic Panama Index (Table 2, above). Then the FFA rates were reported to be 21,750 and 20,750 per day respectively for Q1 and Q2, granting the owner a temporarily locked in freight rate accounting for combined earnings of $1,283,250 for January and February 2006 together (=21,750$/day*31 + 21,750$/day*28).

Now the implementation of this hedging strategy depends on how the owner decides to fix the vessel next.

8.1.1. Spot Hedge

In the first case he aims to fix the vessel for consecutive Trans-Pacific round voyages, which is the P3A_03 route (Table 2, above), for the coming 6 month commencing delivery of the ship in mid-January. The first voyage employs the vessel for approximately 47 days (until the end of February) and earns 16,500$/day, which confirms the owner in his fears that the market was about to soften. Thus, he decides to settle his FFA positions for those two month, essentially buying back the papers he short-sold previously, at 16,014$/day and 16,276$/day, respectively. Hence, he makes a combined profit of $331,088 for Jan and Feb 2006 on the paper trade [(21,750-16,014)*31 + (21,750-16,276)*28] (Nomikos, Laizadeh, 2010 Grammenos Handbook). His earnings for the 47 day voyage are $775,500.

He then fixes the vessel for a similar voyage for another 47 days from the beginning of March on for 18,500$/day. Again, the FFA positions for March and April are unwinded, as they are no longer needed, now at 18,550$/day and 16,925 respectively. However this time, the time frames of FFA settlement periods and voyage duration do not fit as well as for the previous job. By settling the April contract, the remainder of this month is essentially unhedged, because the vessel is already delivered mid-April. Alternatively the owner may settle his April position later upon fixing the next voyage, which however leaves the first half of April unsecured. Another strategy could be to unwind only part of the FFA (15 days). Although desirable, because more precise, limited market liquidity for semi-duration contracts may prevent the actual trade.

Following table 4 and earnings for the 3rd voyage, the first half of 2006 resulted in a total $3,078,000 spot earnings and $638,915 FFA profit. Together this makes $3,716,915 of income opposed to the $3,845,750 the owner sought to lock in autumn the previous year. Although this slight deviation (3.4%) presents an error in the hedging tool, we may still call this a successful undertaking, because total earnings rose by more than half a million dollarios.

Panel A: FFA market							
FFA maturity	**Number of days**	**FFA rate ($/day)**	**Locked in monthly**	**Settlement**		**FFA P/L**	
				Date	Rate ($/day)	Daily	Monthly
January	31	21,750	$674,250	31 Dec 05	$16,014	$5,736	$177,816
February	28	21,750	$609,000	31 Dec 05	$16,276	$5,474	$153,272
March	31	21,750	$674,250	15 Feb 06	$18,550	$3,200	$99,200
April	30	20,750	$622,500	15 Feb 06	$16,925	$3,825	$114,750
May	31	20,750	$643,250	31 Mar 06	$17,533	$3,217	$99,727
June	30	20,750	$622,500	15 May 05	$20,945	-$195	-$5,850
Total Paper			$3,845,750				$638,915

Panel B: Physical market							
Delivery	**Voyage duration**	**Freight rate ($/day)**					**Trip earnings**
13 Jun 06	47	16,500					$775,500
02 Mar 06	47	18,500					$869,500
18 Apr 06	44	16,000					$704,000
01 Jun 06	45	16,200					$729,000
Total physical	183						$3,078,000
Total paper and physical							$3,716,915

Table 4 – Earnings Spot Hedge; Source: Nomikos et al. 2010; Grammenos p.756

8.1.2. Time Charter Hedge

The second case would see the owner fix his vessel for a period time charter of six month instead of consecutive spot charters. This would earn him 15,500 $/day for 183 days. Therefore he settles all his FFA contracts (Q1 and Q2 2006) at 16,250$/day and 15,500$/day, respectively. Hence, total earnings would sum up to $3,809,500, resulting in a hedging error of merely 0.95% to what he aimed to lock-in in the first place (Table 5)

Panel A: FFA market							
				Settlement		FFA P/L	
FFA maturity	**Number of days**	**FFA rate ($/day)**	**Locked in monthly**	**Date**	**Rate ($/day)**	**Daily**	**Monthly**
January	31	21,750	$674,250	31 Dec 05	$16,250	$5,500	$170,500
February	28	21,750	$609,000	32 Dec 05	$16,250	$5,500	$154,000
March	31	21,750	$674,250	33 Dec 05	$16,250	$5,500	$170,500
April	30	20,750	$622,500	34 Dec 05	$15,500	$5,250	$157,500
May	31	20,750	$643,250	35 Dec 05	$15,500	$5,250	$162,750
June	30	20,750	$622,500	36 Dec 05	$15,500	$5,250	$157,500
Total Paper			$3,845,750				$972,750
Panel B: Physical market							
Delivery	**Voyage duration**	**Freight rate ($/day)**					**Trip earnings**
13 Jan 06	183	15,500					$2,836,500
Totla paper and physical							$3,809,250

Table 5 – Earnings Time Charter Hedge; Source: Nomikos et al, 2010; Grammenos p.757

8.2. Hedging Risk

Whilst the above simple examples were relatively effective, given their small hedging errors, we noted that the success of such a strategy is influenced by the following factors:

8.2.1. Timing mismatch

As was observed in the first case, there can be a timing mismatch between the derivative agreement and the frame dates of the fixture. FFAs are usually settled monthly, whilst the vessel may be chartered anytime. We recall that the vessel's earnings were essentially unhedged for either the first or the second part of April and "depending on the volatility of the underlying market this mismatch can have an important effect on the performance of the hedge" (Nomikos and Alizadeh, 2010, Grammenos Handbook).

The timing mismatch goes over into the so-called **"Relocation or non-earning day mismatch"** (Nomikos and Alizadeh, 2010, Grammenos Handbook) and describes the difference between the period hedged and the time the vessel actually trades. Assume the vessel is actually off-hire for some days in the above six month period, for which the owner would actually be exposed to the paper market.

8.2.2. Basis Risk

Alizadeh et al. define the basis of a hedge as "spot price of the asset to be hedged, minus the price of forward contract used for hedging" (2009). Consequently if the future used is derived from that same asset we wish to hedge, the basis becomes zero at maturity of the contract. And if both, physical and virtual asset show equal volatility this will not change. A zero basis, also perfect or textbook hedge, results in all gains or losses experienced in the physical market to be equalized by the opposite development (loss/gain) of the future contract. Unfortunately however, future and spot prices deviate and so does the basis. These deviations present a significant risk, because a corresponding hedge may not always cover spot exposure fully. This is known as "basis risk" and corresponds with the hedging errors received in the scenarios. Therefore it depends on the degree of correlation between spot and future prices. The higher the correlation, the easier and more perfect the hedge will be, too. However, hedgers may "adjust the size of the futures position relative to their exposure in the underlying market" (Alizadeh, et al, 2009). The outcome is called "hedge ratio" and aims at reflecting the correlative relationship in a hedging portfolio more accurately and thus reduce risk. We recall, a 1.0 hedge ratio may only be used if "spot and future prices perfectly correlate" (Alizadeh et al., 2009).

8.2.3. Size Mismatch

Size mismatch may also have been a factor contributing to the hedging errors received in the two cases presented above. Whilst the BPI is setup and calculated using 74,000 mt dwt vessels, our example saw a vessel 9,000 mt dwt smaller than that.

8.2.4. Liquidity Risk

Liquidity is referred to as the number of people willing and able to trade in the paper market. Therefore the lack or even absence of liquidity on certain routes or ship types presents a major risk for market participants. If there are a limited number of

counterparties, unwinding or even establishing a hedge may become obsolete or only possible at a risk premium paid. Hence the effectiveness of FFA contracts depends very much on the liquidity present in the market (Nomikos and Alizadeh, 2010, Grammenos Handbook). To recall: liquidity and transaction cost are crucial to efficient information processing in futures markets.
Actual liquidity may only be estimated, but trade volume is essentially a measurement of liquidity (Skjetne, 2005).

8.3. The theoretical hedging effectiveness of Freight Derivative Contracts

As outlined in the literature review there have been studies elaborating the use of BIFFEX contracts to manage freight risk.
To recall: In basic, financial hedging is the process whereby one takes a position in the futures market that is the exact opposite of one's position in the "real", the physical market. In explanation, a ship owner naturally is "long" on tonnage, meaning he has a vessel and also hopes for an improvement in freight rates. To secure himself against the risks associated with that "hope", he will sell future contracts (BIFFEX/FFA); i.e. go "short" on the paper trade. This way, in case real freight rates drop, the ship owner will make money with his hedging position, hopefully equalizing losses experienced in the physical market. On the other hand, a charterer would do the exact opposite, as he naturally is "short" on tonnage and needs hedging in the paper trade to protect himself against rising transport costs. Any hedger aims to reduce fluctuations in the whole portfolio; i.e. offsetting the variance of physical positions by applying the derivative contract. Further, it becomes a major concern to reduce basis risk for the reasons explained previously.
Using a simple example of a 1-to-1 hedge shows the theoretical effectiveness of the future agreement, because it locks-in a satisfactory freight rate in this case. However, the example also highlights the limitations: Such a hedge only works so smoothly if spot rates and the corresponding future prices correlate perfectly, which in reality might be rare (composite index). Therefore I test the correlation to see whether the scenario result was sheer coincidence or because of a grounded hedging strategy.

8.3.1. Regression Results & Analysis

Following the theory, I regressed the spot rates of three important Panamax trade routes against the 4TCA future composite index published by the Baltic Exchange as outlined previously. The data was drawn from the Clarksons database and is monthly for the 10 years up until December 2012. The spot routes taken individually were Transatlantic (TA) and Transpacific (TP) round voyage as well as one from the Far East to the European (FE-CONT) continent.
For all three variations future and spot prices correlate perfectly, hence equal to 1. Further, Excel produced very high coefficients of determination (R^2) for all three cases. Please see Table 6 for the Anova result obtained for TP.

Regression Statistics	
Multipler R	0.99
R square	**0.97**
Adjusted R Square	0.97
Standard Error	2884.06
Observations	**120.00**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**1.00**	37849485997.12	37849485997.12	4550.42	0.00
Residual	118.00	981500500.35	8317800.85		
Total	119.00	38830986497.47			

Table 6 – Excel Data Analysis Regression Results for trans-Pacific vs. BPI over the last 10 years from Jan 2001 to Dec 2012

For the TA and FE-CONT voyages the degrees of freedom (df) were also 1 and R^2 was 0.98 and 0.92, respectively (Anova; Appendix *I.b).1&3*). Thus the regression analysis showed extremely high results, and following Stulz (2005) these results show a high hedging effectiveness.
Figure 5 shows the regression outcome for trans-Pacific round voyages in form of a graph. The left axis is denoted in $US and corresponds to the spot rates, whilst the right axis represents the values of the BPI in index points.

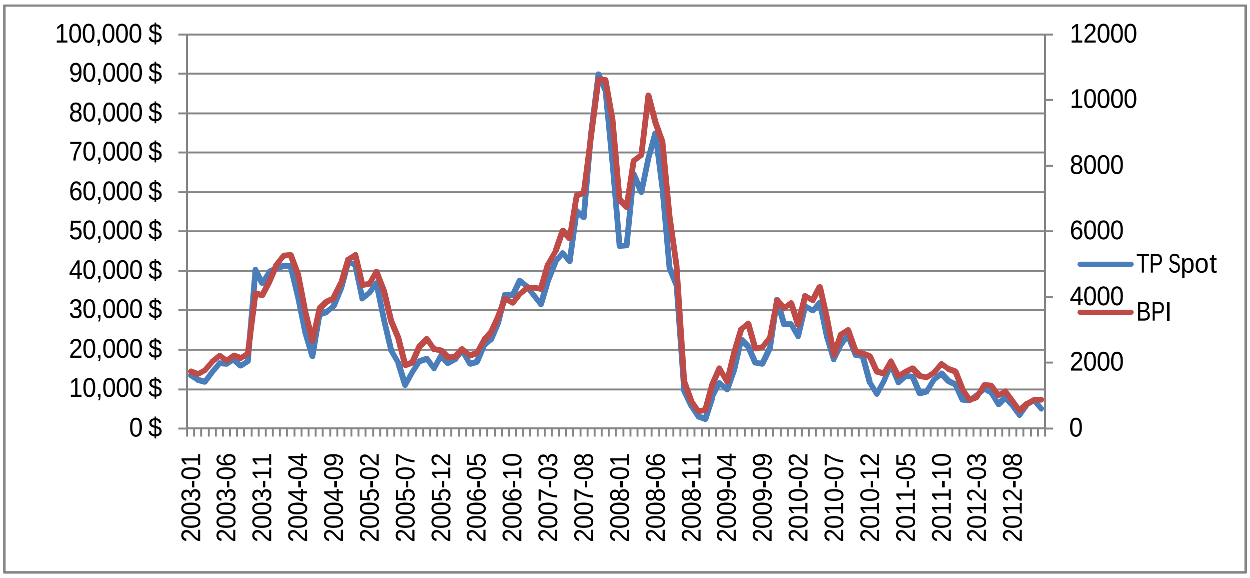


Figure 5 – Transpacific Spot rates vs. BPI 4TC; Source: Own

If the two variables did not correlate so well, traders would be well advised to apply a hedge ratio to try and relativize the mismatch. The hedge ratio is then simply the relative amount of future hedging required by the physical position. “The minimum variance hedge ratio is estimated as the ratio of the covariance between spot and future price changes (returns) over the unconditional variance of spot price returns” (Alizadeh et al., 2009).

When fixing single individual voyages, the owner may as well adjust the contracts to the actual sailing days in order to prevent an over- or under-hedged, as experienced for the third voyage in the spot charter scenario. The ratio is calculated by dividing the FFA period (standard 30 days) by the actual voyage duration. FFAs are traded in ton lots. Thus we multiply the received hedge ratio with the size of the consignment to be shipped. The result gives the actual contract coverage needed in tons.

Hence, the effectiveness is then “determined by the degree of variance reduction achieved”(Kavoussanos, 2010, Grammenos). This method was found to be more reliable by literature than the very simple approach of one-to-one hedging, where every dollar position in the physical market is “backed” by the same value in papers.

Referred to as natural coincidence by Skjetne is the fact that when regressing spot price changes vs future price changes, the gradient is our optimal hedge ratio. Further, the adjusted R^2 becomes the Hedging Instrument Effectiveness (HIE), a common measure, where $R^2=1$ presents a perfect hedge. HIE indicates the degree of possible risk reduction; or statistically, to what extent the degree of variance in the dependent variable depends on the independent variable?

On the other hand, the statistical analysis presented very high, almost perfect coefficients of determination (R^2) and an actual application of a hedge ratio is not particularly relevant to the outcome of the discussion in this particular analysis (Panamax composite).

Thus the final outcome of the test indicates that using the BPI 4TCA composite index to hedge its underlying routes can in fact be very accurate, even on a 1-to-1 basis.

Despite good correlation and satisfactory outcomes from the two scenarios, liquidity and basis risk may still present significant constraints to the “real” effectiveness of freight futures as hedging tools. In fact, Bockmann (Bloomberg, 2012) raises exactly those two issues.

Because of the general overcapacity present in the shipping industry today freight rates are highly distressed; i.e. very low. But the cost of freight, as a proportion of cargo cost, also determines its significance as a risk to charterers and thus, the requirement to hedge. This has resulted in fewer contracts being traded presenting a current lack of liquidity in the market (Figure 6). On the other hand, the fact of low freight rates, keeps ship owners reluctant to enter long term charter agreements. Therefore trading in the spot market exposes them to high volatility, which actually requires an appropriate hedge. Further, the article describes a shift from OTC to cleared FFAs following a number of contract defaults after the rates collapsed in 2008. The fact that most FFAs traded today are cleared, shows that credit risk is not so much of an issue in today’s market (Figure 7).

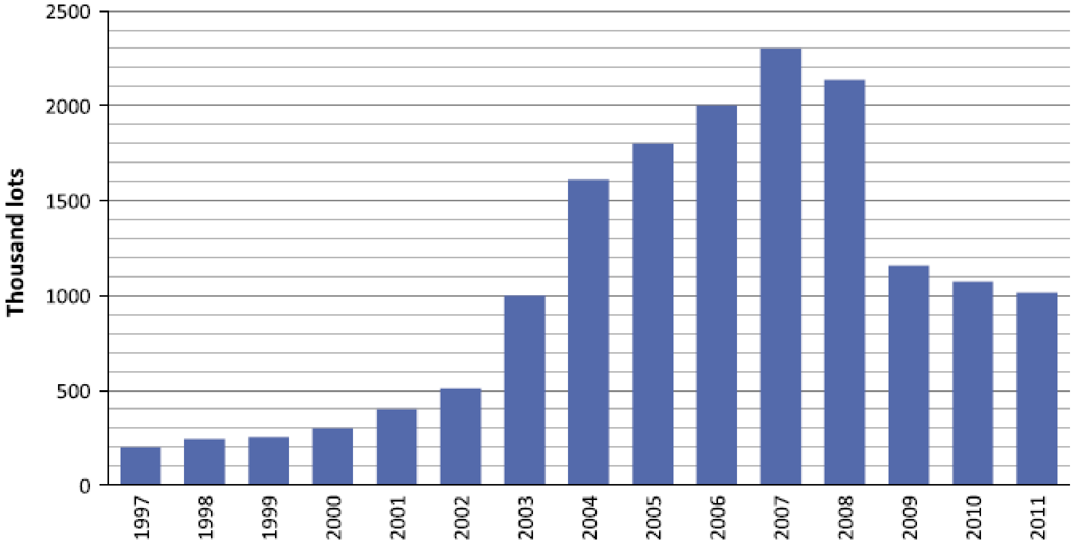


Figure 6 – FFA Trade Volume; Source: Alizadeh 2012; Trading volume and volatility in the shipping forward freight market, page.2

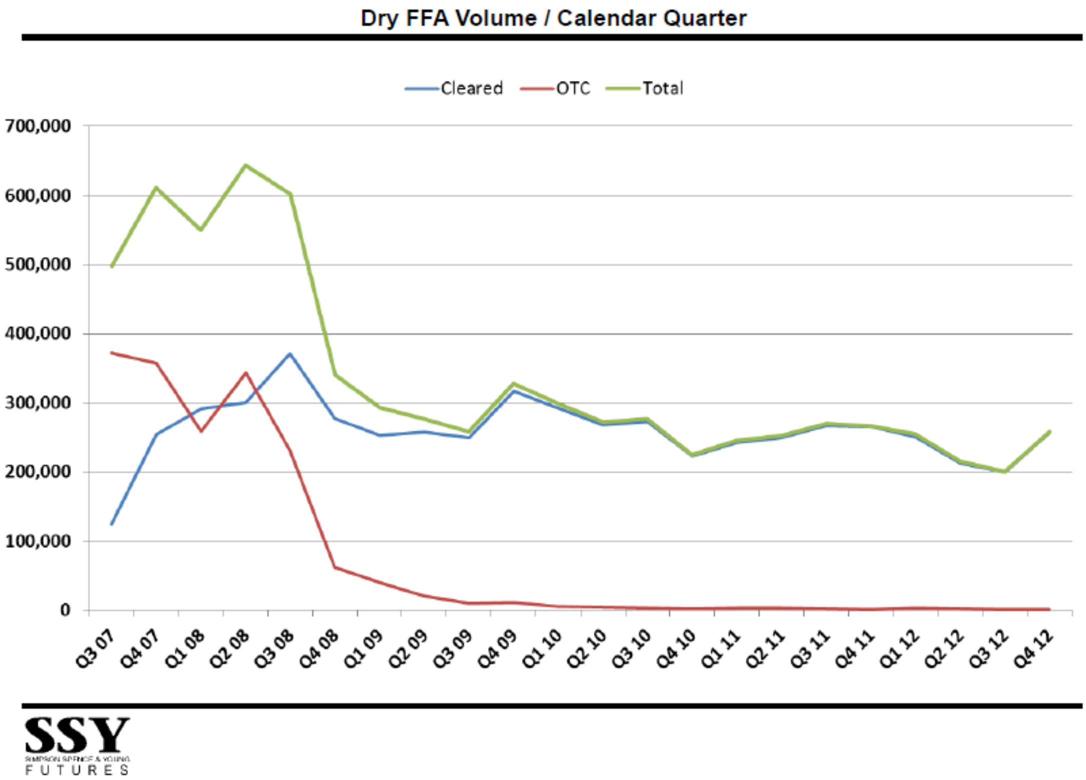


Figure 7 – Dry FFA Trade Volume 2009 Cleared vs Non-cleared; Source: Duncan Dunn, SSY Presentation, date unknown

The spot freight market may in fact be as distressed as to leaving some vessels without any employment. In that case the position on the physical side becomes a total loss and can by no means be equalized with an unleveraged hedge in the FFA market. E.g. assuming perfect correlation: if at the time of short selling (post crisis) our vessel earned 21,000$/day, the FFA would be priced the same. Now, if 20 new vessels entered the market, freight rates would consequently decrease due to the rise in tonnage supplied (e.g. to 14,000$/day, by 30%). Assuming oversupply keeps the vessel idle for the next period, the owner loses 15,000$/day on his physical position, but only earns 7000$/day. To cover this gap, the owner would have to apply leverage of three (3*7,000$/day=21,000$/day); hence initially sell contracts worth 66,000$/day. Earning a rate of zero is of course beyond the forecasting scope of any price index, but can always happen, especially in today's market conditions. Considering the other risks a ship owner has to face, a ship also requires maintenance and repairs or may break down or even sink. In those events he does not earn a rate, which consequently cannot be hedged; hence FFA effectiveness would be zero. Therefore, FFAs can minimize the exposure to freight volatility, but cannot hedge a vessel's earnings as such.

9. Conclusions

Literature has proven that future prices do achieve good price discovery for the corresponding spot prices and have a positive effect on their volatility. Through the analysis we have seen that both, a naive 1-to-1 hedge, as well as the least squared test and hedge ratio elaboration show that modern future contracts can be very effective hedging tools. At least for the Panamax sector issues such as index composition (basis risk) were successfully tackled. Minor discrepancies may be smoothed using hedge ratios. Credit risk is widely under control considering that most contracts are cleared through an exchange nowadays, but may always appear in the OTC market. Only liquidity, the willingness/ability to buy and sell could be source of concern.
But those weaknesses remain (credit and liquidity risk) and may never be fully eliminated, because they are substantial to trade.

9.1. Limitations

The regression analysis run was a success as such, because it showed great coverage by the composite index for its underlying routes. However, the routes themselves are already simplified and describe whole trade routes between regions and port ranges, rather than ports. The European Skaw-Gibraltar range, for instance, is long and measures hundreds of nautical miles between Rotterdam and Gibraltar, alone. A distance, which takes time and pays freight on its own. Although shipowners can apply a hedge ratio to relativize some of their mismatch, the scope of this thesis may still be too broad to benefit them operationally. In addition I only focused on one segment (Dry Bulk) and one ship class (Panamax), which may not be very representative for a whole industry, which is known for its variation. Therefore I suggest for future undertakings to run regression analysis for multiple segments and ship types for composite indices at first and possibly next, a selection of specific routes to refine the statistical picture and become individually relevant. During the selection of routes and indices focus is to be laid on areas that are either very specialized or suffer from a lack in liquidity in the paper trade, with regard to testing the effectiveness of cross hedging possibilities (e.g. illiquid Handysize futures substituted by FFAs from bigger Supramax market) or towards FFA effectiveness on relevant North-South routes (e.g.Eur – Africa).

Bibliography

Albertijn, S., & al, e. (2011). Financing Shipping Companies and Shipping Operations: A Risk-Management Perspective. (M. Stanley, Ed.) *Journal of Applied Corporate Finance , Volume 24* (Issue 4), p. pp.70.

Alizadeh, A. H. (2012). Trading volume and volatility in the shipping forward freight market. (Elsevier, Ed.) *Transportation Research , Part E* (49), pp. 250-265.

Alizadeh, A. H., & Nomikos, N. K. (2009). *Shipping Derivatives and Risk Management.* Basingstoke: Palgrave Macmillan.

Bockmann. (2012). *Bloomberg.com.* Retrieved August 2013, from http://www.bloomberg.com/news/2012-09-20/freight-futures-trading-seen-plunging-53-after-shipping-rout.html

Bunea-Bonta, C. A., Petre, M. C., & Culi, G. (2009, October 11). *http://mpra.ub.uni-muenchen.de - Munich Personal RePEc Archive.* Retrieved September 2013, from Issues on Hedge Effectiveness Testing: http://mpra.ub.uni-muenchen.de/18131/1/MPRA_paper_18131.pdf

Dinwoodie, J., & Morris, J. (2003). Tanker forward freight agreements:the future for freight futures? (T. a. Francis, Ed.) *Maritime Policy & Management , 1* (30), pp. 45-58.

Dunn, D. (date unknown). *SSYonline.com.* Retrieved September 2013, from http://www.ssyonline.com/dyn/_assets/_pdfs/futures/FFA.pdf

Haralambides, H. (1993). *Freight Futures Trading and Shipowners' Expectations.* Malmö, Sweden.

Inc., W. P. (Ed.). (1999). The forward pricing function of the shipping freight futures market. *The Journal of Futures Markets , 3* (19), 353.

Investopedia. (Date of making unknown). *Investopedia.com.* Retrieved August 2013, from http://www.investopedia.com/terms/c/crosshedge.asp

Kavussanos, M. G. (2010). Business Risk Measurement and Management in the Cargo Carrying Sector of the Shipping Industry - An Update. In C. T. Grammenos, *The Handbook of Maritime Economics and Business* (pp. 709-739). London: Lloyd's List.

Kavussanos, M. G., & Nomikos, N. K. (2003). Price Discovery, Causality and Forecasting in the Freight Future Market. (K. A. Publishers, Ed.) *Review of Derivatives Research* , pp. 203-230.

Kavussanos, M. G., & Visvikis, I. D. (2002). *Market Interactions and Volatilities between Spot and Forward Shipping Markets.*

Nomikos, N. (date unknown). *bbk.ac.uk.* Retrieved September 2013, from Managing Shipping Risk in the Global Supply Chain–The Case for Freight Options: http://www.bbk.ac.uk/cfc/papers/nomikos.pdf

Nomikos, N. K., & Alizadeh, A. H. (2010). Managing Freight Rate Risk Using Freight Derivatives: An Overview of Empirical Evidence. In C. T. Grammenos, *The Handbook of Maritime Economics and Business* (pp. 745-772). London: Lloyd's List.

Skjetne, R. A. (2005). *Applied Financial Risk Management for the Shipping Industry Using IMAREX Derivatives.* Bergen: NORWEGIAN SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION.

Stulz, R. M. (2005). *fisher.osu.edu.* Retrieved September 2013, from http://fisher.osu.edu/fin/faculty/stulz/publishedpapers/milkeninstitute_pubpaper.pdf

Thoung, L. T., & Visscher, S. L. (1990). The Hedging Effectiveness of Dry-Bulk Freight Rate Futures. *Transportation Journal* .

unknown, a. (date unknown). *econ.iastate.edu.* Retrieved September 2013, from http://www2.econ.iastate.edu/classes/econ353/asinski/Financial%20Derivatives.pdf

I. Appendix

Data Sets and outcomes. Please note: Annova presented results in German; the second position under Regressions-Statistik presents the coefficient of determination R^2. The time series hold three different Panamax (Bulk) spot prices ($US/day) and the Baltic Panamax Index development (points) over a period of 10 years from January 2003 until December 2012. Rates were obtained through the Clarksons Database.

a) Data

Month	TA Spot	TP Spot	Far East/Eur Spot	BPI
2003-01	11450	13450	12500	1731
2003-02	12625	12412	11038	1657
2003-03	14688	11850	10250	1763
2003-04	16562	14488	12125	2044
2003-05	17650	16630	12900	2218
2003-06	15062	16462	13862	2053
2003-07	17125	17625	15375	2222
2003-08	16800	15940	13490	2130
2003-09	17500	17125	15375	2273
2003-10	29200	40400	37600	4100
2003-11	27000	36875	36375	4053
2003-12	34125	39875	39000	4461
2004-01	40700	40700	40300	4988
2004-02	42875	41375	39250	5265
2004-03	42250	41375	38000	5285
2004-04	37600	33200	29200	4652
2004-05	28125	24250	21250	3543
2004-06	20562	18312	15938	2672
2004-07	29700	28950	25600	3641
2004-08	32500	29625	28000	3863
2004-09	32250	31125	29125	3953
2004-10	35800	35800	32700	4425
2004-11	42000	42438	39375	5144
2004-12	40600	41400	39100	5285
2005-01	37500	33000	30875	4361
2005-02	37375	34500	32500	4394
2005-03	42000	37000	35200	4774
2005-04	38900	27500	24660	4162
2005-05	30000	19875	17250	3270
2005-06	25750	16688	14125	2767
2005-07	16150	11100	8990	1927
2005-08	14750	14375	12250	2001
2005-09	21000	17100	14900	2483

2005-10	23125	17750	15562	2729
2005-11	20125	15250	12688	2414
2005-12	16500	18550	14750	2373
2006-01	14375	16600	14812	2154
2006-02	14250	17625	15938	2179
2006-03	16850	19870	18400	2419
2006-04	16625	16500	15625	2223
2006-05	17375	16912	16125	2283
2006-06	20650	21200	19800	2678
2006-07	22062	22688	21750	2912
2006-08	28375	26812	25188	3393
2006-09	30200	34000	32400	3946
2006-10	26000	33875	33750	3811
2006-11	27250	37562	38375	4089
2006-12	32700	36100	36500	4272
2007-01	34500	33875	34062	4286
2007-02	35375	31500	31125	4245
2007-03	42450	37600	34800	4989
2007-04	44750	42375	38250	5390
2007-05	52375	44625	40875	6016
2007-06	50800	42500	39200	5787
2007-07	63625	55250	48750	7101
2007-08	62900	53700	48800	7167
2007-09	71097	74267	68742	8830
2007-10	82316	89943	86821	10631
2007-11	84819	85934	85353	10616

2007-12	80368	67300	64354	9395
2008-01	63500	46375	41500	6954
2008-02	65200	46600	39100	6743
2008-03	68750	64500	51750	8149
2008-04	74750	60000	48500	8330
2008-05	95200	68700	54500	10144
2008-06	74125	75000	60500	9324
2008-07	79375	61000	51750	8715
2008-08	62200	40900	34100	6470
2008-09	38000	36500	32000	4943
2008-10	10400	9600	9000	1417
2008-11	5375	5875	4500	835
2008-12	4000	3125	2375	515
2009-01	5100	2450	1450	551
2009-02	12875	7900	4812	1332
2009-03	17000	11562	7125	1824
2009-04	10812	9938	5500	1407
2009-05	23020	14950	8120	2293
2009-06	29000	22625	11375	3015
2009-07	32500	20900	11450	3194
2009-08	20250	16750	10750	2435
2009-09	22500	16500	8938	2459
2009-10	24500	20580	10250	2770
2009-11	35000	32625	16750	3899
2009-12	32625	26562	16625	3660
2010-01	32500	26500	17250	3823

2010-02	25750	23438	15688	3155
2010-03	36812	31125	19250	4024
2010-04	31850	29900	19650	3885
2010-05	39812	32000	20250	4305
2010-06	29750	23250	15750	3342
2010-07	17150	17600	11900	2242
2010-08	24625	21125	12762	2857
2010-09	25750	23750	13875	2994
2010-10	18000	18700	11760	2333
2010-11	17625	18325	11688	2270
2010-12	21650	11770	7030	2194
2011-01	16312	8812	3938	1732
2011-02	14625	12062	4625	1672
2011-03	16750	16438	6562	2048
2011-04	12700	11750	5150	1598
2011-05	14875	13375	6500	1733
2011-06	16688	13125	5812	1828
2011-07	15300	8950	4450	1585
2011-08	14188	9375	4025	1558
2011-09	14000	12450	4500	1682
2011-10	17250	14062	4312	1968
2011-11	16562	12000	3600	1806
2011-12	15200	11230	2750	1721
2012-01	9438	7275	62	1183
2012-02	5375	7188	-1375	862
2012-03	5800	8400	400	954

2012-04	11000	10125	1606	1325
2012-05	12688	9062	1438	1287
2012-06	8450	6200	-800	997
2012-07	9438	8050	-625	1115
2012-08	6100	6100	-1370	832
2012-09	2062	3500	-2438	526
2012-10	5125	6188	-2062	756
2012-11	6200	7200	-1220	864
2012-12	8125	5012	-1625	858

b) Outcomes

1. Trans-Atlantic Spot vs Baltic Panamax 4TC

OUTPUT SUMMARY

Regression-Statistic	
Multiple R	0.98968698
R squared	**0.97948032**
Adjusted R squared	0.97930643
Standard Error	2861.01981
Observations	**120**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**1.00**	46105095830.21	46105095830.21	5632.58	0.00
Residual	118.00	965881251.71	8185434.34		
Total	119.00	47070977081.92			

2. Trans-Pacific vs. Baltic Panamax 4TC

SUMMARY OUTPUT

Regression Statistics	
Multipler R	0.99
R square	**0.97**
Adjusted R Square	0.97
Standard Error	2884.06
Observations	**120.00**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**1.00**	37849485997.12	37849485997.12	4550.42	0.00
Residual	118.00	981500500.35	8317800.85		
Total	119.00	38830986497.47			

3. Far East-to-European Continent Spot vs Baltic Panamax 4TC

OUTPUT SUMMARY

Regressions-Statistik	
Multiple R	0.95957292
R squared	**0.9207802**
Adjusted R squared	0.92010884
Standard Error	5147.94212
Observations	**120**

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	**1.00**	36347248114.19	36347248114.19	1371.53	0.00
Residual	118.00	3127154347.13	26501308.03		
Total	119.00	39474402461.33			