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Is the Baltic Capesize Index a good proxy for actual Capesize earnings?
– A simulation approach

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Abstract

The purpose of this dissertation is to investigate if the Baltic Capesize Index is a good proxy for actual Capesize earnings and why they deviate. The results may implicate if forward freight agreements are suitable for revenue management in practice. This because forward freight agreements are bought and held through maturity, and by definition, forward prices will converge to spot prices as they reach maturity. What matters is therefore the difference between spot index and actual earnings.

The dissertation is based on a simulation approach where both single linear regression and the dollar-offset method are used to evaluate how good proxy the Baltic Capesize Index is. Our findings indicate that actual earnings are most affected by the basis risks geography and timing, and the "lag" before changed market conditions are reflected in actual earnings. Linear regression and the dollar-offset method are ambiguous whether the Baltic Capesize Index is a good proxy for actual Capesize earnings. To conclude whether the Baltic Capesize Index is a good proxy it is therefore necessary to conduct more research on which methods that are appropriate within shipping.

Acknowledgments

We would like to thank our advisor Roar Os Ådland for all his help and feedback through this dissertation. The dissertation is based on ideas presented to us by our advisor. We are grateful that he shared his unique insight and knowledge about the shipping market with us. We would also like to thank Klaveness Chartering for sharing important data regarding port congestion.

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1. Introduction

1.1 Motivation

Shipping goods at sea has for decades been an important source for the trade flow in the world. Today the shipping market handles about 90% of world trade, making it vital to the functioning of the global economy (UNCTAD, 2012). The industry is commonly known to be cyclical and highly volatile, and its risky profile has turned many shipowners bankrupt, but also into millionaires.

In the period from 2003 and up to the mid-2008, dry bulk freight rates reached levels that could not have been predicted in advance. Freight rates were up nearly 500% followed by a sharp collapse in the last quarter of 2008. In total, freight rates dropped nearly 95% (Alizadeh & Nomikos, 2009). There were several factors contributing to the high market volatility, which seems to have changed the way the industry view and manage its risks. This change has resulted in an environment where the participants are more aware of the risk they face and try their best to explore different strategies to manage and reduce risk. Freight derivatives are mainly found within bulk shipping, and can provide real gains for market participants. This, as their existence has made risk management cheaper, more flexible and readily available to parties exposed to movements in freight rates (Kavussanos & Visvikis, 2008).

From a shipowner's perspective, the usage of derivatives have increased, both traded over-the-counter and on exchange. Example of such an exchange is the International Maritime Exchange (IMAREX). Earlier studies, such as Kavussanos & Visvikis (2000a, 2000b, 2000c), have examined optimal hedge ratios and hedge effectiveness for short-term voyage based forward freight agreements within bulk shipping. These studies are based on standard financial theory and indicated a poor hedging performance. The poor performances were mainly due to lack of a cost-of-carry relationship between forward freight agreements and spot prices. Freight is by definition a non-storable commodity, and forward prices are therefore driven by market expectations rather than a cost-of-carry relationship. In the Capesize segment, the most liquid contracts are currently found on time charter average based contracts, with a longer hedging horizon (The Baltic

Exchange, 2012). This implies that short-term hedging on voyage based contracts is not common in practice, making studies such as Kavussanos and Visvikis less relevant.

In practice, forward freight agreements are bought and held through maturity, and forward prices will per definition converge to spot prices as they reach maturity. The difference between spot index and actual earnings may therefore implicate if forward freight agreements are suitable for revenue management in practice. As far as we know, no one has examined if the spot index is a good proxy for actual earnings in the Capesize segment. This dissertation will therefore investigate if the Baltic Capesize index is a good proxy, which may imply if forward freight agreements are a suitable instrument for revenue management in practice.

1.2 Objective

The purpose of this dissertation is to investigate if the Baltic Capesize Index is a good proxy for actual Capesize earnings and why they deviate. The results may implicate if forward freight agreements are suitable for revenue management in practice. We will answer this question with a simulation approach, where actual earnings will be reproduced in the period 2003 - 2012. By using financial theory on hedging performance, we can highlight how good of a proxy the Baltic Capesize Index is for actual Capesize earnings. Implementing different physical basis risk factors, one by one, we hope to emphasize their importance and what separate the Baltic Capesize index from being a perfect proxy for Capesize earnings.

1.3 Literature review

As far as we know, no other studies have examined if the spot index is a good proxy for actual earnings in shipping, for any segments within the industry. However, there have been several studies examining the performance of derivatives in different commodities. Results from these studies are not directly transferable to our dissertation, but may still give an impression of the extent of hedging effectiveness to be expected. We will in the following briefly summaries some of these studies, with main focus on studies related to freight.

Hedging performance on financial derivatives is a well-documented area. For instance, Franckle (1980) examined the variance reduction that can be obtained for interest rate futures. Figlewski (1984) and Lindahl (1992) performed a similar study on stock indices, while Mallaris and Urrutia (1991) studied hedging performance on currencies. These studies suggest that it is possible to reduce the variability of spot positions by as much as 98%. Though, relatively limited studies have been conducted on derivatives based on freight. Part of this reason is due to the lack of available information, which is needed to support empirical work in these markets (Kavussanos & Visvikis, 2008).

The little research that have been conducted on freight derivatives, are in contrast to what is seen in the financial market. Kavussanos and Nomikos (2000a) examined hedging performance of BIFFEX's[1] futures contracts on freight in the Panamax and Capesize segment. They applied naïve, conventional and time-varying hedge ratios and reported maximum hedge effectiveness of no more than 18.96% for in-sample studies, and 22.7% for out-of-sample studies. In-sample and out-of-sample studies indicate that hedge ratios estimated from VECM-GARCH-X models outperform alternative specifications in reducing market risk. When BIFFEX altered the composition of the underlying index in order to attempt to improve hedging effectiveness, Kavussanos and Nomikos (2000b) reported maximum hedge effectiveness ranging from 18.46% to 39.95% for the altered contracts.

Skjetne (2005) took a similar approach as Kavussanos and Nomikos (2008), investigated hedging effectiveness of IMAREX futures contracts for some tanker routes and two Capesize routes, C4 and C7. His results suggested hedging effectiveness in the range of 37% to 70%.

Rasmussen and Tversland (2007) examined hedging effectiveness on Panamax futures contracts available at IMAREX. They estimated constant hedge ratio and time-varying hedge ratio for in-sample studies, and reported effectiveness ranging from 29.5% to 34.26%. Their findings supported Kavussanos and Nomikos (2008) that the time-varying hedge ratio outperformed the constant hedge ratio for in-sample studies.

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[1] Baltic International Freight Futures Exchange

Gilleshammer and Hansen (2010) investigated hedge effectiveness on certain Panamax, Capesize and dirty tanker routes. They found that the hedging efficiency in the dry bulk market ranges from 38.5 - 76.1%, and concluded that time-varying-hedge ratio slightly outperforms constant-hedge ratios.

1.4 Structure of our dissertation

In our dissertation we will start with a brief introduction to the shipping industry. We elaborate on historical development in trade flows, the dry bulk segment, important drivers of supply and demand, the freight rate mechanism and risk factors in shipping. Lastly we will introduce the Baltic Exchange, which compile freight rates and relevant indices.

Chapter 3 provides a theoretical foundation of risk management, as well as theory on risk management in shipping. We will also present Ederington's (1979) framework on how to find the optimal hedge ratio along with the hedging effectiveness, and discuss a possible alternative method. In addition, the theory behind basis risk and the relevant basis risk factors in shipping will be discussed.

Chapter 4 gives a description of the model, and which assumptions that have been necessary to estimate actual earnings as realistic as possible. The model is described in such a detail that replication of our result is possible. In Chapter 5 we present and discuss our findings. Next, we will discuss limitations regarding our dissertation and suggest further research. Finally, we summarize the dissertation and conclude.

2. The shipping industry and the dry bulk segment

This section we will give an introduction to the shipping industry and its complexity. We will also introduce the Baltic exchange, the only independent source of maritime market information for trading and settling physical and derivative contracts.

2.1 Historical development

Shipping goods by sea has for many generations been the most efficient way for transporting either raw materials or manufactured goods in large quantities. As trade between countries has increased over the last centuries, so has the seaborne trade. Looking at historical data, the total world seaborne trade in 1950 included about 500 million metric tonnes of cargo, and has since then expanded to 8,748 million metric tonnes in 2011. Today the international shipping industry is responsible for the carriage of about 90% of world trade and is therefore vital to the functioning of the global economy (UNCTAD, 2012). It is the availability, low cost and efficiency of maritime transport that has made possible the major shift towards industrial production in Asia.

Table 2.1: Historical development in trade

Year	1970	1980	1990	2000	2007	2008	2009	2010	2011
Oil and gas	1,440	1,871	1,755	2,163	2,747	2,742	2,642	2,772	2,796
Main bulks	448	608	988	1,295	1,953	2,065	2,085	2,335	2,477
Other dry cargo	717	1,225	1,265	2,526	3,334	3,422	3,131	3,302	3,475
Total	2,605	3,704	4,008	5,984	8,034	8,229	7,858	8,409	8,748

The table shows historical development in trade, given in metric tonnes

Source: (UNCTAD, 2012)

Today, there are four long hauls, standardized by the Baltic Exchange and the corresponding Capesize trip charter routes. Fronthaul trips ships ballast from Europe, pick up cargo in the Atlantic/Mediterranean and sail laden to Asia for discharge. Backhaul trips ships ballast from

Asian discharge ports, pick up cargo in Australia, Indonesia, Indian Ocean or South Africa and sail laden to Northwest Europe. Trans-Pacific trips ships ballast from North Asia, pick up cargo in Australia, Indonesia or west coast Americas, and return laden to North Asia. Trans-Atlantic trips ships ballast from Europe, pick up cargo in the Atlantic basin and return laden to a European discharge port.

Examining seaborne trade patterns for the last ten years it is evident that there has been a tremendous drop in trade volume on both Backhaul and Trans-Atlantic routes. This development is shown in Exhibit 2.1, indicating how the trade volume in the Capesize segment has shifted towards the Pacific basin the last decade.

Exhibit 2.1: Trade development in the Capesize segment
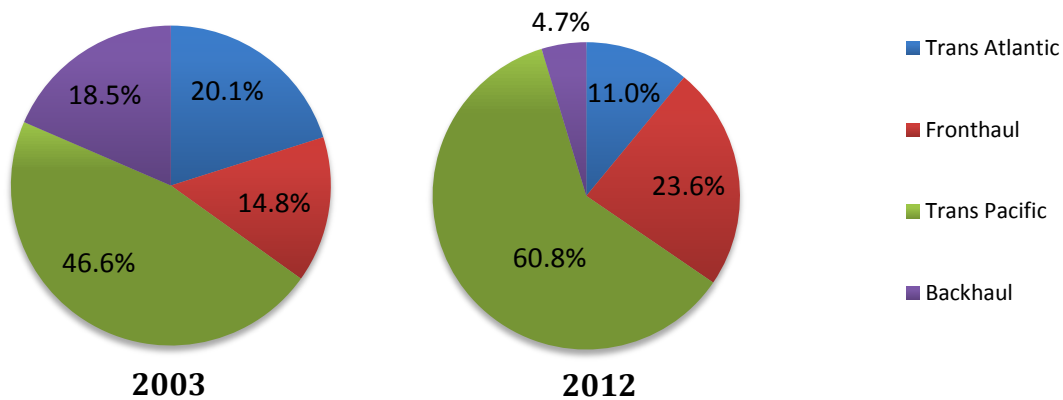
The different panels show trade flows in the Capesize segment in the years 2003 and 2012
Source: Thurlestone shipping

2.1 The dry bulk segment

The bulk shipping segment has traditionally been defined by the principle of "one ship, one cargo". Often, bulk transport has been associated in literature and in practice with the shipping of commodities in unpackaged form, which can easily be handled and transported in bulk. The segment is subdivided according to the physical properties of cargoes, i.e. dry, and wet. The main

dry bulks are iron ore, coal, bauxite/alumina and phosphate, while main wet bulks are oil and liquid natural gas.

Within dry bulk shipping, the market is typically classified into two main segments, major- and minor bulk. Major bulk includes iron ore, coal and grain, typically transported by large Capesize or Panamax vessels. Clarksons fleet register define a Capesize vessel as a dry bulk carrier with a loading capacity above 100,000 dead weight tonnage, from now on referred to as dwt, while a Panamax vessel has a loading capacity between 60,000-100,000 dwt. These two vessel types contribute with about two thirds of the world dry bulk trade. Minor bulk includes fertilizers, steel products, construction materials such as cement and aluminum, non-grain agricultural products, forest products and sundry minerals. These products are typically shipped by smaller vessels, such as Handymax, 40,000-60,000 dwt, and Handysize, 10,000-40,000 dwt (UNCTAD, 2012).

Iron ore, coking coal and steam coal are the three largest commodities within dry bulk trade. Iron ore and coking coal are raw materials used in steel production, while steam coal is an important source of energy. In 2011 the main iron ore exporters were Australia, Brazil, India, South Africa and Canada, having a joint market share of 73%. The largest importers are China, Japan and the Republic of Korea. Figures show that most of the iron ore trade is between Australia and China, as Australia stands for 42% of the total export and China 63% of the total import (UNCTAD, 2012). The largest importers of steam- and coking coal where China, Japan, the Republic of Korea and India and the largest exporters where Indonesia, Australia and Russia (World Coal Association, 2012). According to these figures, most of the transportation is done in the Trans-Pacific basin. This is in line with the trade flow presented in Exhibit 2.1.

2.2 Supply and demand in shipping

Shipping is a very complex industry, and to gain a better understanding of the market drivers we will introduce Stopford's simplified model for supply and demand. This model emphasizes the ten most important factors that affect demand and supply for the seaborne trade. The main source is Stopford (2009) and all other sources will be referred to.

Table 2.2: Ten variables in the shipping market model

Supply		Demand	
1	World fleet	1	The world economy
2	Fleet productivity	2	Seaborne commodity trades
3	Shipbuilding production	3	Average haul
4	Scrapping and losses	4	Random shocks
5	Freight revenue	5	Transport costs

Source: (Stopford, 2009)

2.2.1 Supply

2.2.1.1 World fleet

The demand for vessels is dependent on four different decision-makers; shipowners, charterers, the financial sector and regulators. Shipowners are the primary decision-makers as they are ordering new vessels, scrapping old ones and laying up tonnage when the rates are low. Secondly, charterers can become shipowners themselves or influence shipowners through time charters. Thirdly, the financial players, such as banks, influence shipowners ability to buy new vessels as they lend out money to the investment. Lastly, regulators affect the supply by safety or environmental legislation that affects the transport capacity of the fleet.

2.2.1.2 Fleet productivity

The total fleet is fixed in size, but the fleet productivity is not constrained in the same manner. The fleet productivity is measured in tonne miles per deadweight and is determined by four main factors: speed, port time, deadweight utilization and loaded days at sea. First, speed determines the time a vessel spends on a voyage. Ådland (2013) show that Capesize vessels in the latter years have operated well below their designed speed and thereby reduces the transport capacity of the fleet. Secondly, time spent in ports is an important variable when evaluating productivity. New loading/off-loading technology has dramatically reduced the time spent in ports. Thirdly, deadweight utilization refers to the cargo capacity lost to bunker, stores etc. preventing a ship from carrying a full load. A common assumption is that bulk carriers operate at 95% and tankers

operate at 96% of loading capacity. Vessels may also at some points transport cargo, which is far below its capacity. The final variable for measuring fleet productivity is divided between loaded days at sea and unproductive days. Unproductive days refer to time spent on ballast voyage, port congestion or off hire. A reduction in unproductive days allows for an increase in loaded days at sea.

2.2.1.3 Shipbuilding production

A third component for understanding the supply function is shipbuilding. New building of vessels plays an important role in the adjustments of capacity within the market. Shipbuilding is a long-cycle business and the time between ordering and delivering can vary from 1 to 4 years. This depends on the kind of vessel and the order book held by the shipbuilder. On average a vessel has an estimated lifetime of 15 to 30 years. These time horizons mean that shipowners must place orders on the basis of future demand. Historically, intense ordering of new vessels has resulted in oversupply and eventually huge drop in freight rates. This was last seen in 2008 and, as the rates went downward, many shipping companies had trouble financing their new investments and went bankrupt (Church, Milford, & Kary, 2012)

2.2.1.4 Scrapping and losses

The growth of the merchant fleet depends not only on new buildings, but also on the scrapping rate and vessels lost at sea. There are several factors deciding when it is optimal to scrap a vessel. The main factors are the age of the vessel, technical obsolescence, scrapping prices, current earnings and market expectations. The buyer is usually an intermediary who resells it to demolition yards located in the Far East. Brokers with broad knowledge of the industry handle the transaction. Scrap prices can be very volatile and depend on the availability of vessels for scrap and the demand for scrap metal, as well as the vessels suitability for scrapping.

2.2.1.5 Freight revenue

The final factor influencing the supply of transportation by sea is freight rates. The freight rate is ultimately the regulator for decision-makers for adjusting their capacity in the short run, and to find ways of reducing their costs and improving their services in the long term. In shipping there

are two main pricing markets, these are the freight market and the liner market. In the freight market, such as bulk shipping, it is a wholesale operation where shipowners only sell their service to a small number of industrial customers. In contrast, liner shipping provides shipping services for small quantities of cargo to a wide range of customers. However, due to standardization of containers, the two segments have been brought closer together in economic terms. In both cases, the pricing system is central to the supply of transportation. In the short run, shipowners adjust their operating speed and move in and out of lay-up as rates adjust. In the long run, freight rates play an important role for investment decisions, which may result in scrapping or ordering of new vessels.

2.2.2 Demand

2.2.2.1 The world economy

The most influential factor for shipping demand is the world economy. This is natural as the world generates demand for sea transportation through trade of raw materials or manufactured products. In general, the world economy affects demand by the following two factors; business cycle and the trade development cycle.

The business cycle is considered to be the most important cause of short-term fluctuations in seaborne trade and shipping demand, as fluctuations in the world economy are transferred to the seaborne trade. Historically, there has been a correlation between growth in seaborne trade and world GDP.

Trade development cycle refers to countries' long-term development. Over time, a country will shift its demand from raw materials to services and durables as it matures, which has a direct effect on the structure of seaborne trade.

2.2.2.2 Seaborne commodity trade

Seaborne commodity trade can be divided into either short or long term. The volatility observed in short-term is due to the seasonality of some trades. It is mainly explained by the seasonal variations caused by harvest for agricultural products and energy consumption. Transport volume

of agricultural commodities is in general hard to plan, so charterers of these commodities rely heavily on the spot charter market to meet their tonnage requirements. As a result, fluctuations in the grain market have a larger impact on the charter market than some much larger trades such as iron ore, where tonnage requirement are largely met by long-term contracts (Stopford, 2009).

As for long-term trends, the best way for identifying these is to study the economic characteristics of the industries, which produce and consume traded goods. Even though businesses are different, there are four types of changes to look for. These are changes in demand for the particular commodity, changes in supply sources, changes due to a relocation of a processing plant that changes the trade pattern, and changes in the charterer's transport policy.

2.2.2.3 Average haul

The demand for seaborne transportation is determined by a precise matrix of distance which determines the time it takes for a vessel to complete a voyage. A vessel transporting iron ore from the Middle East to Western Europe via the Cape travels five times as far as a vessel sailing from Ceyhan in Turkey to Marseilles. This distance effect is referred to as average haul of the trade. Stopford (2009) defines average haul as the weight of cargo shipped (in tonne) times the average distance of transport, but it is usually referred to as distance only.

Historically there have been several examples where vessel demand has changed due to changes in average haul. An example of such an incident was the closure of the Suez Canal in 1956 and 1967. The closure increased the average distance from the Arabian Gulf to Europe from about 6,000 miles to 11,000 miles. The impact on haul time can change quickly as stated in the example or it can change slowly over time as the demand for specific routes evolves.

2.2.2.4 Random shocks

As discussed above, sudden political decisions may have large effects of average haul. In addition, there are several other factors that can result in random shocks that upset the stability of the economic system. Examples of such events are wars, extreme weather and new resources. All

of them are different from cyclical events because they are unique and very often have a major impact on the shipping market.

Historically, economic shocks have had the greatest impact on the shipping market. The great depression in the 1930s is a good example, where the Wall Street Crash in 1929 caused trade to decline. Trade also declined in 2009 as a result of the financial crisis in 2008. Capesize freight rates went from a historical high level in 2008 to a 95% decline.

2.2.2.5 Cost of transportation

The final factor influencing the demand for transportation by sea is the cost of transportation. The cost of transportation has always been an important factor when deciding to ship raw materials or processed goods. According to a study done by the EEC[2], the transportation cost in 1980 accounted for 20 percent of the cost of dry bulk cargo delivered to countries within the community (Stopford, 2009). Since then, larger and more fuel efficient vessels have generated a more cost efficient way for transporting goods at sea. Even though the cost of transportation is not as influential to the demand for seaborne trade as the world economy, their long-term effect on trade development should not be underrated.

2.3 Freight rate mechanism

The freight rate mechanism is considered to link supply and demand together. Shipowners and charterers come together and negotiate a freight rate, reflecting the balance of vessels and cargo available in the market. Hence, the shipping market is often used as textbook examples of perfect competitive markets. For instance, if there are many vessels available in the market and the demand for these vessels are low, the rates will go down. Contrary, if the supply of vessels is low, rates goes up. Once freight rates are set, both shipowners and charterers make adjustments so that the supply and demand eventually comes in balance. When studying the freight rate mechanism it is therefore important to consider three different aspects; the supply function, the demand function and the equilibrium price.

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[2] European Economic Community

2.3.1 Supply function

The supply function for one individual vessel is shown in exhibit 2.2. The supply curve is shaped as a J-curve, describing the relationship between freight rates and tonne miles transported per annum.

Exhibit 2.2: Supply function for an individual vessel
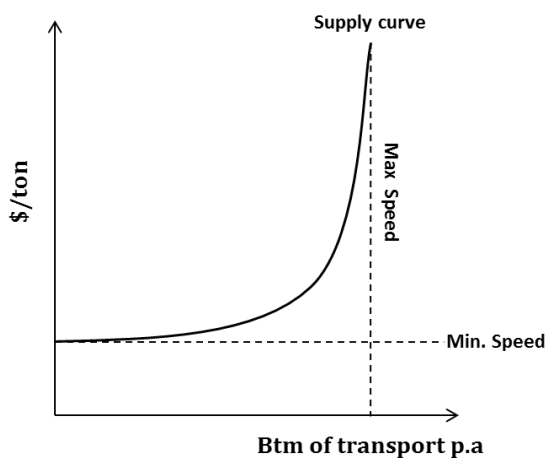
Source: (Stopford, 2009)

The J-formed curve shows that the operating speed will lie between a maximum and minimum speed, depending on the freight rate. As freight rates go up, shipowners will increase the vessels operating speed, and reduce it as rates decline. This change in operating speed will have an immediate effect on the total supply of vessels. Note that if the freight rates get below the minimum speed line, the ship is typically put into lay-up.

The next step is to illustrate how the market adjusts when implementing supply provided by a fleet of vessels. The supply function for a fleet is built up based on the supply curves for each individual vessel, exhibits 2.3. Some of the vessels are older and less efficient than others. This is reflected in the different supply curves where the most efficient vessels are presented by the curves to the left. The supply function for a fleet adjusts vessels in and out of lay-up in response to fright rates. If freight rates fall below the operating costs of a vessel, it goes into lay-up and the supply is reduced by one vessel. The slope of the short-term supply curve is dependent on three

factors determining the lay-up of the marginal vessel. These are the age, transportation cost and the relationship between speed and freight rates. First, older vessels generally have higher operating cost. Second, larger vessels have lower transportation cost per tonne of cargo than smaller vessels. Hence, as rates are low, larger vessels tends to drive smaller vessels into lay-up when they are competing for the same cargo. Third, the relationship between speed and freight rates will be discussed more in depth in section 4.2.4.3.

Exhibit 2.3: Supply function for a fleet
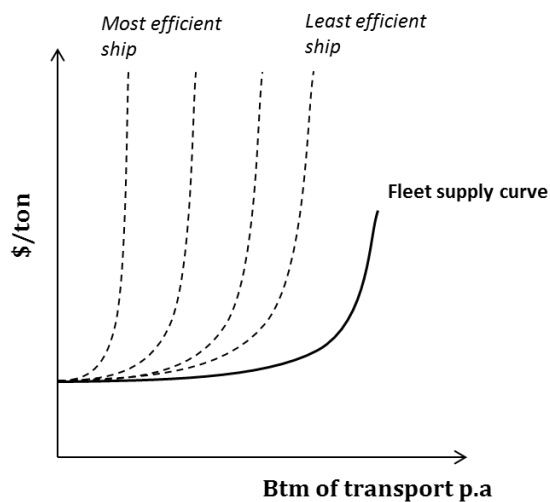
Source: (Stopford, 2009)

2.3.2 Demand function

The demand function shows how the demand changes as the freight rates changes. The curve is almost vertical, seen in exhibit 2.4. This is mainly due to lack of competing transportation options. Charters need to transport their goods, regardless of the price. This is why the curve is to be considered as almost inelastic. A charterer will not take on an extra vessel just because the freight rate goes down. In addition, the freight rate only account for a small portion of material costs.

Exhibit 2.4: Demand function for vessels
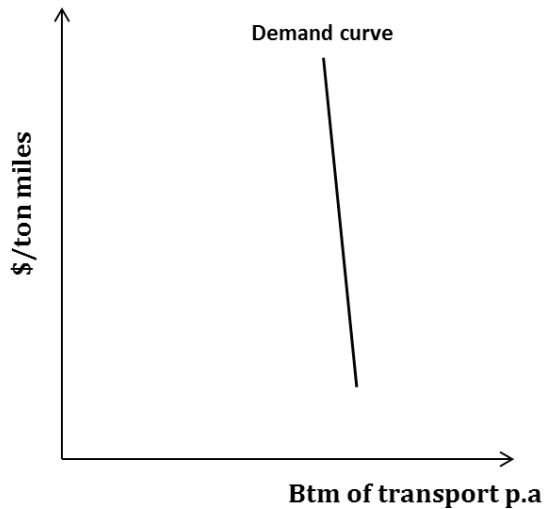
Source: (Stopford, 2009)

2.3.3 The equilibrium

The equilibrium is met when the shipowner and charterer have found a mutually acceptable price. In reality, the price that the seller and buyer agree upon depends on how much time they have to adjust their positions. This means that in general there are three main time variables to consider, momentary equilibrium, the short run-equilibrium and the long run equilibrium.

2.3.3.1 Momentary equilibrium

In the momentary equilibrium there are deals in the market that has to be made right away. Shipowners can either fix on the offered rate, or wait for better times and in the meantime lose money. In such a short time frame, the shipping market is highly fragmented and falls into small regions. Meaning that excess supply in one region cannot be utilized elsewhere. The equilibrium is described in the exhibit 2.5 below. In the first case there are more vessels than demand, showed by the D_1 curve. In this situation, the alternative to fixing is earning nothing. Thus, rates fall down to operating costs. If instead it is excess of cargo, shown by the D_2 curve, the charterer

must bid for vessels. The increased demand will lead to significantly higher freight rates. Note that this can be seen as an auction where sentiment is often the driver in this short-term market.

Exhibit 2.5: Momentary equilibrium
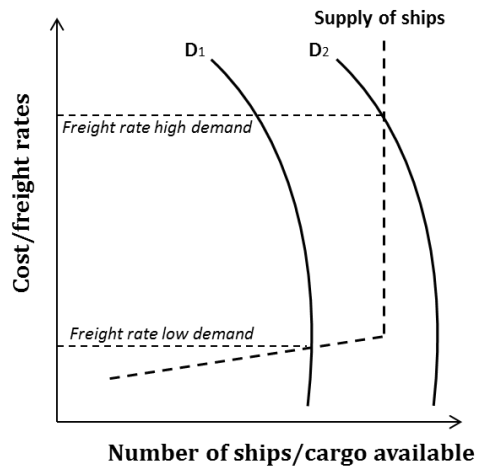
Source: (Stopford, 2009)

2.3.3.2 The short-run equilibrium

The short-run equilibrium differ from the momentary equilibrium as shipowners and charterers have time to adjust supply by short-term measures such as lay-ups, reactivation, combined carriers switching markets or operating speed. The short-run equilibrium is shown in exhibit 2.6.

With low demand, D_1, the freight rate settles at a low point. Here the least efficient vessels are laid up and the fleet is slow steaming. In the short run, a significant increase in demand, moving the demand curve to D_2, may not have a large effect on the freight rates. This is because fleets will be adjusted, as more vessels will be taken out of lay-up and into service. In addition, the operating speed will be increased. A further increase in demand, D_3, will have a large effect on the freight rates, as it is limited how much further the fleet can adjust.

Exhibit 2.6: Short-run equilibrium
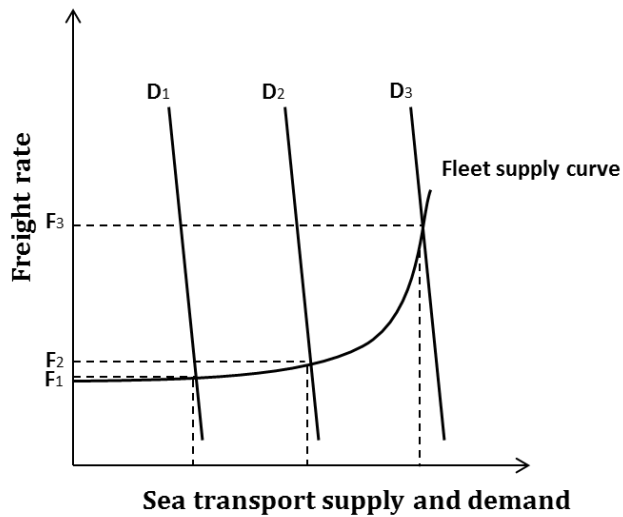
Source: (Stopford, 2009)

2.3.3.3 The long run

In the long run, shipowners have time to deliver new vessels and scrap old ones and charterers have time to rearrange their supply sources. Supply and demand are adjusted through four different markets; the freight market, the new buildings market, the secondhand sales market and the demolition market. It is typical for a shipowner to trade in all of the four markets, which means that the markets are closely correlated. The center of the four markets is the balance sheet to a shipowner, and it is the cash flows that decide the business cycles.

The main source of cash inflow comes from the freight market, through time charter voyage charter and freight derivatives. Shipowners will also have cash inflow from the demolition market if they decide to scrap their vessels. As for the second-hand market, it does not lead to either in or out flow of cash, but is rather a re-allocation of cash. The main source of cash outflow comes from the new building market, as shipyards will use these cash to finance material, labor and profits.

Contrary, rising freight rates increases the cash inflow to the shipowners, and allows them to pay higher prices for second-hand vessels. The price for these vessels will increase up to a given point

where the new building market seems better valued. Due to high freight rates, it seems profitable for them to increase their fleet, and the number of ordered new buildings rises. When these vessels are delivered the total fleet increases. This will subsequently lead to oversupply and falling freight rates. Then, financially weak shipowners will be forced to sell their vessels on the second-hand market to meet their obligations. Secondly, this will also affect older vessels available for sale in the second hand market as these might not get any offers, and has to be sold for scrapping. As more vessels are scrapped, the supply fall, which in turn will lead to increased freight rates. The whole process will then start over again.

2.4 Contracts

In the freight market there exist four main contractual agreements. These are; the voyage charter, the time charter, the contract of affreightment, and the bare boat charter.

In a voyage charter the shipowner provides transport between two ports, and receives a fixed price per tonne. The contract may be for one or more voyages, and the terms will be stated in a charter party[3]. In a voyage charter all costs are paid by the shipowner, here under capital costs, operating costs, port costs, bunkers cost and canal dues.

With a time charter the charterer takes control of the vessel for the time to complete a single voyage (trip charter) or for a period of months or years (time charter). The charterer has complete operational control over the vessel, and pays all voyage expenses, leaving capital and operating costs to the shipowner. Time charter contracts over a longer period are often used as collateral for loans used to purchase the needed vessel.

The contract of affreightment is an agreement to supply cargo on a specific route for a certain number of times at a fixed interval. This allows the shipowner to plan the use of his vessels in the most efficient manner. The contract has the same cost profile as voyage charter

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[3] Charter party; a contract between a shipowner and a merchant, by which a ship is let or hired for transport of goods on a specified voyage, or period.

A bare boat charter is an agreement where the charterer has full control of the ship, without owning the vessel. Under these arrangements the investor is often a financial institution that purchases the vessel and hand it over to the charterer on long contracts, often between 10-20 years. The charterer pays all cost except capital cost.

2.5 Risk in shipping

Shipowners and other parties in the shipping sector are exposed to numerous risk factors. In general, the value of a company depends on its expected net cash flow from operations. Therefore, any factors that might have a negative impact on the cash flow can be identified as a risk. In this section we will highlight the most important risk factors, and how these affect shipping companies. The section will be based on Alizadeh & Nomikos (2009).

2.5.1 Price risk

Price risk refers to possible negative impacts on the cash flow due to changes in input and output prices. Input prices refer to changes in the price that the firm has to pay for labor, raw materials etc. Whereas, output prices refer to level of price that firms can claim for its goods and services.

The most important risk factor for shipping companies is perhaps the risk associated with changes in freight rates. As described earlier, freight rates are very volatile and have a direct impact on profitability. Volatility on the cost side is also affecting the profitability, especially bunker costs as they on average account for more than 50 percent of the total voyage costs. Bunker prices are closely related to world oil prices, which are volatile both in the short and long term.

Other price risks are fluctuations in interest rates, currency risk and asset price risk. The shipping sector is very capital intensive, and most vessels are financed through loans with floating interest rates. Consequently, only small changes in interest rates can have a large impact on a company's profit margin. Also, currency risk might occur if freight income has to be converted into a different currency. Finally, asset price risk refers to fluctuations in the value of vessels. This is

important as it affects the balance sheet and may affect the company's creditworthiness, as vessels are used as collaterals in transactions.

2.5.2 Credit risk

In shipping most agreements are negotiated directly between counterparties. Credit risk is the uncertainty whether the counter-party fulfills his financial obligations as initially agreed. Examples of such agreements are time charter contracts between a shipowner and a charterer, new building agreements between a shipowner and a shipyard, freight derivatives transaction between two investors etc. In each of these cases the parties are exposed to each other's ability to fulfill the contract.

2.5.3 Pure risk

Pure risk can be defined as the reduction in the value of assets, due to physical damage, accidents or losses (Alizadeh & Nomikos, 2009). In shipping pure risk includes factors such as risk of collision, loss of vessels or liability from oil or chemical spillage. In contrast to other risk factors, pure risk has the potential of having a large and sudden impact on the company's value. The frequency and severity of pure risk can be influenced by the company's actions. For example, the probability of oil spill is smaller for a modern vessel, than a hulk from the 1980's.

2.5.4 How to manage risk?

Alizadeh and Nomikos (2009) identify four important reasons for why shipping companies should manage risk, which are bankruptcy costs, capital structure and the cost of capital, benefits for public listed companies and taxes.[4]

In shipping there are various instruments for risk reduction. For instance, reduction in price risk can be done through different derivatives, either shipping specific or financial derivatives. Derivatives are financial instruments, which derive its value from the value of underlying entities, such as an asset or index. Derivatives will be thorough discussed in chapter 3. Credit risk can be

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[4] For in depth information see (Alizadeh & Nomikos, 2009)

managed through collateralization, downgrade triggers, contract design and credit derivatives. Collateralization means that the party exposed to credit risk takes some sort of collateral, for instance a valuable asset or a letter of credit. Downgrade triggers means that a party can close out or change the agreement if it is a downgrade in the counterparty's creditworthiness. Contract design refers to the possibility to design the contract in a way that it incorporates for default and non-performance compensations. Typically, pure risk is managed through insurance contracts.

Christoffersen (2003) showed that companies implementing risk management strategies tend to outperform comparative companies not managing their risk. His study also reveals that in general, larger firms tend to manage risk more actively than smaller firms. This might be due to the fact that smaller firms only have limited access to derivative markets and lack the expertise (Alizadeh & Nomikos, 2009).

2.6 The Baltic Exchange

The Baltic Exchange first opened in 1744, as a coffee house where people met to make arrangements and draw up agreements for the transportation of goods by sea (The Baltic Exchange, 2013). It was not until the early 1980s they realized that risk management techniques applied in commodity and financial markets could be developed and applied for risk management in shipping, and the first daily freight index was published in May 1985 (Alizadeh & Nomikos, 2009). Today, the Baltic Exchange is the only independent source of maritime market information for trading and settling physical and derivative contracts. Hence, the Baltic Exchange plays an important role in the market by reporting the spot prices on each specific route. In addition, the exchange also develops and constructs different indices showing the development within different segments.

The Baltic exchange reports freight rates for all major routes for both the wet and dry bulk market. These rates are calculated on a daily basis, and are reported in the market 1 pm London time. The Baltic Exchange is able to deliver data because of its network of independent brokers, who report the freight on various routes. These freight rates are based on actual fixing in the

market. In the absence of fixing, the shipbroker report what he considers a likely price if the fixing had taken place. The assessments are based on exact route definitions detailed by the Manual for Panellists produced by the Baltic Exchange. The manual includes definitions on variables such as route- and vessel specifications. Table 2.6.1 summarizes the voyage charter routes specified in the manual of panellists for the Capesize segment.

Table 2.3: Voyage charter routes

Name of route	Route	Loading capacity (dwt)	Turn time load/discharge (in hours)	Maximum age (years)
C2	Tubarao/ Rotterdam	160,000	6/6	18
C3	Tubarao/Qingdao	160,000	6/24	18
C4	Richards Bay/Rotterdam	150,000	18/12	15
C5	West Australia/Qingdao	160,000 or 170,000	6/24	18
C7	Bolivar/Rotterdam	150,000	12/12	15

The table shows voyage charter routes specified by the Baltic Exchange in the Manual for Panellists

Source: (The Baltic Exchange, 2012)

Time charter routes are non-standardized routes. The Manual for Panellists only presents a delivery and redelivery range, rather than a specific route. All data presented are based on a vessel referred to as Baltic standard vessel. This vessel has a capacity of 172,000 dwt, fuel consumption of 56 tonne per day at the design speed of 14.5 laden or 15 knots ballast. Based on the design speed, delivery- and redelivery range the Manual for Panellists specify an expected duration for the voyage. This is defined as round voyage duration. The routes are presented in table 2.4.

Table 2.4: Time charter routes

Route	Delivery range	Redelivery range	Dwt	Duration	Speed (laden/ballast)	Fuel con.	Maximum age
C08_03	Gibraltar-Hamburg	Gibraltar-Hamburg	172,000	30-45	14.5/15.0 knots	56 tonne/day	10
C09_03	Amsterdam-Rotterdam-Antwerp	Amsterdam-Rotterdam-Antwerp	172,000	About 65	14.5/15.0 knots	56 tonne/day	10
C10_03	China-Japan	China-Japan	172,000	30-40	14.5/15.0 knots	56 tonne/day	10
C11_03	China-Japan	Amsterdam-Rotterdam-Antwerp range or passing Passero	172,000	About 65	14.5/15.0 knots	56 tonne/day	10

The table shows time charter routes specified by the Baltic Exchange in the Manual for Panellists
Source: (The Baltic Exchange, 2012)

The Baltic exchange also reports data on indices that are based on weighted averages of major routes for each segment. The composition of these routes is occasionally updated, reflecting trends and developments in the freight market. As for the dry bulk trade the Baltic Dry Index, BDI, is widely used as the market indicator. This index is calculated as the equally weighted average of indices on the Capesize, Panamax, Supramax and Handysize segment. In the Capesize segment the Baltic Capesize Index, BCI, are used as a market indicator. This index is an average of the four time charter routes, where the routes are equally weighted.

3. Risk management

In section 2.5 we discussed different risk factors in the shipping industry, and explained how some of them could be managed by derivatives. This chapter will take that discussion one step further and elaborate on derivatives in general and shipping specific. First we will provide a theoretical background on forward contracts and basis risk. Later we will provide two frameworks to measure hedging performance that can be used to evaluate the similarity between the Baltic Capesize Index and actual Capesize earnings.

3.1 Forward contracts

Rising price volatility has led to a number of specialized financial instruments that allow participants to hedge against unexpected price movement. A common way to manage such risk is by using derivative contracts. A derivative is a contract for a transaction whose value depends or derives from the values of other more basic underlying variables. Derivatives specify the terms of a transaction in the future, and examples of derivatives are forwards, futures, swaps and options. This section will give an introduction to forward contracts, and are based on Hull (2012).

A forward contract is an agreement to buy or sell an asset at a certain time in the future, for a certain price. In a forward contract there are two parties that have opposite positions. One party enters a long position, which means that he has agreed to buy the asset for a certain price at a certain time in the future. The counter-party enters a short position, which means that he agrees to sell the asset for a certain price at a certain time in the future. Both parties are obliged to fulfill their obligations. The initial value of a forward contract is equal to zero, and nothing changes hands before maturity. It is usually settled in cash, but it can also be settled physically. Forward contracts are usually traded over-the-counter, which means that they are traded over a network of dealers instead of a centralized exchange. A key advantage of over-the-counter trading is that the contract terms do not have to be those specified by an exchange. Forward contracts can therefore be tailor made.

For descriptive purposes consider the following example. A shipowner has studied historical fuel prices and is convinced that he has found a pattern that implies rising spot prices in the near future. Therefore, he enters a forward contract to reduce his risk. The contract counterparty is a fuel producer, who is, in contrast to the shipowner, afraid of falling spot prices. By entering a forward contract they can both remove their underlying price risk in fuel. The spot price of a metric tonne of fuel today, S_0, is $550. The shipowner enters a long position in the forward contract with a settlement price of $570 per metric tonne at time 1, $F_{0,1}$.

At time 1 the spot price on fuel has raised to $600 per metric tonne, S_1. Because of the forward contract the shipowner is obliged to buy the fuel for $570 per metric tonne. In general the payoff of a long position can be written as

$$Payoff_{Long\ position} = S_t - F_{0,t} \qquad (1)$$

In the example, the shipowner earns a payoff of $30 per metric tonne, as he can bunker his vessel for $570 per tonne instead of the spot price at $600. Similarly, the producer has a negative payoff of $30 per tonne, as he alternatively could have sold his fuel at the spot price of $600 per metric tonne. In general, the payoff from a short position in a forward contract is

$$Payoff_{Short\ position} = F_{0,t} - S_t \qquad (2)$$

Even though the fuel producer had a negative payoff, he was guaranteed that the shipowner would bunker his vessel at time 1 for the agreed forward price. Similarly, the shipowner was guaranteed the price he could bunker his vessel for. This shows that both the shipowner and the fuel producer are perfectly hedged and knew exactly what their cash flow would be at time 1.

3.1.1 Pricing forward contracts

When considering forward contracts it is important to distinguish between consumption assets, investment assets and non-storable assets. A consumption asset is an asset primarily held for consumption, like pork bellies and corn, while an investment asset is primarily held for

investment, like stocks and bonds. Note that some assets may not be held exclusively for investment, for instance both silver and gold can be held for both investment and consumption purposes. A requirement to be regarded as an investment asset is that the asset is held by a large number of investors solely for investment purposes. Non-storable assets are assets that cannot be stored or carried forward in time.

3.1.1.1 Investment assets

In general, the price of a forward contract on investment asset with a known yield is given by the formula

$$F_{0,T} = S_0 e^{(r-\delta)T} \tag{3}$$

Where S_0 is the spot price on the underlying asset, r is the risk free rate, δ is the dividend yield, T is the time to maturity and $F_{0,T}$ is the forward price with maturity at time T. The price of a forward contract is based on a concept known as replication. The idea of replication is that the price of the derivative should be the cost of creating the same outcome synthetically. Table 3.1 shows one out of many ways to replicate a forward contract.

Table 3.1: Replication of a long forward position

	t = 0	t = T
Long Forward	0	$S_T - F_{0,T}$
Buy S_0	$-S_0 e^{-\delta t}$	S_T
Borrow	$S_0 e^{-\delta t}$	$-S_0 e^{(r-\delta)t}$
Cash flow	0	$S_T - S_0 e^{(r-\delta)t}$

Source: Hull (**2012**)

For the replicated portfolio to have an initial value of zero, the investment in the underlying asset is financed through debt. Since there are continuous dividend payments, new shares are constantly purchased. At time T, the underlying asset is sold and the debt is repaid with interests.

The derivative and its replicating portfolio lead to identical outcomes, so under no arbitrage condition they must have the same cost. Hence,

$$S_T - F_{0,T} = S_T - S_0 e^{(r-\delta)t} \iff F_{0,T} = S_0 e^{(r-\delta)t} \qquad (4)$$

If $F_{0,T} > S_0 e^{(r-\delta)T}$, it is an arbitrage opportunity as the forward contract is overvalued. Arbitrageurs can then buy the asset and short forward contracts on the underlying asset. Alternatively $F_{0,T} < S_0 e^{(r-\delta)T}$, the forward contract is undervalued and arbitrageurs can short the asset and enter a long forward contract.

3.1.1.2 Consumption assets

Forward contracts on consumption assets are priced based on the same intuition as investment assets. Though, they are a bit more complicated as they are often subject to storage costs and have a convenience yield. Convenience yield is the benefit associated with holding the underlying asset, rather than the contract or derivative product. Mathematically, the price of these forward contracts can be expressed as

$$F_{0,T} = S_0 e^{(r+u-y)T} \qquad (5)$$

Where u is the storage cost in proportion of the underlying asset, and y is the convenience yield. All other factors are the same as stated above. To see if the equation holds for consumption assets, we must consider the same two arbitrage situations, over- and undervaluation. If the forward contract are overvalued, $F_{0,T} > S_0 e^{(r+u-y)T}$, arbitrageurs can take advantage of the situation by purchasing the asset and short the forward contract. According to basic economic theory, overvaluation will lead to decreased demand for the overvalued asset and increased demand for the undervalued asset. In time, equilibrium will be restored as the price for the undervalued asset increases and the price for the overvalued asset are reduced.

If a forward contract is undervalued, $F_{0,T} < S_0 e^{(r+u-y)T}$, arbitrageurs can sell the asset and take a long position in the forward contract. However, since the asset is primarily held for consumption,

they will be reluctant to do so. Hence, they will not sell the commodity in the spot market and buy forward contracts, as it will be used in production or consumed in any other way. Therefore, it is no reason for why the price of a forward contract for consumption commodities cannot be

$$F_{0,T} \leq S_0 e^{(r+u-y)T} \qquad (6)$$

3.1.1.3 Non-storable assets

Spot and future prices for financial and commodity markets are related through the cost-of-carry relationship. This is a no-arbitrage condition linking the spot and forward prices for commodities that can be stored and carried forward in time. In contrast to consumption assets, Kavussanos (2002) and Kavussanos and Visvikis (2004, 2006) points outs that freight services are non-storable. Another example of a non-storable commodity is electricity. Such commodities are not practical to store or carry forward in time. Therefore, the forward contract and the underlying asset are not linked through a no-arbitrage condition, but rather by market expectations regarding spot prices at maturity. The prices today of a forward contract for delivery at time T equals the spot price that the market agent expects to apply at maturity. Mathematically this relationship can be expressed as

$$\boldsymbol{F_{t,T} = E(S_T|\Omega_t)} \qquad (7)$$

where $E(S_T|\Omega_t)$ is the conditional expectations operator at time t. Ω_t is the information set available to market participants at the same time, conditional on which the expectation is computed. This pricing relationship is referred to as the unbiasedness hypothesis, as it imply that forward prices are unbiased predictors of the realized spot price and, on average, the forecast error from forward contracts will be zero (Alizadeh & Nomikos, 2009). The unbiasedness hypothesis will be explained in depth in section 3.2.2.1.

3.2 Freight derivatives

Within finance, derivatives have been used for risk management for a long time and are now much bigger than the stock market measured in terms of the underlying asset. However, it is only during the last decade derivatives have been used consistently in shipping.

Freight derivatives are hedging instruments that are developed to enable shipowners to hedge their exposure to freight market risk. Traditionally shipowners have managed risk through time chartering, but freight derivatives may prove to be a better alternative for risk management. First of all, it is more efficient as shipowners retain operational control of the ship, and can at the same time benefit from spot market conditions. Secondly, the commissions from trading in freight derivatives are lower compared to chartering agreements. Thirdly, it is easier to trade in and out of freight derivative positions compared to physical positions. Lastly, there is no physical delivery with freight derivatives, as they are settled in cash. Freight derivatives are also useful for other parties that want to have shipping exposure, such as commodity traders, financial institutions, oil companies, or other investors that want a different cycle. (Kavussanos & Visvikis, 2008)

Today there exist mainly two types of freight derivatives, forward freight agreements (FFA) and freight options. This section will only elaborate on forward freight agreements, as freight options are not relevant for this dissertation. For in depth information on other freight derivatives see Kavussanos & Visvikis (2008) or Stopford (2009).

3.2.1 Forward freight agreement

The first freight derivative product was the Baltic International Freight Futures Exchange (BIFFEX) contract, traded in the London International Financial Futures and Option Exchange (LIFFE) from May 1985 until April 2002. The underlying asset was the Baltic Freight Index (BFI). Kavussanos (2002) showed that BIFFEX contracts did not produce effective hedges. In 1992, over-the-counter FFA contracts were introduced and this reduced the trade in the BIFFEX contract. The BIFFEX contract was eventually withdrawn from the trading floor in April 2002.

FFA contracts are currently used in the dry and wet bulk sector of shipping, with major routes or indices serving as the underlying asset. At first there were little to no liquidity in the market, but this has changed heavily over the last decade, both in number of contracts and in value. The market was estimated to be worth $150 billion in 2008, but has according to market estimates fallen to around $8 billion to $12 billion in 2012 (Reuters, 2013). An important driver behind the rapid growth the last decade is the interest from players outside the shipping markets. There has been an influx of new participants such as hedge funds and investment banks, attracted by the market volatility. (Alizadeh & Nomikos, 2009)

FFA is principal-to-principal contracts for difference[5] between a seller and a buyer. The contracts are settled monthly and like other forward contracts they are traded over-the-counter. Currently there are two types of FFA contracts; voyage and time charter based contracts. Voyage charter contracts are based on a certain trading route, and are given on a $/ tonne basis. The settlement price on these contracts is the average of the last seven working days of the month. The time charter contracts are based on the four time charter routes[6] and given on $/day basis. The settlement price on these contracts is the average price over the entire month. The contracts are traded in blocks of months, quarters or years. There is no physical delivery of the underlying asset, but rather a cash settlement. Hence, the parties are betting on the future direction of freight rates. (Kavussanos & Visvikis, 2008)

The following example can illustrate their usage. Consider a shipowner who wants to lock in a rate for his vessel in 2013 in order to protect himself from falling freight rates the following year. Since the shipowner is long in tonnage, he enters a short position in FFA contracts at the beginning of January. Hence, the shipowner keeps control of the vessel and plays the spot market for a year. At the same time he sells a one-year FFA contract based on the four time charter average for Capesize vessels. The charterer is short in tonnage, so he goes long in FFAs in order to fix his freight costs. Both parties offset a risk exposure in the real physical market by an equal

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[5] Contract for difference: Contracts between a seller and a buyer, where the seller pays the difference between the current asset value and the contracted value.

[6] See table 2.4

and opposite, and usually simultaneous, paper transaction in the FFA market. If any monthly settlements are below the agreed price the shipowner will be paid the difference, and vice-versa.

If we for illustrative purposes assume that the FFA price is $10,000 per day and that the average of January 2013 was $8,000. Then, the shipowner is due ($10,000 − $8,000) ∗ 31 $days$ = $62,000. Physical earnings on the spot market will balance these monthly cash flows.

3.2.2 Price discoveries

Compared to other derivatives, there has been relatively little research on freight derivatives compared to the equity market. Most of the research that has been conducted is concentrated on its economic functions, like price discovery and hedging effectiveness. This can be explained by the fact that if derivatives do not perform their basic function, there is no reason to trade in them.

3.2.2.1 The unbiasedness hypothesis

As mentioned before, FFA contracts are non-storable. Thus, the forward prices are driven by expectations of market agents regarding the spot prices that will prevail at the maturity of the contract. Kavussanos and Visvikis (2002, 2004 and 2006) studied the relationship between current forward and expected spot prices. Their research showed that forward prices are unbiased forecasts of the spot price that will be realized at maturity (Kavussanos & Visvikis, 2008). Mathematically, this relationship can be expressed as

$$F_{t,T} = E(S_t) + u_t \quad ; \quad u_t \sim iid(0, \sigma^2) \qquad (8)$$

Where, $F_{t,T}$, is the price for an FFA contract settled at time t with maturity at time T. $E(S_t)$ is the expected value of spot at the settlement date and u_t is an independent and identically stochastic error-term with mean equal to zero and variance σ^2. This price relationship is called the unbiasedness hypothesis.

The concept of the unbiasedness essentially implies that, over a long period of time, the average forecast error from FFAs would be zero. This means that FFA prices will not consistently over-

or under estimate the underlying spot market. However, FFA contracts will not necessarily have the most accurate estimate for forecasting the expected spot price. FFA contracts tend to produce forecasts that, on average across a large number of observations, are not consistently biased. Therefore, the forward curve for FFA contracts contains useful information about the current sentiment and the future direction of the market. (Alizadeh & Nomikos, 2009)

Since information about the future is invaluable, several studies have been made to test the unbiasedness hypothesis. For instance, Kavussanos and Visvikis (2004) tested the hypothesis with a least square regression model, under the assumptions that there is no risk premium and rational use of information. Given these assumptions, a forward contract will then theoretically be equivalent to the spot price at maturity. This relationship can be empirically tested using the following formula

$$S_t = \beta_1 + \beta_2 * F_{t,t-n} + u_t \quad ; \quad u_t \sim iid(0, \sigma^2) \qquad\qquad (9)$$

Kavussanos and Visvikis (2004) argue that unbiasedness depends on the market and the type/length of the contract under investigation. Unbiasedness holds when the following parameter restrictions $\beta_1 = 0$ and $\beta_2 = 1$ are valid. The hypothesis was tested on different Panamax trading routes, and indicated that FFA contracts one and two months prior to maturity are unbiased predictors of the realized spot price. FFA contracts with three months to maturity was unbiased predictors only on certain Panamax routes, hence P2[7] and P2A[8]. For routes where the unbiasedness hypothesis holds, decision makers can use FFA prices as indicators of future spot prices.

Ishizaka et al. (2007) examined how several different factors affecting equilibrium in both spot and future/forward rates in the shipping market, assuming non-storability of freight rates. They took an equilibrium approach for deriving future/forward rates, rather than a cost-of-carry relationship. They constructed a forward curve from wet bulk data and examined the

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[7] P2 is based on a Panamax vessel with loading capacity of 54,000dwt sailing HSS US Gulf/ Japan

[8] P2A is based on a Panamax vessel with a loading capacity of 74,000dwt, with a basis delivery Skaw- Gibraltar range, for a trip to the Far East redelivery Taiwan-Japan range. (The Baltic Exchange, 2012)

unbiasedness hypothesis. By using the futures curves, they examined if there are any differences between the predicted values and the futures prices at maturity when market structure and conditions differ. Note that under the assumption of deterministic interest rates, future and forward prices are equal. At maturity, observed futures curve and risk-premium curve indicated biasedness in all market conditions. Starting at a low demand state, the slopes of the future curve are downwards and the risk-premium curves tend to be upward sloping. Contrary, as demand is starting at a high point, the future curve tends to be upwards sloping and the risk-premium tends to be decreasing. Their results suggest that in a period of high demand, market participants believe that the present period is more important than the future period. This is why negative risk-premiums might exist for the future[9]. In general, in a period with low demand, each participant values the future higher compared to the present period, and vice-versa.

Goulas and Skiadopolous (2011) performed a similar analysis as Kavussanos and Visvikis (2004) on various major freight indices. Their analysis concluded that there exists positive risk premium in the freight futures market. This implies that the unbiasedness hypothesis does not hold for IMAREX and questions the price discovery role of freight future prices (Goulas & Skiadopoulos, 2011).

3.2.2.2 Lead-lag relationship

The lead-lag relationship describes the relationship of return and volatility between FFA contracts and the spot freight market. Kavussanos and Visvikis (2008) proved that FFA contracts are leading the underlying spot market. This might be due to the fact that FFA trades are cash-settled. Therefore, the transaction cost for FFA contracts is lower than the underlying spot market. In addition, investors might have several different FFA contracts on one or more of the trading routes for different time intervals, providing ease of shorting. On the contrary, spot fixtures require greater initial costs and take longer time to complete. This is why market agents react faster to new information through the FFA market, compared to the spot market. One can therefore observe that spot prices will lag behind FFA prices. (Kavussanos & Visvikis, 2008)

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[9] Conversely, in a period of low demand, market participants believe that the future period is more important than the present period. This is why positive risk-premiums might exist for the future

3.3 Basis risk

Basis in a hedging situation can be described as the difference between the spot price and the derivative contract that is being used. If the asset to be hedged and the asset underlying the derivative contract are the same, the basis has a tendency to converge to zero at maturity. Though, as maturity approaches they might have different price changes depending on the correlation between them. If for instance the spot price and derivative price always changes by the same amount, they are perfectly correlated and the basis will not change. (Hull, 2012)

$$Basis = Spot\ price - Price\ of\ derivative\ contract\ used \qquad (\,10\,)$$

In practice, the basis is seldom equal to zero, and the correlation is different from 1. For instance, the asset to be hedged may not be exactly the same as the asset underlying the forward contract, or the hedger may be uncertain as to when the asset will be bought or sold in the future. There might also be a requirement to close the derivative position prior to delivery. In these cases, the basis will differ from zero. When the basis differs from zero, it is referred to as basis risk. There are several factors that might increase the basis risk, for instance storage costs, interest costs and transportation costs. Note that basis risk can lead to an improvement or worsening of a hedger's position. As an example, consider a short hedge. If the basis increases unexpectedly, the hedger's position improves. Contrary, if the basis decreases unexpectedly, the hedger's position worsens. For a long hedge, the reverse holds. (Hull, 2012)

Mathematically basis risk can be expressed as

$$\sigma^2(\Delta B_t) = \sigma^2\big(\Delta S_t - \Delta F_{t,T}\big) = \sigma^2(\Delta S_t) + \sigma^2\big(\Delta F_{t,T}\big) - 2\rho_{S,F}\sigma(\Delta S_t)\sigma\big(\Delta F_{t,T}\big) \qquad (\,11\,)$$

Equation 11 shows that the basis risk between spot and a forward contract is determined by the standard deviation of changes in spot-, ΔS_t, and future, $\Delta F_{t,T}$, price and the correlation between them, $\rho_{S,F}$. This is consistent with Kavussanos and Visvikis (2006b), claiming that basis risk is mainly determined by the correlation coefficient. In practice this means that if the basis risk is high, the correlation coefficient is low.

3.3.1. Contango and backwardation

Depending on the sign of the basis, the market is either categorized as in contango or backwardation. For instance, if the basis is negative, the spot forward price is higher than the spot price, and we say that the market is in contango. Conversely, if the basis is positive then the contract is in backwardation. These terms are also used to describe the entire shape of the forward curve. When the forward curve is falling, forward prices decrease as time to maturity increases, it is said to be in backwardation. Contrary, a rising forward curve is said to be in contango. In exhibit 3.1, both situations are presented, assuming that the spot price remains constant. This assumption will not hold in practice, as both S and F will fluctuate as we approach maturity.

Exhibit 3.1: Forward price in contango and backwardation
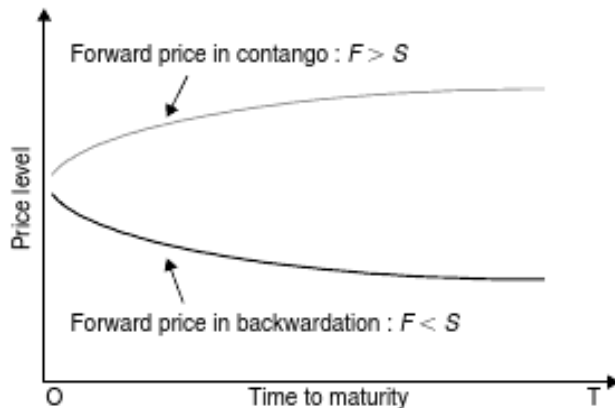
Source: (Alizadeh & Nomikos, 2009)

3.4 Basis risk in shipping

In general, basis risk is a result of hedging with imperfect substitutes. This is also the case for the shipping industry, and any difference between actual earnings and BCI may be explained by basis risks. In this section we will elaborate on the most important sources of physical basis risk in shipping.

3.4.1 Technical specifications

The basis risk technical specifications are due to technical difference between an actual vessel and the vessel that FFA contracts are based on, the Baltic standard vessel. The Baltic standard vessel is used as a reference when the Baltic exchange comprises rates on the four time charter routes. In reality, the Capesize fleet today consists of numerous of vessels, each with different specifications. Consequently, a Capesize vessel might differ strongly from these standard specifications. Especially important are the cargo size, design speed and fuel consumption, as these affect actual earnings.

The vessel segmentation in the dry bulk sector is rather wide and, as earlier mentioned, a vessel is categorized as a Capesize if it has a deadweight tonnage above 100,000. A physical vessel might therefore transport significantly more or less cargo than a standard vessel, which yields complete different earnings potential. Vessels might also have different fuel consumption and design speed than the standard vessel. For example, newer vessels tend to be far more fuel-efficient than older counterparts, and have therefore lower bunker costs. Difference in design speed may influence the time spent on a voyage. Note that design speed often differs from the actual operating speed (Ådland, 2013). Shipowners tend to sail at a much lower speed than the design speed (slow steaming), in order to obtain lower fuel consumption. More on this subject will be described in section 4.2.4.3. When these specifications deviate they are all a source of basis risk.

3.4.2 Geography

For the hedger it is best to select an FFA route that has strong correlation with the physical exposure. The optimal choice of contract would be an FFA contract based on the exact same route as the underlying. Though, contracts are seldom to be found on one specific route due to poor liquidity. As mentioned, the shipowner might be forced to hedge with FFA contracts based on the four time charter average. Such contracts are based on spot rates from both the Atlantic and Pacific basin. In addition, it is not common to hedge certain voyages, but rather on a year-to-year basis. Thus, there might be large deviations between the hedged voyage and the routes underlying the FFA contract.

As an example, consider a vessel operating in the Pacific basin. The vessel transports iron ore between China and Western Australia, obtaining regional freight rates. The shipowner hedges his vessel with a FFA contract based on the four time charter average. Consequently, the shipowner hedges earnings from the Pacific basin with a contract that is partially based on rates from other geographical regions. The inability to hedge with a tailor-made FFA contract for the same geographical area leads to a hedge with an imperfect substitute, and are hence a source of basis risk.

A possibility to reduce the basis risk is to hedge with FFA contracts based on voyage charter routes, hence C2, C3 etc. The liquidity on these FFA contracts is poor, but considered to be better than for FFA contracts based on a specific time charter route. This means that a shipowner can hedge his ship with FFA contracts that are based on the same geographical area. This will naturally reduce the amount of basis risk due to geography. A problem here is that you reduce one source of basis risk, by adding another. The added basis risk is a result of the cost difference in a voyage charter and a time charter contract. Time charter contracts are exposed to bunkers prices, and the price risk is on the charterers' hand. In a voyage charter contract the shipowner will only hedge the dollar per day rate, leaving the bunker price risk unhedged. Note, that this added risk from bunkers price fluctuations could be hedged by other derivatives.

3.4.4 Duration

Duration refers to the risk of using different time on a voyage than expected. As previously mentioned, BCI is based on the four time charter routes. These routes have standard voyage length stated in the Manual for Panellists made by the Baltic Exchange, seen in table 2.4. Each time duration of a voyage is different compared to this standard, there will be a mismatch between the underlying FFA market and the physical exposure. This mismatch is a source of basis risk. There are several factors that influence duration of a voyage. First of all vessels tend to operate under different speeds than the stated Baltic standard speed at 14.5 knots laden and 15 knots ballast. Even if the speed is similar to Baltic standard, harsh weather and unforeseen accidents can influence duration. Secondly, duration is also affected by port congestion. Port congestion is basically a queue waiting for loading or discharging. Exhibit 3.2 shows port

congestion for port Dampier in Australia from mid-2004 to 2012. Factors influencing voyage duration will be discussed in section 4.2.4.

Exhibit 3.2: Port congestion for Port Dampier in Australia
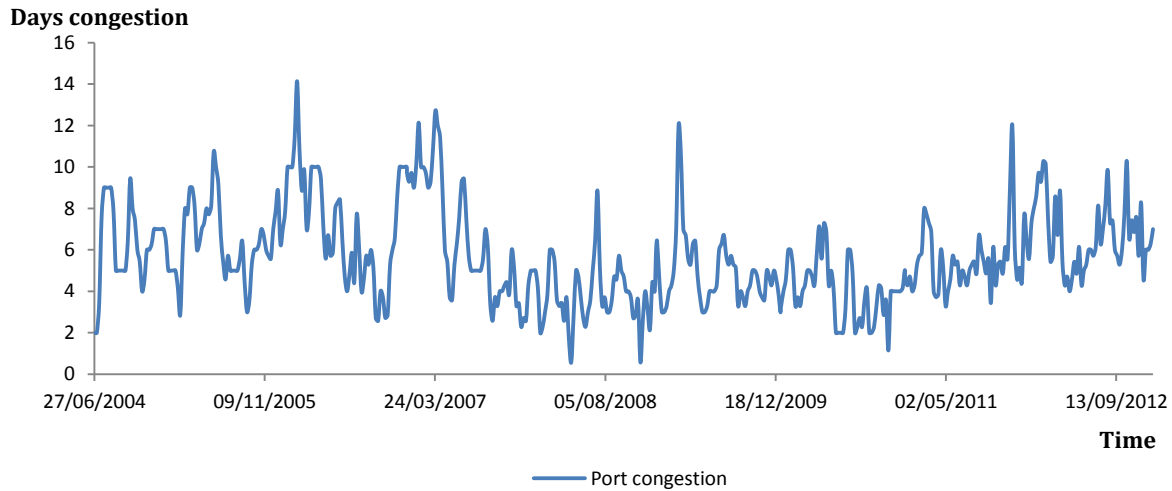
Days congestion

The exhibit shows port congestion for Port Dampier in Australia for the period 6/27/2004 to 12/31/2012
Source: Klaveness Chartering

3.4.5 Unemployment

In practice a shipowner typically does not hedge each voyage, but has a longer time horizon on hedging positions. An example is that a shipowner hedges his vessel with a three-year position in a FFA contract. Because of unemployment or lay-up, the shipowner might not have income from his vessel the entire period. Each period the vessel does not have an income, the shipowner hedges a non-existing cash flow. This difference is a source of basis risk. Lay-up refers to the decision of temporary cessation of trading of a vessel. In the Capesize segment lay-up is almost non-existent currently, as vessels remain in the market even if spot decrease below operating costs. Unemployment is more common, as vessels tend to lie idle and wait for orders in poor markets. Unemployment is a relevant basis risk, but not in the scope of this dissertation.

3.4.6 Timing

Timing refers to the mismatch between paper and physical contracts. Paper contracts are settled at the end of each month as an arithmetic average of spot rates within the month, while physical contracts can be concluded any time in that period. This means that the settlement rate, arithmetic average over the month, will be different from the spot rate that the vessel is fixed. Depending on the volatility of the underlying market this mismatch can have an important effect on the performance of the hedge. (Alizadeh & Nomikos, 2009)

This basis risk can be removed by using index-linked physical contracts, where the freight rate is updated daily according to the prevailing Baltic index. This way, the physical contract and the FFA are priced similarly. Some operators in the dry market apply this method. (Alizadeh & Nomikos, 2009)

3.5 Optimal hedge ratio and hedging effectiveness

To evaluate if the Baltic Capesize Index is a good proxy for actual Capesize earnings we will examine its hedging performance. The ultimately objective of a hedge is to minimize the risk. A traditional naïve or one-to-one hedge assumes that the underlying and the derivative move closely together, however it fails to recognize imperfect correlation between spot index and actual earnings. In the following section, we will introduce two methods for calculating the optimal hedge ratio and its hedging effectiveness.

3.5.1 Minimum variance framework

Ederington (1979) developed a minimum variance framework that took imperfect correlations between the underlying and derivative into account, showing that it was possible to offset potential risk associated to a given spot position using future contracts. With Ederington's framework it is possible to calculate the minimum variance hedge ratio and its hedging effectiveness. This ratio depends on the relationship between changes in the spot- and future prices. The price of a future contract is equal to price of a forward contract, under an assumption of deterministic interest rates. The following will describe how the formula is derived.

S_t denotes the value of the hedged item, h is the hedge ratio and F_t denotes the value of the future contract at time t. Then the combined value of the portfolio, P_t, at time t is

$$P_t = S_t - hF_{t,T} \qquad (12)$$

The change in value for this position from time t-1 to t is defined as

$$\Delta P_t = \Delta S_t - h\Delta F_{t,T} \qquad (13)$$

where $\Delta P_t = P_t - P_{t-1}$, $\Delta S_t = S_t - S_{t-1}$ and $\Delta F_t = F_{t,T} - F_{t-1,T}$. By converting equation 13, the variance of the hedged portfolio can be described as

$$\sigma^2_{\Delta P} = \sigma^2_{\Delta S} + h^2\sigma^2_{\Delta F} - 2h\sigma_{\Delta S,\Delta F}$$
$$= \sigma^2_{\Delta S} + h^2\sigma^2_{\Delta F} - 2h\rho_{\Delta S,\Delta F}\sigma_{\Delta S}\sigma_{\Delta F} \qquad (14)$$

Then by minimizing the variance by taking the first order derivative of $\sigma^2_{\Delta P}$ with respect to h, the result can be expressed as

$$\frac{\partial \sigma^2_{\Delta P}}{\partial h} = 2h\sigma^2_{\Delta F} - 2\rho_{\Delta S,\Delta F}\sigma_{\Delta S}\sigma_{\Delta F} = 0 \qquad (15)$$

The minimum variance hedge ratio can be expressed as the ratio of the covariance between spot and future price changes over the unconditional variance of future price changes

$$h^* = \frac{\sigma_{\Delta S,\Delta F}}{\sigma^2_{\Delta F}} = \rho_{\Delta S,\Delta F}\frac{\sigma_{\Delta S}}{\sigma_{\Delta F}} \qquad (16)$$

3.5.1.1 Hedge effectiveness

Ederington (1979) showed that while traditional theory suggested that the best hedge ratio was based on a naïve one-to-one hedge ratio, this is not always correct. In addition, portfolio theory provided a measurement of hedging effectiveness. The hedge effectiveness is a measurement of

the portion of the variance that is eliminated by hedging. Mathematically, this can be expressed as

$$e = 1 - \frac{\sigma_{\Delta P}^2}{\sigma_{\Delta S}^2} \qquad (17)$$

where hedging effectiveness is denoted as e. Inserting equation 14 into the formula, the effectiveness can be expressed as

$$e = 1 - \frac{\sigma_{\Delta S}^2 + h^2 \sigma_{\Delta F}^2 - 2h\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta S}^2} = \frac{\sigma_{\Delta S}^2 - \sigma_{\Delta S}^2 - h^2 \sigma_{\Delta F}^2 + 2h\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta S}^2} = \frac{-h^2 \sigma_{\Delta F}^2 + 2h\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta S}^2} \qquad (18)$$

In order to use the minimum variance hedge ratio to find the hedging effectiveness, equation 16 has to be incorporated into the previous formula.

$$e = \frac{-\left(\frac{\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta F}^2}\right)^2 \sigma_{\Delta F}^2 + 2\left(\frac{\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta F}^2}\right)\sigma_{\Delta S,\Delta F}}{\sigma_{\Delta S}^2} = \frac{\frac{\sigma_{\Delta S,\Delta F}^2}{\sigma_{\Delta F}^2}}{\sigma_{\Delta S}^2} \qquad (19)$$

Finally, hedging effectiveness can be expressed as the squared coefficient, ρ^2, of correlation between changes in spot- and future prices.

$$e = \frac{\sigma_{\Delta S,\Delta F}^2}{\sigma_{\Delta F}^2 \sigma_{\Delta S}^2} = \rho^2 \qquad (20)$$

The hedging effectiveness measures the relative reduction in portfolio risk, which results from the inclusion of the optimal amount of future contracts in the portfolio. Thus, the objective is to obtain the minimum risk position for the combined portfolio. ρ^2 measure the reduction on an existing portfolio variance which results from the use of the minimum variance hedge ratio. If $\rho^2 = 1$, the hedging effectiveness is 100 percent and the hedge is optimal. If $\rho^2 < 1$, there are still risk remaining and the hedge is not perfect. (Ederington, 1979)

3.5.2 Single linear regression

An alternative method for finding the optimal hedge ratio is by single linear regression. This model will yield the same result as the Ederington framework, and a link between the two can be explained mathematically.

Linear regression is defined as

$$\Delta S_t = \alpha_0 + \beta_1 \Delta F_{t,T} + u_t \qquad (21)$$

where α and β are constants. In the linear regression model, ΔS_t is the dependent variable, whereas $\Delta F_{t,T}$ is the explanatory variable. u_t is the error term from ordinary least square estimation. Inserting equation 21 into equation 13 gives

$$\Delta P_t = \Delta S_t = \alpha_0 + \beta_1 \Delta F_{t,T} + u_t - h\Delta F_{t,T} = \alpha_0 - (h + \beta_1)\Delta F_{t,T} + u_t. \qquad (22)$$

Applying this to the variance for the risk minimizing portfolio

$$\sigma_{\Delta P}^2 = \beta_1^2 \sigma_{\Delta F}^2 + h^2 \sigma_{\Delta F}^2 - 2h\beta_1 \sigma_{\Delta F}^2 + \sigma_u^2. \qquad (23)$$

Next, minimize the variance by deriving equation 23 with respect to h and set it equal to zero

$$\frac{d\sigma_{\Delta P}^2}{dh} = 2h\sigma_{\Delta F}^2 - 2\beta_1 \sigma_{\Delta F}^2 = 0 \qquad (24)$$

$$h^* = \frac{2\beta_1 \sigma_{\Delta F}^2}{2\sigma_{\Delta F}^2} = \beta_1. \qquad (25)$$

Thus, the optimal hedge ratio is equal to the slope coefficient from the regression. By replacing h* with β_1, equation 18 can be expressed as

$$e = 1 - \frac{\beta_1^2 \sigma_{\Delta F}^2 + \beta_1^2 \sigma_{\Delta F}^2 - 2\beta_1^2 \sigma_{\Delta F}^2 + \sigma_u^2}{\sigma_{\Delta S}^2} \Leftrightarrow e = 1 - \frac{\sigma_u^2}{\sigma_{\Delta S}^2} = R^2. \qquad (26)$$

R^2 is a measure of how well the estimated regression lines fit actual observations. Hence, hedging effectiveness can be set equal to R^2 in the linear regression model.

3.5.2.1 Assumptions underlying the regression model

The estimation technique used in classical linear regression models is based on five assumptions related to the errors from the regression (u_t). These are

1. The errors have zero mean, $E(u_t) = 0$
2. The variance of the errors is constant and finite over all values of x_t, $Var(u_t) = \sigma^2 < \infty$
3. The errors are linearly independent of one another, $Cov(u_i, u_j) = 0$
4. There is no relationship between the error and corresponding x variety, $Cov(u_t, x_t) = 0$
5. The errors are normally distributed, $u_t \sim N(0, \sigma^2)$

If these assumptions hold the estimators will be the best linear unbiased estimators of their true values. In this model, it is assumed that error term (u_t) in equation 21 is normally distributed with a zero mean and constant variance or homoscedastic in order to conduct single or joint hypothesis tests about the model parameters. u_t is also assumed to be uncorrelated, meaning that the covariance of the residuals of the spot returns and residuals of the futures returns is zero over time.

Assumption one is easy to test by including a constant term, u_t in equation 21 (Brooks, 2008). Due to the practical approach in this dissertation, with simulations, testing the other assumptions for all regression analysis is comprehensive and thought to be beyond the scope of this dissertation.

3.6 Is basic financial theory applicable in shipping?

The Ederington framework is a well-accepted method for estimating optimal hedge ratio and hedging efficiency within finance. The single linear regression that can be derived from the

framework has been applied by for instance Kavussanos and Visvikis (2000a) when investigating hedging performance of different freight routes. Their results indicate that it is optimal to use low hedge ratios, and that the corresponding hedging efficiency was low when hedging with FFA contracts. This has mainly been due to the low correlation between freight rates and the FFA contracts, as a result of no cost-of-carry relationship between them. Such low hedge ratios may question whether a financial theory, which is based on hedging instrument with high correlation, is applicable in practice to determine optimal hedge ratio and hedging efficiency in shipping.

Gray (1990) questioned whether an excessive degree of statistical accuracy in the calculation of correlations and the level of the hedge is necessary, and argues that this may be fundamentally misleading. The freight market is a difficult and hard-to-define market, in contrast to financial markets where each price is known on a penny basis on a second-to-second basis. He further argues that freight hedging is by definition a comparatively imprecise mechanism, and that a more sensible approach for estimating correlation is preferable. The correlation is not expected to be close to perfect, but there is still a reasonable correlation between actual earnings and freight derivatives that can be utilized. Even though the shipping industry and freight derivatives market has evolved since Gray presented his views, the fundamental of his arguments is still relevant.

There exist alternative methods for measuring hedging efficiency, which is not based on the correlation. An example of such a method is the dollar-offset method, which may be more sensible than Ederington's framework and linear regression. This method has a more practical approach and determines hedging efficiency based on absolute changes in the value of the underlying and the derivative. The method is commonly applied for measuring hedging efficiency in accounting. As an extension of the discussion above we will introduce the method, and later compare the results between the different methods.

3.6.1 The dollar-offset method

The dollar-offset method is a quantitative method that compares changes in fair value or cash flow of the hedged item and the derivative. It can both be applied period-by-period or cumulatively. If the change in the derivative exactly offsets the change in the value of the hedged

item, the negative of their ratio would be -1.00. The cumulative form of the dollar-offset method can be expressed mathematically as

$$Dollar\ offset\ ratio = -(\sum_{i=1}^{n} X_i / \sum_{i=1}^{n} Y_i) \qquad (27)$$

Where X_i is periodic changes in the value of the derivative and Y_i is periodic changes in the value of the hedged item. Which ratios that are regarded as "highly efficient" is a matter of interpretation. Swad (1995) argued that ratios between 0.80 and 1.25 should be regarded as efficient. Hence, all ratios outside of this range have to be regarded as inefficient. This range has later become an industry standard in accounting (Finnerty & Grant, 2003).

An important drawback with the method is that the ratio test is very sensitive to small changes in the value of the hedged item or derivative. As an example, consider an inventory valued at $1,000,000 and the hedge is a short position in a futures contract. If the fair value of the inventory and the basis only change by a small amount, for instance 1% and 0.33%, these changes imply an inefficient ratio of 33%, even though the correlation between the variables can be close to perfect. Canaberro (1999) suggests that under reasonable assumptions, the 0.80-1.25 standard rejects 36% of all hedges when the squared correlation, R^2, is 0.98 or better. However, due to the highly volatile freight rates observed in shipping, the problem with small changes is of less importance.

Charnes, Koch & Berkman (2003) argue that a meaningful measure of hedge efficiency should incorporate both the correlation between the hedged item and the hedging instrument and a hedge ratio included in a combined portfolio. These variables are not incorporated in the dollar-offset method. Therefore, they argue that the dollar-offset model is not preferred for measuring hedge efficiency.

4. Data and model description

This section will provide description of the data set used and a detailed description of the model.

4.1 Data

Our data series contains Capesize freight rates from 1st of January 2003 and up until 31st of December 2012 from the Baltic Exchange. Exhibit 4.1 presents a graphical plot of the historical freight rates in the Baltic Capesize Index, which best reflects the historical development in the Capesize segment. It shows how the spot prices were rising prior to the financial crisis and how the market reacted.

Exhibit 4.1 Historical BCI spot prices
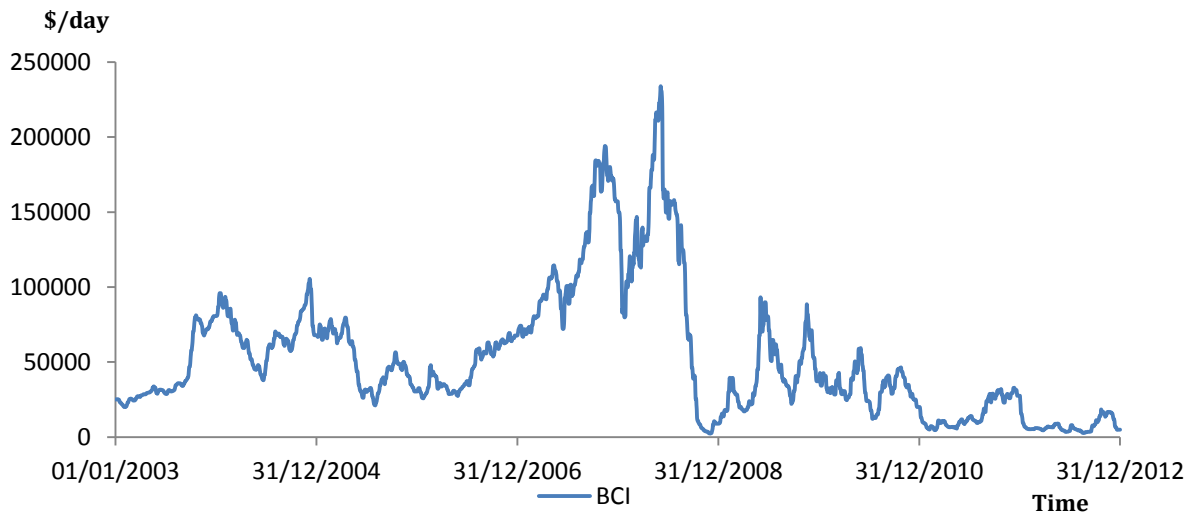
Source: The Baltic exchange

Descriptive data for the historical freight rates are presented in table 4.1 and 4.2. The voyage charter rates are presented in table 4.1 and time charter routes in table 4.2. The statistics are based on daily simple returns for each route.

Table 4.1: Descriptive statistics for voyage charter rates

		C2	C3	C4	C5	C7
# observations		3,653	3,653	3,653	3,653	3,653
	2004-2008	0.001	0.001	0.000	0.001	0.000
Mean	2009-2012	-0.001	-0.000	-0.001	-0.000	-0.001
	2004-2012	0.000	0.000	0.000	0.000	0.000
	2004-2008	0.019	0.020	0.022	0.025	0.019
Std. dev.	2009-2012	0.019	0.019	0.015	0.025	0.018
	2004-2012	0.019	0.020	0.020	0.025	0.019
Median		0.000	0.000	0.000	0.000	0.000
Kurtosis		10.123	11.300	20.828	14.465	10.651
Skewness		0.466	0.214	0.957	0.817	0.538

Numbers are presented in absolute terms

Table 4.2: Descriptive statistics for time charter rates

		C8_03	C9_03	C10_03	C11_03	TC Avg BCI
# observations		3,653	3,653	3,653	3,653	3,653
	2004-2008	0.001	0.001	0.001	0.001	0.001
Mean	2009-2012	0.000	-0.001	0.000	0.116	-0.001
	2004-2012	0.001	0.001	0.001	0.035	0.000
	2004-2008	0.036	0.028	0.041	0.035	0.031
Std. dev.	2009-2012	0.063	0.031	0.059	3.062	0.048
	2004-2012	0.046	0.029	0.047	1.678	0.037
Median		0.000	0.000	0.000	0.000	0.00
Kurtosis		42.824	16.480	25.863	2730.664	16.099
Skewness		2.885	0.932	2.279	50.656	1.375

Numbers are presented in absolute terms

The mean of all the daily simple returns are close to zero over the whole period, except for the route C11_03. The same can also be seen from the standard deviation, where all, except C11_03, have a daily standard deviation of about 2-6%. This is due to the fact that the time charter rates

for C11_03 have been strongly negative, with a bottom of -$13,402 on 23rd of August 2012[10]. A negative dollar per day rate implies a higher voyage cost than income. According to Bjerknes & Herje (2013) the eastbound cargo volumes on the Fronthaul voyage is about 5-7 times greater than the westbound voyage. Hence, most vessels will not obtain cargo on this leg, and sometimes the Backhaul freight rates will be negative on a time charter basis (Ådland, 2013). Looking at the mean return and the standard deviation on the period 2004-2008, the calculations shows that all routes had a similar development in freight rates.

Kurtosis[11] is used to measure whether the dataset is peaked or flat relative to a normal distribution. If the kurtosis is high the dataset tend to have a distinctive peak near the mean, declining rather rapidly, and have heavy tails (National Institute of Standards and Technology, 2012). The distribution of returns for all the routes in 2004-2012 seems to be leptokurtic, i.e. it has fatter tails than the normal distribution. This is confirmed as the kurtosis is above 10 for all routes.

Skewness[12] is a measure of the lack of symmetry for the dataset. A dataset or distribution is symmetric if it looks the same to the right and left of the center point. Meaning that the skewness for a normal distribution is zero, and any symmetric data should have skewness near zero (National Institute of Standards and Technology, 2012). Looking at the dataset in table 4.1 and 4.2, all the routes have a positive skewness to the right, i.e. the right tail is long relative to the left tail. This is due to the fact that the $/tonne rates will never be less than zero. On contrary, there is no upper limit for how high spot rates may become. Positive skewness is therefore to be expected.

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[10] As freight rates become negative, the simple return will generate either large negative or positive returns as the spot rates shift from negative to positive or vice-versa. The calculations will also generate increasing simple returns as the spot rates falls from a negative number to a larger negative number.

[11] $Kurtosis\ for\ a\ standard\ normal\ distribution = \frac{\sum_{i=1}^{N}(Y_i-\bar{Y})^4}{(N-1)\sigma^4} - 3,$ where $\bar{Y}$ is the mean, σ is the standard deviation and N is the number of data points.

[12] $Skewness = \frac{\sum_{i=1}^{N}(Y_i-\bar{Y})^3}{(N-1)\sigma^3},$ where $\bar{Y}$ is the mean, σ is the standard deviation and N is the number of data points.

4.1.1 Converting freight rates

Historical freight rates are based on a business year. The number of business days in a year can vary from one year to another depending on the number of weekend days. It can also vary from business to business, depending on the number of company holidays. The Baltic exchange only reports 252 freight rates per annum. As vessels operate 365 days per year, it has been necessary to convert the data set into 365 days per year. For each day missing a reported rate, the rate is set equal to the last reported rate. For instance, Saturday and Sunday rates are set equal to the rate reported on Friday. Note that vessel will only be fixed on weekdays.

4.2 Model description

The objective of this dissertation is to investigate if the Baltic Capesize Index is a good proxy for actual earnings and why they deviate. The results may implicate if forward freight agreements are suitable for revenue management in practice. In order to do so, it is critical to simulate a cash flow that is as realistic as possible. A major part of this dissertation has therefore been devoted to estimate income as precisely as possible. This section will give a thorough description of the model and necessary assumptions.

4.2.1 Routes

As the demand for dry bulk cargo has increased, numerous new harbors capable of handling Capesize vessels have appeared. Implementing all possible routes and harbors in the world will by far exceed the scope of this dissertation. Therefore, the model includes ten major routes in the Capesize segment, and it is assumed that this is sufficient to simulate realistic cash flows.

Our data set consists of five voyage charter routes and five time charter routes. In order to increase the number of routes, time charter rates have been transferred to voyage charter rates[13]. Creating such generic rates is possible, as time charter routes are non-standardized and only a delivery and redelivery range is given. The routes are presented in table 4.3. The table also

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[13] $Voyage\ equivalent\ rate = \dfrac{TC\ rate * \left(\frac{Distance\ Ballast}{24 * speed} + \frac{Distance\ Laden}{24 * speed}\right) + Fuel\ cost + Port\ cost}{Cargo\ intake}$

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presents what type of path each route belongs to and the length of the ballast- and laden distance. All route specific data are gathered from Clarksons Shipping Intelligence Weekly, except the route Qingdao – Tubarao – Qingdao. This route is categorized as a Pacific – Atlantic – Pacific route and has increased in importance the latter years, especially for very large ore carriers[14].

Table 4.3: Route description on 10 major Capesize routes

Route	Start - Load – Discharge	Path	Distance Laden (nm)	Distance Ballast (nm)
C2	Rotterdam - Tubarao – Rotterdam	TAC	5025	5025
C7	Rotterdam – Bolivar – Rotterdam	TAC	4500	4500
C8_03	Rotterdam - Baltimore – Rotterdam	TAC	3665	3665
C3	Rotterdam - Tubarao - Beilun/Baoshan	FHC	10874	4974
C5	Qingdao - Hay Point – Qingdao	TPC	4104	4104
C10_03	Beilun/Baoshan - Goa - Beilun/Baoshan	TPC	4497	4668
C10_03	Beilun/Baoshan - Dampier- Beilun/Baoshan	TPC	3371	3500
C11_03	Qingdao – Queensland – Rotterdam	BHC	13633	3943
C4	Qingdao - Richards Bay - Rotterdam	BHC	7054	7341
C3	Qingdao – Tubarao - Qingdao	P-A-P	10874	10874

Source: Clarkson Shipping Intelligence Weekly

4.2.2 Voyage pattern

When a shipowner has fulfilled the contract terms, he can freely choose where to take his vessel next. For instance, he might take another round voyage or choose reposition his vessel to another ocean. The model chooses the next route randomly on the basis of a probability for each route. This probability is based on historical trade flows from Thurlestone Shipping, see exhibit 2.1. The exhibit shows trade patterns for Trans-Pacific, Trans-Atlantic, Fronthaul and Backhaul, but it does not contain route specific trade flows. Therefore each route within a category has been given an equal weighting. For instance, in 2012, 60.8% of all trade flows was Trans-Pacific. Since there are included three different Trans-Pacific routes in the model, the probability for choosing one of the routes is 20.3%. All the other route probabilities are presented in table 4.4. Note that the Pacific – Atlantic – Pacific route is here considered as a Fronthaul.

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[14] Also referred to as VLOC, and is bulk carriers with dwt above 300,000 tons

Table 4.4: Development in probability for different routes

Path	Route	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TAC	C2	6.7%	7.8%	6.5%	6.8%	6.8%	5.7%	3.7%	4.4%	4.4%	3.7%
TAC	C7	6.7%	7.8%	6.5%	6.8%	6.8%	5.7%	3.7%	4.4%	4.4%	3.7%
TAC	C8_03	6.7%	7.8%	6.5%	6.8%	6.8%	5.7%	3.7%	4.4%	4.4%	3.7%
FHC	C3	7.4%	8.5%	5.4%	8.5%	9.6%	9.7%	11.6%	11.7%	11.3%	11.8%
TPC	C5	15.5%	15.1%	18.5%	16.1%	16.3%	18.0%	19.2%	18.9%	19.6%	20.3%
TPC	C10_03	15.5%	15.1%	18.5%	16.1%	16.3%	18.0%	19.2%	18.9%	19.6%	20.3%
TPC	C10_03	15.5%	15.1%	18.5%	16.1%	16.3%	18.0%	19.2%	18.9%	19.6%	20.3%
BHC	C11_03	9.3%	7.1%	7.0%	7.2%	5.7%	4.8%	4.1%	3.4%	2.7%	2.4%
BHC	C4	9.3%	7.1%	7.0%	7.2%	5.7%	4.8%	4.1%	3.4%	2.7%	2.4%
P-A-P	C3	7.4%	8.5%	5.4%	8.5%	9.6%	9.7%	11.6%	11.7%	11.3%	11.8%
		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

In practice, a vessel located in the Atlantic basin can only make Trans-Atlantic round voyages or Fronthauls, as strategic repositioning of vessel is not incorporated[15]. Hence, only Trans-Atlantic and Fronthaul voyages are relevant to determine probabilities for the next voyage. Table 4.5 and 4.6 present probabilities for vessels located in the Atlantic basin and Pacific basin respectively.

Table 4.5: Probabilities for a vessel located in the Atlantic basin

Position: Atlantic basin	Rate	2003	2006	2008	2010	2012
Rotterdam – Tubarao – Rotterdam	C2	24.4%	23.5%	21.3%	17.8%	16.1%
Rotterdam – Bolivar – Rotterdam	C7	24.4%	23.5%	21.3%	17.8%	16.1%
Rotterdam – Baltimore - Rotterdam	C8_03	24.4%	23.5%	21.3%	17.8%	16.1%
Rotterdam – Tubarao – Beilun	C3	26.9%	29.4%	36.1%	46.7%	51.8%

Table 4.6: Probabilities for a vessel located in the Pacific basin

Position: Pacific basin	Rate	2003	2006	2008	2010	2012
Qingdao – Hay Point – Qingdao	C5	21.4%	22.7%	24.6%	25.2%	26.2%
Beilun – Goa - Beilun	C10_03	21.4%	22.7%	24.6%	25.2%	26.2%
Beilun – Dampier - Beilun	C10_03	21.4%	22.7%	24.6%	25.2%	26.2%
Qingdao – Queensland – Rotterdam	C11_03	12.8%	10.1%	6.5%	4.5%	3%
Qingdao – Richards Bay – Rotterdam	C4	12.8%	10.1%	6.5%	4.5%	3%
Qingdao – Tubarao – Qingdao	C3	10.2%	11.9%	13.2%	15.6%	15.3%

4.2.3 Vessel specifications

The model is based on three different Capesize vessels. One is assumed to be identical to the Baltic standard vessel, this way basis risk due to technical specifications will be absent. The two other are gathered from Clarkson World Fleet Register, and is based on peer group analysis. This means that each vessel is based on around 30 actual Capesize vessels. When implementing data for a group of almost identical vessels instead of one vessel, we believe that we will avoid special case observations. To emphasize the importance of vessel specifications the other two vessels differ from the Baltic Standard vessel. The three different vessels are presented in table 4.7.

Table 4.7: Vessel specifications

	Built	Loading capacity	Speed Laden	Speed Ballast	Fuel con.	Fuel. Con. in port
Baltic Standard	-	172,000 dwt	14,5 knots	15 knots	56 tonne	3.5 tonne
Hanjin Haypoint	1990	150,302 dwt	13.53 knots	14.03 knots	43.79 tonne	1 tonne
Cape Azalea	2012	220,000 dwt	14.66 knots	15.16 knots	63.6 tonne	3.5 tonne

Source: Clarkson Fleet Register

In reality, a vessel can never load 100% of its dwt capacity, as dwt is the sum of cargo, fuel, crew, provisions etc. All vessels are therefore assumed to have a constant loading factor of 95%. The different technical specifications will impact vessels profitability through fuel costs, port charges and income. Fuel costs are dependent on the vessels fuel consumption and operating

speed. Port charges vary by the vessels dwt and income is dependent on the vessels loading capacity.

4.2.4 Voyage duration

Voyage duration is a key variable for simulating a realistic cash flow, as it decides the number of voyages possible, fuel cost and when vessels are fixed on the next voyage. Variables affecting voyage duration in addition to distance are time spent in port, port congestion, operating speed and sea margin. In the following section, we will describe how the different variables are incorporated.

4.2.4.1 Time spent in Port

On a voyage, vessels need to both load and discharge cargo. The length of this operation varies between ports, as some ports are more modern and efficient than others. Different type of vessels will also affect time spent at port. Data used are gathered from Clarkson and are observed averages for Capesize vessels on the routes. The figures are presented in table 4.8. (Clarkson, 2012)

4.2.4.2 Port congestion

As a vessel arrives at its designated port, the time the vessel spends waiting for anchorage is an important factor to determine the duration of a trip. Congestion in bulk load ports is an increasing problem as the average waiting time has increased in recent years (DNV, 2013).

Data provided by Klaveness Chartering and Ådland shows that congestion differs quite heavily from day to day, therefore weekly averages is believed to give a better idea of actual congestion in a period. Gathering a complete dataset for all relevant ports proved to be difficult. On some ports we do not have any data, while on others the data do not cover the whole relevant period. On ports where there is no data, the congestion is assumed to be equal to a port nearby. Table 4.8 highlights sources on congestion for each route. On ports where we missed data on certain periods, the congestion is assumed to randomly vary within a given interval based on observed trends. In appendix 9.1, it is highlighted how the observed trend is used for simulating missing

values. In addition, since congestion only has been a problem since 2006, the maximum congestion was reduced for the period 2003 to 2005.

Table 4.8: Distance and time spent at port for different routes

Route	Laden distance	Ballast, distance	Port time, days	Source congestion, Load	Source congestion, discharge	Sea margin
Rotterdam – Tubarao – Rotterdam	5025	5025	6	Tubarao	0*	5%
Rotterdam – Bolivar – Rotterdam	4500	4500	9.9	Tubarao	0*	5%
Rotterdam – Baltimore - Rotterdam	3665	3665	8.5	Tubarao	0*	5%
Rotterdam – Tubarao – Beilun	10874	4974	9.5	Tubarao	Beilun	5%
Qingdao – Hay Point – Qingdao	4104	4104	10.5	Hay Point	Qingdao	5%
Beilun – Goa – Beilun	4497	4668	11.5	Goa	Beilun	5%
Beilun – Dampier – Beilun	3371	3500	7.5	Dampier	Beilun	5%
Qingdao – Queensland – Rotterdam	13633	3943	9.4	Hay Point	0*	5%
Qingdao – Richards Bay – Rotterdam	7054	7341	8.9	Richards Bay	0*	5%
Qingdao – Tubarao – Qingdao	10874	10874	9.5	Tubarao	Qingdao	5%

* Congestion has not been a problem in Rotterdam, and it is assumed to be equal to zero

4.2.4.3 Operating speed

Operating speed influences the time spent at sea, the fuel consumption and thus the fuel cost. Each vessel has a designed operating speed, but this may not be the speed they operate at. There have been several studies on how shipowners can maximize their cash flow by operating at an optimal speed. Ådland (2013) suggest that Capesize vessels constantly slow steam, regardless of the theory on optimal speed choice. In the following, this level of operating speed is assumed to be 11.5 knots, and will be referred to as the charterparty speed. The model incorporates operating speed based on Baltic standard speed, optimal speed and charterparty speed, to emphasize how the cash flows and hedging efficiency are affected. Below we give a thorough description of the theory around optimal speed choice.

4.2.4.3.1 Optimal speed

Over the years there has been different studies looking at how to find the optimal operating speed. Strandenes (1981) looked at potential cost cutting from slow steaming for large tankers compared to smaller sizes and bulk carriers. Next, Ronen (1982) formulated a theoretical framework for speed optimization in subject to different operational modes. Assman (2012) tested the theoretical linear relationship between the log-speed and the logarithmic of the freight/fuel price ratio for the dry bulk and VLCC[16] market. These studies show that the relationship between vessel speed (V) and the daily fuel consumption (F) can be expressed as

$$F = \alpha * V^{\beta} \qquad \text{In the range } V_{min} < V < V_{max} \qquad\qquad (28)$$

Where α and β are vessel-specific constants that vary depending on whether a vessel is sailing laden or ballast. The speed (V) is set to vary within a minimum and maximum range. Vessels have to maintain a minimum speed for safe steering and are not able to travel at speeds above designed maximum. Maximum operating speed varies between the three vessels, but the minimum speed is assumed to be constant at 6 knots. For simplicity, the fact that charter-parties may lay restriction on the operating speed has been ignored.

As the relationship between speed and fuel consumption is in place, the next task a shipowner has to overcome is how to optimize his income, supposing that the vessel is chartered on a voyage charter. For the purpose of illustration we ignore the time spent in port and add this to the model later on. As port costs do not depend on the chosen vessel speed we can simplify the daily spot earnings of the vessel (π) as

$$\pi = \frac{R*W}{\frac{D}{24*V}} - P_b * F = \frac{R*W}{\frac{D}{24*V}} - P_b * \alpha * V^{\beta} \qquad\qquad (29)$$

where R is the spot freight rate obtained on a voyage charter party ($/tonne), W is the cargo size (in tonnes), P_b is the price of bunkers ($/tonne) and the total trip distance is D (nautical miles).

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[16] Very Large Crude Carrier

By deriving the profit with respect to speed and set the equation equal to zero we get the optimal formula

$$\frac{d\pi}{dV} = \frac{24*R*W}{D} - \beta * P_b * \alpha * V^{\beta-1} = 0 \tag{30}$$

$$V^* = (\frac{24*R*W}{D*\beta*P_b*\alpha})^{\frac{1}{\beta-1}} \tag{31}$$

Equation 31 tells us that the optimal speed is a non-linear function of the ratio between spot freight rate and fuel price, given that the distance, D, is constant. In other words, the optimal speed is given by the ratio between freight rates and bunker prices. The equation is consistent with theory about equilibrium in the shipping sector presented earlier. When rates are low, one way to increase spot rates is by reducing the supply of vessels. When shipowners adjusts the operating speed, this will have an impact on total supply and the prices for their services.

Exhibit 4.2: Optimal laden speed
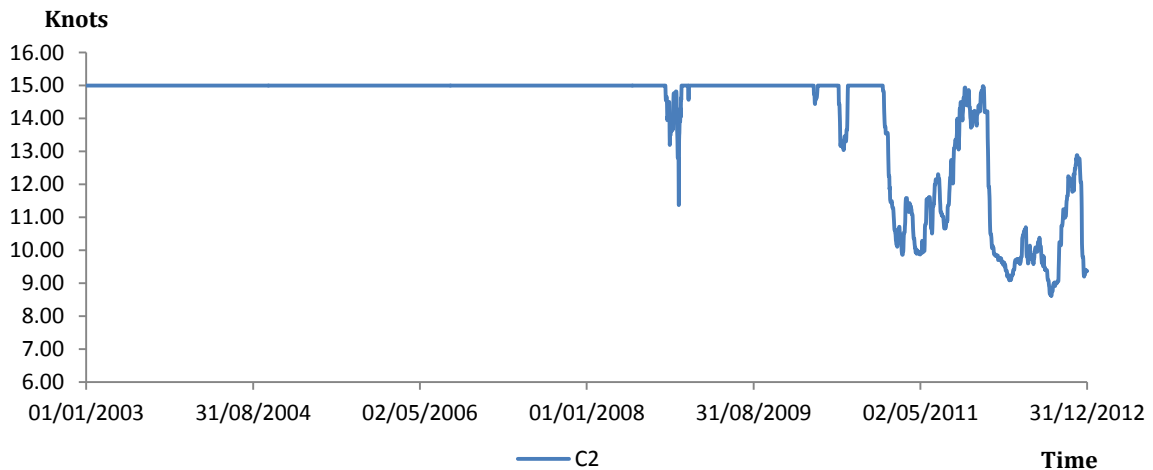
The exhibit shows the theoretical optimal speed for the Baltic standard Capesize vessel on the C2 route (Rotterdam – Tubarao – Rotterdam) from 1/1/2003 to 12/31/2012

Exhibit 4.2 shows that prior to mid-2011 the ratio between bunker prices and freight rates was such that there was not optimal to slow steam. It is important to have in mind that this is a static model, not adjusted for changes in the spot prices as days go by. Once the optimal speed has been

found, the vessel is set to operate at that level throughout the leg, regardless on the development in bunker prices or spot rates. The speed is updated twice for each voyage, one for the ballast leg and one for the laden leg.

4.2.4.4 Sea Margin

Time spent at sea is not only determined by the operating speed, but is also affected by weather and other delays. To account for such delays it is added a 5 percent sea margin. The sea margin influences the operating speed, and is set to reduce the operating speed by 5%. (Ådland & Strandenes, 2004)

4.2.5 Voyage cost

Voyage costs mainly consist of fuel costs, port charges, pilotage and canal dues. Canal dues are not relevant, as no route involves canal transit. Pilotage constitutes a very small part of total voyage costs, and has therefore been ignored. In the following section, we will describe how fuel cost and port charges are implemented.

4.2.5.1 Fuel cost

Voyage costs are mainly determined by fuel costs, which depend on bunker prices and fuel consumption. Equation 32 shows the calculation

$$\text{Fuel cost} = \text{Duration} * \text{Fuel consumption} * \text{Bunker price} \qquad (\,32\,)$$

Fuel consumption is a function of operating speed, seen in equation 28. Vessel specification, from Clarksons fleet register, only states fuel consumption when the vessel is operating at the design speed. By converting equation 28, all other combinations of speed and fuel consumption are given by the relationship (Ådland, 2013)

$$\frac{F}{F_d} = \left(\frac{V}{V_d}\right)^{\beta} \qquad (\,33\,)$$

where F_d and V_d presents the corresponding fuel consumption and the design speed respectively. This means that by rearranging equation 28, the parameter α can be written as

$$\alpha = \frac{F_d}{V_d^{\beta}} \qquad (34)$$

It is assumed that the standard value for the power function parameter β is set to 2.5535 for laden and 2.6161 for ballast, presented in exhibit 4.1 (Ådland, 2013). Based on the equation above, table 4.9 shows how the α-parameter varies for the different vessels.

Table 4.9: α parameter for different vessels

Vessel	Laden	Ballast
Baltic Standard	0.0606	0.0469
Hanjin Haypoint	0.0566	0.0437
Cape Azalea	0.0669	0.0518

Vessels also consume fuel in port. These rates are dependent on ship specifications and are set to 1 tonne/day for the 1990 vessel, Hanjin Haypoint, and 3.5 tonnes/day for the other two. (Clarkson, 2012)

In the model there are only implemented two possible bunker prices, as there are observed only small differences in bunker prices between ports. Vessels with an initial location in the Atlantic basin are assumed to bunker in Rotterdam[17]. Vessels located in the Pacific basin are assumed to bunker in Singapore[18]. Regardless of route or duration of the voyage, all bunker costs are determined by its initial location and start date.

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[17] The bunker price is based on BUNKRD380, a price index for 380 centistoke fuel in Rotterdam

[18] The bunker price is based on BUNKSI380, a price index for 380 centistoke fuel in Singapore.

4.2.5.2 Port charges

Port charges are based on loading and discharging costs for a 172,720 dwt vessel in 2009 from AXS Marine. It is assumed to be a linear relationship between port charges and deadweight tonnage, and that 2009 figures are representative for the entire period. Consequently, port charges are given in \$/tonne and vary based on the vessel size.

4.2.6 Summary of the calculations used in the model

In table 4.10, we present the different symbols and calculations made use of in the model. The presentation is intended to give the reader a better understanding of the results presented.

Table 4.10: Formula used in different calculations

Denomination		Calculations
D	Distance	**Days at sea**
w	Weather	$Days = D/[24 * V * (1 - w)]$
V	Operating Speed	
FC	Fuel cost	**Fuel cost**
Con	Fuel consumption	$FC_{Sea} = Days * Con * P_b$
P_b	Bunker price	$FC_{Port} = (TP + C) * Con * P_b$
R	Rate, \$/tonne	
W	Loading capacity	**Voyage cash flow**
PC	Port Charge	$CF = R * W - (FC_{Ballast} + FC_{Laden}) - PC$
C	Port Congestion	
TP	Time at port	**Daily cash flow**
		$Daily\ CF = CF/(D_B + D_L + TP + C)$

4.2.7 Voyage example

To emphasize how the different variables affect voyages, we will exemplify one specific voyage and a vessel's trade pattern over a year. The example is based on a Baltic standard vessel that operates with optimal speed in an environment with port congestion. Exhibit 4.3 illustrates an example of a Trans-Pacific round voyage between Beilun, China and Goa, India fixed 1/1/2012. The figures made use of in exhibit 4.3 can be found in table 4.11.

Exhibit 4.3: Example of a Trans-Pacific round voyage
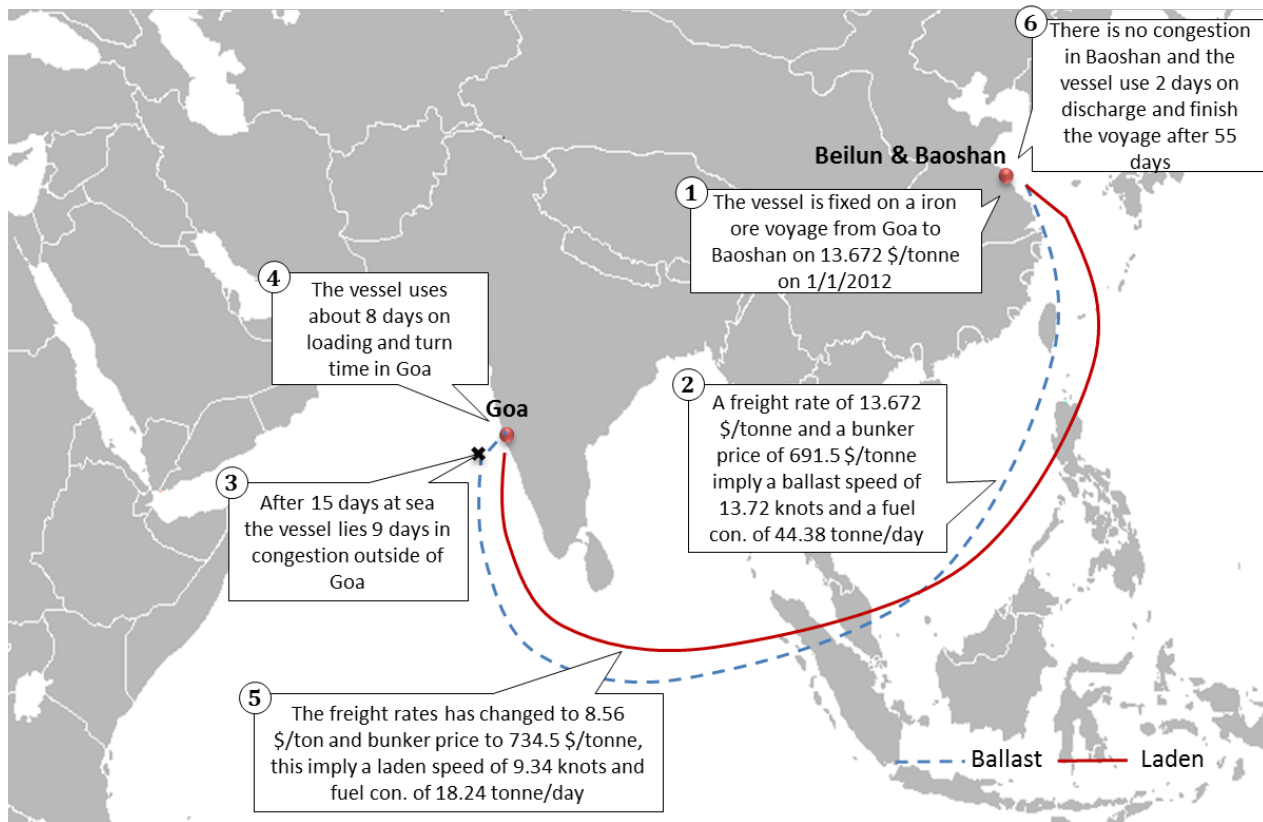
The exhibit shows an example of a Trans-Pacific round voyage between Goa, India and Baoshan, China in 2012

Table 4.11: Calculations based on exhibit 4.3

Input		Calculations
Freight rate	13.672 $/tonne	$Speed, ballast = \left[\dfrac{24h * \$13.672 * 163,400}{(4668 + 4497) * \beta * 691.5 * \alpha}\right]^{\frac{1}{\beta-1}} = 13.72$
Loading capacity	163,400 tonne	$Days\ ballast = \dfrac{4668}{[24 * 13.88 * (1 - 5\%)]} = 15\ days$
Port charge, Goa	0.38 $/tonne	$Fuel\ con, ballast = \alpha * 13.72^{\beta} = 44.38\ tonne/day$
Port charge, Baoshan	0.607 $/tonne	$Fuel\ cost, ballast = 15 * 44.38 * 691.5 = \$457,840$
Bunker price	691.5 $/tonne	
Fuel con. in port	3.5 tonne/day	$Port\ charge, Goa = 0.38 * 163,400 = \$61,275$
Ballast distance	4668 nm	$Fuel\ cost, Goa = (9 + 8) * 3.5 * 691.5 = \$41,144$
Laden distance	4497 nm	
Sea margin	5%	$Speed, laden = \left[\dfrac{24h * \$8.56 * 163,400}{(4668 + 4497) * \beta * 734.5 * \alpha}\right]^{\frac{1}{\beta-1}} = 9.34\ knot$
Input affecting speed laden		$Days\ laden = \dfrac{4497}{[24 * 9.34 * (1 - 5\%)]} = 21\ days$
Freight rate	8.555	$Fuel\ con, laden = \alpha * 9.34^{\beta} = 18.24\ tonne/day$
Bunker price	734.5	$Fuel\ cost, laden = 21 * 18.24 * 691.5 = \$266,186$
		$Port\ charge, Baoshan = 0.607 * 163,400 = \$99,118$
		$Fuel\ cost, Baoshan = 2 * 3.5 * 691.5 = \$4,840$
		$Voyage\ income = 13.915 * 163,400 = \$2,273,711$
		$Fuel\ cost = 457,840 + 41,144 + 266,186 + 4,840 = 770,011$
		$Port\ charge = 99,118 + 61,275 = 160,393$
		$Voyage\ result = 2,273,711 - 770,011 - 160,393 = 1,303,647$

The shipowner earned $ 1,303,647 in total on the voyage between Beilun/Baoshan and Goa, calculated in table 4.11. After the first voyage the vessel is fixed on a Backhaul, transporting coal from Richards Bay, South Africa to Rotterdam, the Netherlands. In Rotterdam the vessel is fixed on another coal voyage, this time from Bolivar, Colombia back to Rotterdam. Then the vessel

moves back to the Pacific, by transporting iron ore from Tubarao, Brazil to Qingdao, China. Before the end of 2012 the vessel made two Trans-Pacific voyages between Australia and China. The vessel completed 6 voyages in 2012, and the pattern is shown in exhibit 4.4.

Exhibit 4.4: Example of a vessels trading pattern over a year

The exhibit shows a simulated trading pattern for a Baltic standard Capesize vessel in 2012. The vessel manage to complete 6 voyages the current year

Table 4.12: Information regarding exhibit 4.4

Nr	Date	Path	Type	Distance (miles)	Days at sea	Congestion & Port time	Waiting days
1	1/1/2012	Beilun – Goa	Ballast	4,668	15	17	-
2	2/2/2012	Goa – Baoshan	Laden	4,497	21	2	1
3	2/27/2012	Qingdao – Richards Bay	Ballast	7,341	43	8	-
4	4/18/2012	Richards Bay – Rotterdam	Laden	7,054	44	4	0
5	6/4/2012	Rotterdam – Bolivar	Ballast	4,500	17	3	-
6	6/25/2012	Bolivar – Rotterdam	Laden	4,500	18	4	0
7	7/16/2012	Rotterdam – Tubarao	Ballast	5,025	17	5	-
8	8/8/2012	Tubarao – Beilun	Laden	10,874	41	2	0
9	9/20/2012	Beilun – Dampier	Ballast	3,500	14	9	-
10	10/13/2012	Dampier – Baoshan	Laden	3,371	13	7	2
11	11/5/2012	Qingdao – Hay Point	Ballast	4,104	14	10	-
12	11/29/2012	Hay Point – Qingdao	Laden	4,104	16	5	0

The table shows duration and distance for each leg the vessel in exhibit 4.4 completed in 2012

Table 4.13: Cash flow calculations to exhibit 4.4

Path	Rate	Bunker Price	Fuel cost	Port Charge	Income
Beilun – Goa – Baoshan	$ 13.67	$ 691	$ 770,011	$ 160,393	$ 1,303,647
Qingdao – Richards Bay – Rotterdam	$ 8.77	$ 742	$ 614,840	$ 232,601	$ 586,067
Rotterdam – Bolivar – Rotterdam	$ 8.53	$ 579	$ 586,778	$ 273,848	$ 533,503
Rotterdam – Tubarao – Beilun	$ 17.91	$ 588	$ 1,149,644	$ 182,675	$ 1,594,829
Beilun – Dampier – Baoshan	$ 6.72	$ 646	$ 511,401	$ 171,173	$ 415,042
Qingdao – Hay Point - Qingdao	$ 9.71	$ 599	$ 637,640	$ 168,703	$ 780,271

The table shows fuel costs, port charge and income for the voyages made in exhibit 4.4

Table 4.12 and 4.13 consist of specifications on the different voyages. There is earlier shown how the optimal speed varies in 2012, exhibit 4.2, and the effect operating speed and fuel consumption has is exemplified in table 4.13. Consider the Backhaul voyage from Qingdao to Rotterdam, a voyage that took 98 days including port congestion. Because of a high bunker price and a low freight rate, the optimal was to slow steam at a speed of 8.72 knots. Such a low speed yields low fuel consumption, and despite a long duration it only had fuel cost of $ 614,840. The fuel cost for

the first voyage is over \$150,000 higher, despite lower bunker price and duration of only 55 days. This as the ratio between freight rates and bunker prices implied a much higher operating speed, yielding higher fuel consumption.

4.2.8 Other factors

Cash flows in the model are converted into daily averages per vessel. These estimates are used to calculate the average difference between daily earnings and BCI, hedge ratio and hedge efficiency. For each simulation the vessel will operate one year ahead of the relevant period, else daily income would be constant until the first vessel finishes the first voyage.

Daily differences between actual earnings and BCI tend to vary between being positive and negative. Hence, calculating the arithmetic average will yield deceptive results, as positive values would be cancelled by negative values. Instead, it is preferable to use root mean square[19], RMS, as a measure of average return. On average RMS is equal or slightly larger than arithmetic averages.

Hedge ratios and hedge efficiencies are based on beta and R^2 in linear regression and the dollar-offset method, discussed in section 3.5 and 3.6. The linear regression is between daily changes in actual earnings and BCI, respectively ΔS and ΔF. However correlation between daily changes in actual earnings and BCI proves to be low, exhibit 4.14. The low correlation can be explained by the smoothness in changes in actual earnings.
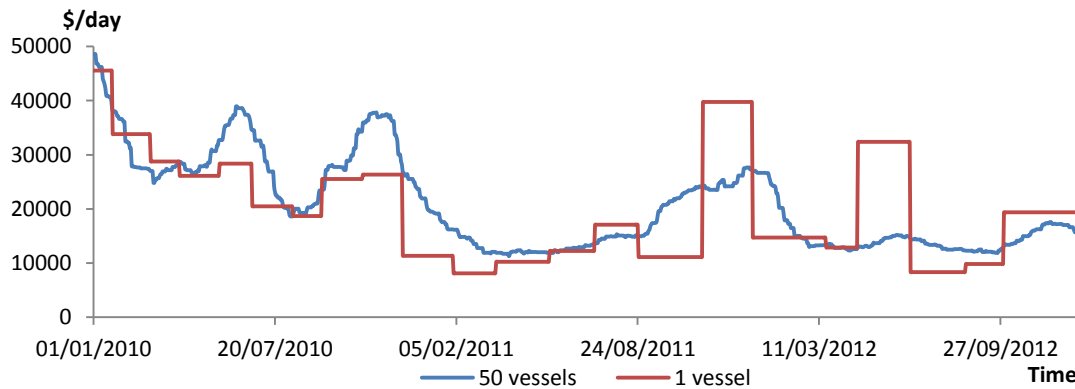
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[19] Root mean square, or quadratic mean, is a statistical measure of the magnitude of a varying quantity. Mathematically it can be expressed as $x_{RMS} = \sqrt{\frac{1}{n} * (x_1^2 + x_2^2 + x_n^2)}$

Exhibit 4.5: Daily earnings for different fleet sizes

The exhibit shows daily earnings in 2010 to 2012 for two different fleet sizes

Exhibit 4.5 shows daily earnings for a fleet of one and 50 vessels. Consider the fleet of 50 vessels. Each time the shipowner's daily income changes, one or more of his vessel has been fixed. Since vessels are fixed around 4-8 times per year, it is seldom more than one or two vessels that are fixed each time the daily cash flow changes. Changes in actual earnings will therefore be more "smooth" compared BCI. To increase correlation the interval has been increased to monthly averages of daily actual earnings and monthly averages of daily BCI. By reducing to monthly observations, the smoothness effect is thought to become less important. Table 4.14 shows how the correlation increases by reducing the number of observations.

The dollar-offset method is based on cumulative changes in actual earnings and BCI. The smoothness effect will also infer absolute changes, and it is therefore looked at monthly absolute returns.

Table 4.14: Correlation for daily and monthly averages between actual earnings and BCI

# Vessels		1	5	10	15	25	50
Daily Correlation	2004-2008	2.5%	6.2%	7.3%	8.0%	9.5%	11.0%
	2009-2012	2.2%	4.9%	6.6%	7.7%	9.5%	11.7%
Monthly	2004-2008	30.2%	48.6%	53.6%	55.8%	57.5%	59.0%
Correlation	2009-2012	20.0%	37.0%	40.8%	42.8%	44.1%	44.9%

Deciding the number of simulations is a tradeoff between accuracy and efficiency. The results are based on 500 simulations as the standard error[20] is below 0.3% for all the results. At this point, the standard error has converged and a significant increase in number of simulations is necessary to further reduce the standard error. A standard error of 0.3% is acceptable for the purpose of this dissertation and the simulations are still reasonably efficient.

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[20] Standard error is the standard deviation of the sampling distribution of a statistic, $\frac{\sigma}{\sqrt{n}}$

5. Findings

In the following section we will present our findings. To see if BCI is a good proxy for actual Capesize earnings, we will examine each basis risk factor one-by-one before presenting a realistic simulation of actual earnings. Doing so, we highlight the influence each basis risk has on actual earnings.

Before examining each basis risk, we will elaborate on some general observations not affected by basis risks. We will also examine if the hedging horizon and operating solely in one basin has any effect on the similarity between actual earnings and BCI. This section will only provide the most important findings, however all results can be found in appendix B.

The results are divided into two different time periods. The first period will be prior to and including the financial crisis, 2004-2008, and the second period is for 2009-2012. Doing so, the different simulations will highlight how basis risk factors have changed as the Capesize spot rates have gone from historical high levels and down to historical low levels.

5.1 General observations

To emphasize observations not affected by different basis risks, results shown in this section has a minimum of basis risk. The only basis risk left is the fact that the vessel hedges regionally obtained freight rates with an instrument that is based on a global average and settlement mismatch between paper and physical contracts. Hence, the basis risks geography and timing. The presented results are therefore based on a Baltic standard vessel operating at Baltic standard speed, in an environment without port congestion and no sea margin. The Baltic standard speed is as previously mentioned 14.5 knots laden and 15.0 knots ballast.

5.1.1 Difference between actual earnings and BCI

In the following, there will be a brief discussion of the differences between changes in daily actual earnings and BCI. The difference between actual earnings and BCI in the two periods is presented in table 5.1.

Table 5.1: Difference between actual earnings and BCI

# vessels	1	2	3	4	5	10	15	25	50	100
2004 - 2008	91.3%	81.5%	77.7%	76.1%	75.2%	70.9%	69.7%	68.6%	67.6%	67.5%
2009 - 2012	93.5%	74.3%	66.2%	61.3%	58.4%	51.6%	49.4%	47.5%	46.1%	46.0%

The table shows the difference between changes in daily actual earnings and BCI for different fleet sizes for the periods 2004 – 2008 and 2009 - 2012

In 2004 – 2008 the average daily difference between actual earnings and BCI stabilizes around 67.5%, and in 2009 – 2012 around 46.0%. An important reason for this difference is the "lag" between actual earnings and BCI. The "lag" refers to the time before changed market conditions, in BCI, are reflected in actual earnings. For instance, short voyages might be fixed every 30 days, and longer voyages around every 100 days. Consequently, daily changes in BCI will not immediately be reflected in actual earnings. Changes will first be reflected when a majority of the fleet are fixed on new rates. Exhibit 5.1 and 5.2 show a graphical plot of an example of actual earnings and BCI for the periods, 2004 – 2008 and 2009 - 2012. The exhibits show that it takes time before a top or bottom in BCI is reflected in the fleet's earnings. Large fluctuations in freight rates imply a larger difference between actual earnings and BCI. It is by no surprise that 2008, the year when the market peaked and plummet, is the year when the annual differences was at its largest.

Exhibit 5.1: Actual earnings in 2003 - 2008 compared to BCI
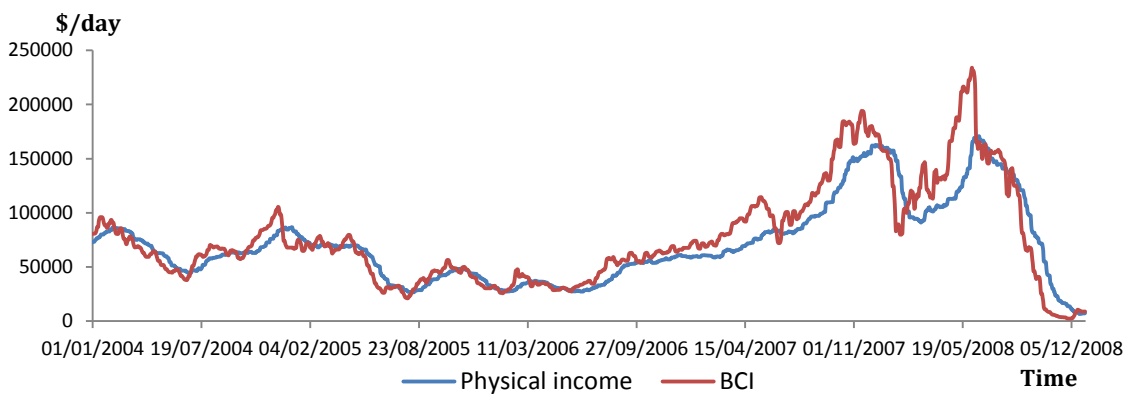
Daily earnings for a fleet of 50 vessels compared the Baltic Capesize Index for the period 2003-2008. The exhibit exemplifies the "lag" effect in a fleet's earnings.

Exhibit 5.2: Physical income in 2009 – 2012 compared to BCI
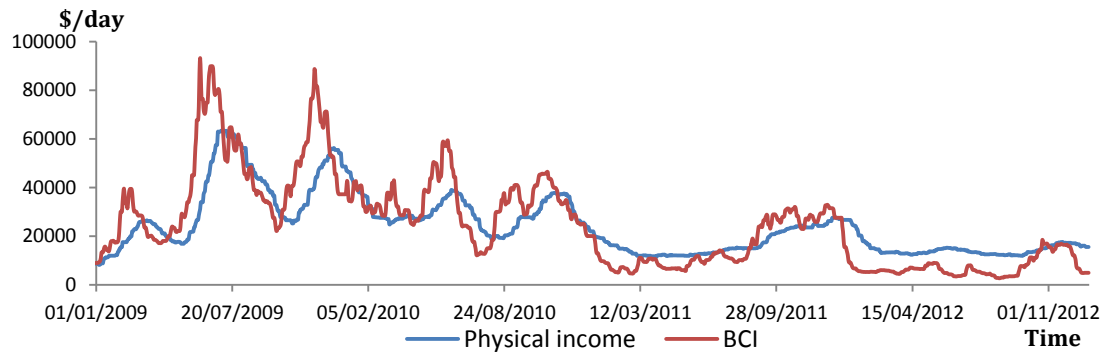
Daily earnings for a fleet of 50 vessels compared to the Baltic Capesize Index for the period 2009-2012. The exhibit exemplifies the "lag" effect in fleet's earnings.

The "lag" effect also explains the difference in daily RMS between actual earnings and BCI for the two periods. After the financial crisis the freight rates has been low, with less fluctuations in absolute terms. Therefore, it can be assumed that the difference in daily earnings and BCI should be even less than what is evident in table 5.1. Though, it is important to notice that the daily differences are given in percentage and not in absolute numbers. When freight rates are low, small absolute deviations will yield large percentage deviations.

A second observation is that the difference between actual earnings and BCI converges fairly quickly as the fleet increases, see table 5.1. The results imply that there are only slight differences in RMS for a fleet consisting of 10 or more vessels. In practice this means that a shipowner will not get an average daily income that is much closer to BCI even if he increases his fleet from 10 to 1000 vessels.

As mentioned above, the results in table 5.1 are affected by basis risk from geography and timing. One might expect that these risk factors would diminish if the fleet of vessels were fixed every day on each of the major routes[21]. At that point, the fleet contains just enough vessels to reduce these basis risks. Though, daily difference between actual earnings and BCI are almost stabilized for a fleet of 10 vessels, which are not large enough to remove the effect of timing and

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[21] Major routes is here referred to Trans- Atlantic, Trans- Pacific, Backhaul and Fronthaul

geography. This convergence in daily income is most likely due to the fact that the income is, as explained under section 4.2, based on averages of daily income per vessel, called simple moving average. Consider the example where a shipowner has a fleet of 50 vessels, and his daily income is an average of all these vessels. By increasing the fleet by one vessel, it will only cause a negligible difference in his daily average income. For increasing fleet sizes, the marginal impact of an extra vessel diminishes.

5.1.2 Optimal hedge ratio and hedge efficiency

A general observation is that the optimal hedge ratio and hedge efficiency are relatively low, regardless of different basis risks. For instance, even with only geography and timing present in 2004-2008, the hedge ratio and hedging efficiency is not higher than 54.2% and 38.9%, respectively.

Table 5.2: Optimal hedge ratio and hedge efficiency

Number of vessels	1	2	3	5	10	15	25	50
Optimal Hedge ratio	58.0%	56.3%	55.2%	55.3%	54.8%	54.9%	54.5%	54.2%
Hedge efficiency	11.2%	18.9%	22.8%	28.3%	34.4%	36.0%	37.7%	38.9%

Optimal hedge ratio and hedge efficiency for different fleet sizes. The results are presented for the period 2004-2008 and are based on monthly data.

The optimal hedge ratio and hedging efficiency is initially derived from correlation between daily, weekly or monthly changes in actual earnings and BCI. Equation 16[22] and 18[23] emphasize how dependent optimal hedge ratio and hedging efficiency are of correlation. Because of the low correlation, even when using monthly data[24], the optimal hedge ratio and hedging efficiency is expected to be low. This is evident in table 5.2, and as noted in section 5.1.1, these figures will not increase despite an increased fleet size.

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[22] Representation of equation 16: $h^* = \frac{\sigma_{\Delta S, \Delta F}}{\sigma_{\Delta F}^2} = \rho_{\Delta S, \Delta F} \frac{\sigma_{\Delta S}}{\sigma_{\Delta F}}$

[23] Representation of equation 20: $e = \frac{\sigma_{\Delta S, \Delta F}^2}{\sigma_{\Delta F}^2 \sigma_{\Delta S}^2} = \rho^2$

[24] See table 4.14

5.1.3 Unstable results in 2009 – 2012

Optimal hedge ratio and hedge efficiency differ heavily between the two periods, as they proved to be extremely unstable for smaller fleet sizes in 2009 – 2012. Exhibit 5.3 shows that the optimal hedge ratio and hedging efficiency stabilizes at fleet of around 50 vessels. From equation 16 we see that the unstable hedge ratio is a result of high standard deviations in actual earnings and low correlation between actual earnings and BCI. The hedging efficiency is close to zero as there is a low correlation between actual earnings and BCI.

Exhibit 5.3: Optimal hedge ratio and hedging efficiency with Baltic standard speed
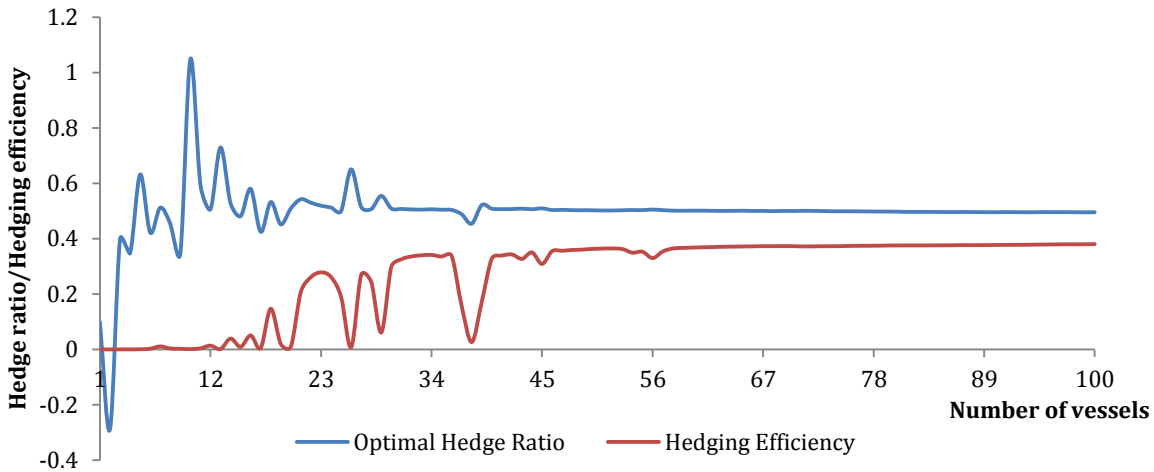
The exhibit shows optimal hedge ratio and hedging efficiency for fleets up to 100 vessels in the period 2009-2012

By changing the operating speed from the Baltic standard speed to optimal speed, both the optimal hedge ratio and the hedging efficiency are stabilized for a fleet of 10 vessels, presented in exhibit 5.4. This implies that results presented in exhibit 5.4 are caused by the operating speed.

Exhibit 5.4: Optimal hedge ratio and hedging efficiency with optimal speed

Optimal hedge ratio and hedging efficiency when operating at optimal speed in the period 2009-2012

After analyzing earnings on each route, it became evident that three routes is the source for the instability. These routes 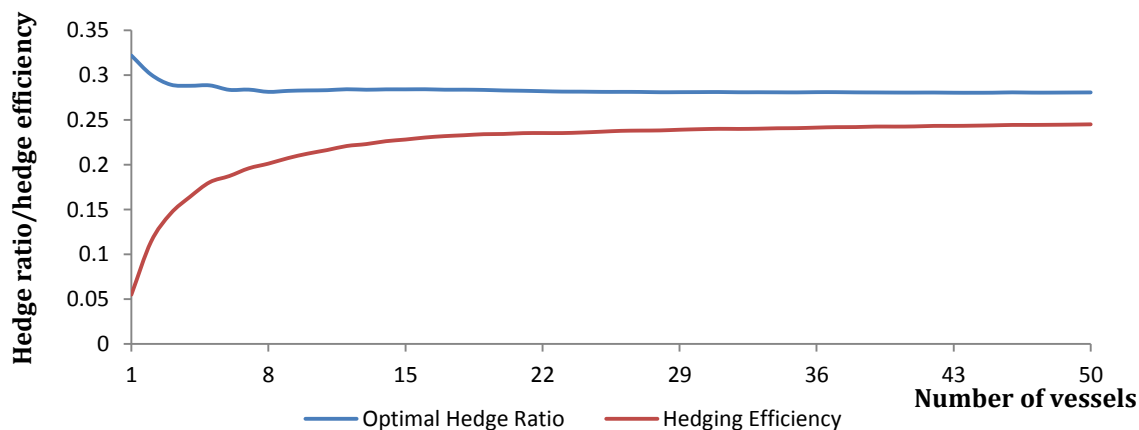were two Backhaul routes, Qingdao – Queensland – Rotterdam and Qingdao – Richards Bay – Rotterdam, and a Trans-Atlantic route, Rotterdam – Tubarao – Rotterdam. What separate these routes from the others is that they will yield negative income for some periods in 2011 and 2012, when operating at Baltic standard speed. Table 5.3 presents a snapshot of the changes in income that a vessel can obtain from voyage-to-voyage. The vessel receives a positive income on a Trans-Pacific voyage, and as the spot rate declines, income turns negative on the following Backhaul voyage.

Table 5.3: Snapshot of negative voyage income

Path	Date	Rate	Port Charge	Fuel cost	Income
Qingdao – Tubarao - Qingdao	5/31/2012	18.457	157,656	2,232,615	625,602
Qingdao – Queensland - Rotterdam	8/18/2012	8.028	284,895	1,934,738	(907,826)

The table shows a snapshot of two possible cash flows. It shows how operating at maximum speed in bad market conditions may result in negative income

The negative income is a result of operating at maximum speed, at a time with low freight rates and high bunker prices. Negative income has a large effect when calculating the monthly changes of average daily income. When the average daily income over a month turns negative, it will

yield large differences between each month. For instance, if actual earnings falls from -\$2000/day at time zero (P_0) to -\$7000/day at time 1 (P_1), the simple return formula[25] will generate a positive return of 250%. On the contrary, if income at time 1 increases to \$3000/day the simple return will generate a negative return of 250%. This example shows that simple return is not well suited for handling negative income rates. Nor is it possible to use logarithmic returns, as they are not defined for negative figures.

It is important to note that the unstable result is not realistic in practice. The shipowner will not fix vessels on rates where he expects to lose hundreds of thousands of dollars, even before operating costs, capital costs etc. are taken into account. The results can be seen as a consequence of a random choice of routes based on probabilities, and the instability can therefore be ignored.

5.2 Basis risk; Geography and timing

In the following section we will study the basis risk factors geography and timing. The model is not constructed to remove these basis risks and they can therefore not be separated. The simulations are based on a Baltic standard vessel operating at the Baltic standard speed in an environment without port congestion and sea margin (The Baltic Exchange, 2012).

Alizadeh and Nomikos (2009) illustrated the magnitude of the basis risk timing by studying percentage difference between FFA settlement rates and freight rates during the settlement month in the period January 2003 to April 2007. Their result showed that FFA contracts, based on the four time charter average, had an average difference in terms of RMS of 8.76%. This difference is small compared to the daily differences, which are observed between actual earnings and BCI, seen in table 5.1. This implies that most of the difference can be explained by the basis risk geography and the "lag" effect. Note, that these results are based on a different approach and a different time frame than this dissertation. Still, they give an idea of the magnitude of the basis risk timing.

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[25] $Simple\ return = \frac{P_1}{P_0} - 1, where\ P_0\ and\ P_1\ is\ the\ price\ of\ an\ asset\ at\ time\ 0\ and\ 1\ respectively$

Exhibit 5.5 shows the hedging efficiency for the period 2004-2008, when only geography and timing are present. The result shows that the efficiency is 38.9% for a fleet of 50 vessels.

Exhibit 5.5: Hedging efficiency with limited basis risk
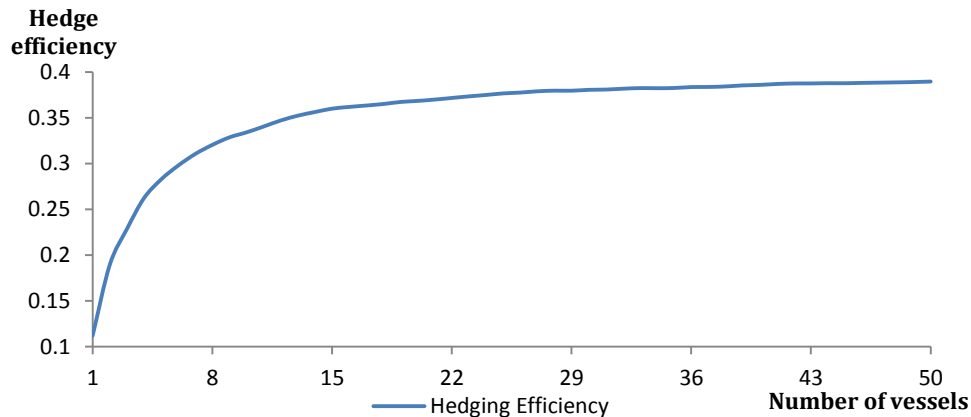
Hedging efficiency in the period 2004 - 2008 when only basis risk from geography and timing is present

The reason for the low efficiency can be related to the discussion in section 5.1.2, the importance of correlation between changes in income and BCI. In theory, a shipowner can have a fleet of vessels that are exactly equal to the Baltic standard vessel, operating at 14.5 knots laden and 15 knots ballast and avoid port congestion. Even so, the correlation between actual earnings and BCI proves to be 62.4% for 50 vessels in 2004 – 2008. The difference from 100% correlation can be explained by the earlier discussed lag effect in addition to the basis risk from geography and timing.

In section 3.4.2 we discussed the possibility of hedging with route specific $/tonne rates, as this should be more efficient than contracts based on the four time charter average. Due to poor liquidity in these FFA contracts, such a strategy is difficult to implement (The Baltic Exchange, 2012). These results imply that even with a theoretical approach, there is a clear difference between actual earnings and BCI.

5.3 Basis risk; Duration

The following section will emphasize how actual earnings are affected by the basis risk duration. Duration refers to the risk of using more or less time on a voyage than expected, mainly due to changes in operating speed and port congestion.

5.3.1 Operating Speed

The following simulation is based on the Baltic standard vessel operating with three different speed levels, Baltic standard speed, charterparty speed and optimal speed. Baltic standard speed is given in the Manual for Panellists and is 14.5 knots laden and 15.0 knots ballast (The Baltic Exchange, 2012). Charterparty speed is 11.5 knots laden and 12.0 knots ballast and optimal speed is found theoretically using equation 30 presented in section 4.2.4.3.1. A more thorough discussion can be found in section 4.2. Note that results found using Baltic standard speed are the same as the one presented in section 5.2. By comparing results when the speed differs, the added basis risk from operating speed will be emphasized.

Exhibit 5.6: Influence on actual earnings from operating speed
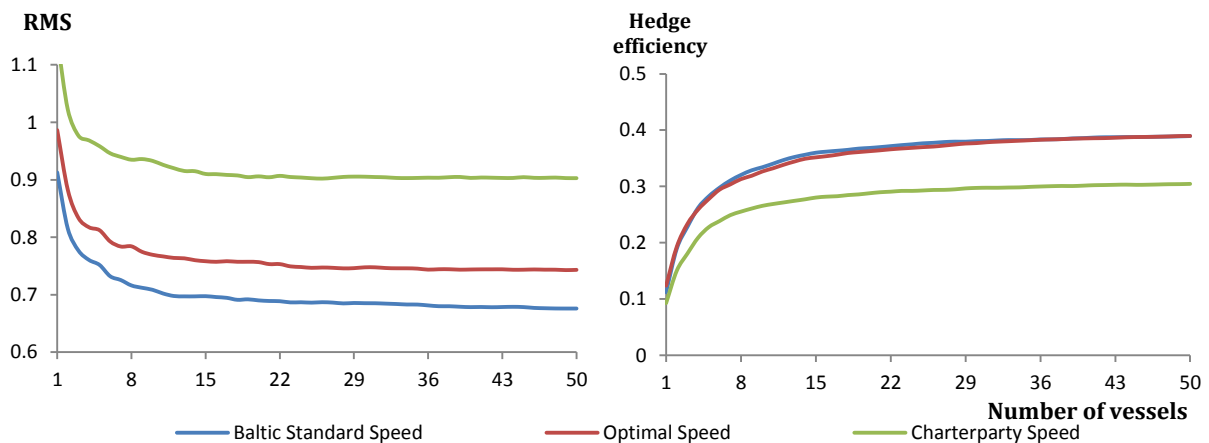
Development in daily differences between actual earnings and BCI, and hedging efficiency depending on the fleet size and operating speed in the period 2004 - 2008

The definition of basis risk states that the higher difference between the spot price and the hedging instrument, the higher basis risk. It is therefore expected that the more operating speed

differ from the Baltic standard speed, the higher basis risk. The charterparty speed has both a larger difference between daily earnings and BCI and a lower hedging efficiency. In other words, the results are consistent with the definition of basis risk, as there is a clear difference between the charterparty speed and Baltic standard speed.

There are only a small difference between optimal speed and the Baltic standard speed in 2004-2008. This is expected as the ratio between freight rates and bunker prices implied an operating speed equal to the Baltic standard speed until mid-2008. The slight differences are due to reduced operating speed in 2008 as a result of the sharp drop in spot freight rates.

The differences in hedging efficiency can once again be explained by correlation. The four time charter routes underlying the BCI assume that vessels operate at Baltic standard speed. If the speed is different from the Baltic standard, the correlation between earnings and BCI will be reduced and the difference increased. Lower correlation will yield lower optimal hedge ratios and lower hedge efficiency.

5.3.2 Port congestion

In addition to operating speed, port congestion is another factor that affects the basis risk duration. As discussed in section 5.1.3, simulation using Baltic standard speed generates unreliable results for the period 2009 – 2012. We therefore believe that the best way to emphasize the basis risk coming from port congestion is by comparing simulations using optimal speed. Operating at optimal speed in the period 2004-2008 will also result in speed that is close to Baltic standard speed. The following results will compare a Baltic standard vessel operating at optimal speed in an environment with and without port congestion.

Exhibit 5.7: Port congestions influence on hedging performance
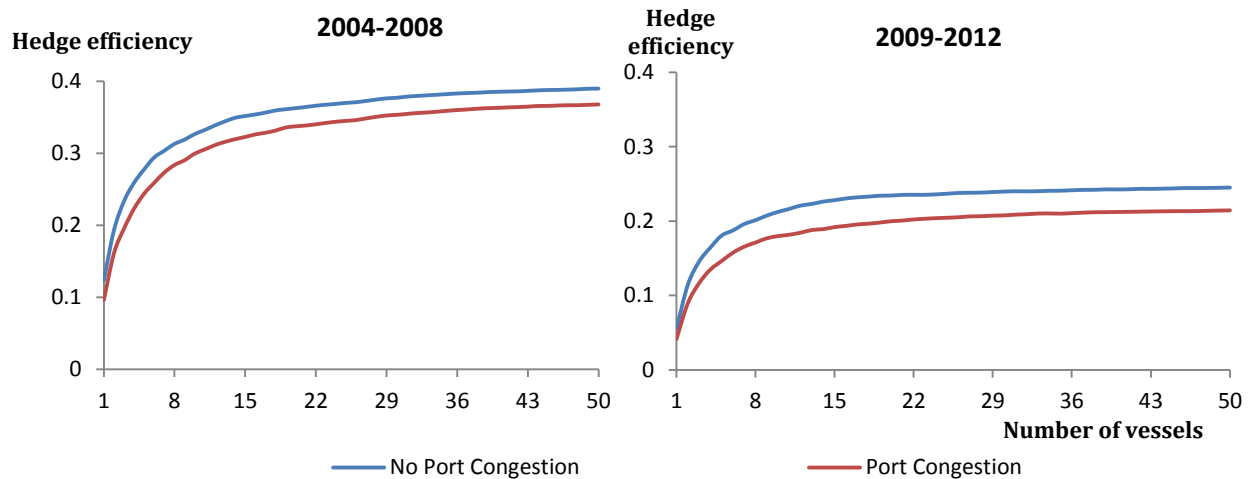
Hedging efficiency in 2004 – 2008 and 2009 – 2012 for different fleet sizes in an environment with and without port congestion

Exhibit 5.7 shows hedging efficiency for both periods, 2004-2008 and 2009-2012. The exhibit shows that hedging efficiency is reduced when implementing port congestion in both periods. This is as expected since longer voyage duration will increase the "lag" effect in actual earnings compared to BCI. Further, this increase will lead to reduced correlation between daily earnings and BCI, as the expected voyage duration given by the Baltic exchange does not account for port congestion.

The results imply that the basis risk due to port congestion reduces hedging efficiency by approximately the same amount for both periods. In both periods port congestion stands for a reduction in hedging efficiency of around 2-3 percentage points. Previous discussion states that port congestion mainly became a problem from 2006, which is reflected in our data series on port congestion. You could therefore believe that port congestion would have a smaller effect on the hedging efficiency in the first period. However, it seems that this is offset by the increased congestion during the peak years before the market plummet.

Compared to the results on hedging efficiency found for different speed levels, it seems that port congestion has a smaller effect on hedging efficiency than operating with the charterparty speed.

If shipowners choose to operate at the Baltic standard speed or the theoretical optimal, duration seems to only reduce hedging efficiency by a couple of percentage. If shipowners choose to operate at the charterparty speed, observed industry average, the efficiency is expected to be reduced four times as much.

5.4 Technical differences

In this section we will examine how different technical specifications affect earnings. The following results are based on the three different vessels introduced in section 4.2.3[26] operating at optimal speed in an environment without port congestion and sea margin.

Exhibit 5.8: Technical specifications influence on actual earnings
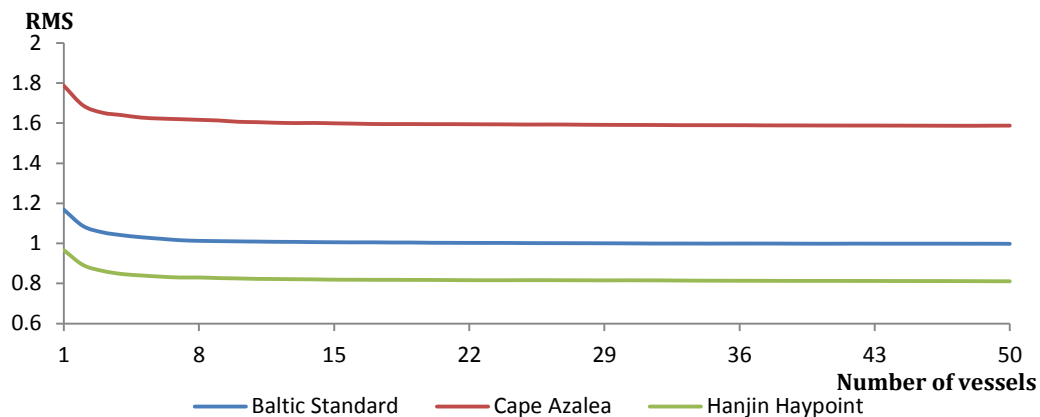
Difference between daily earnings and BCI for the three vessels in the period 2009-2012

Exhibit 5.8 shows daily difference between actual earnings and BCI for the Baltic standard vessel, Hanjin Haypoint and Cape Azalea. An expected result would be that the daily difference increases the more vessel specifications differ from the Baltic standard vessel. Though, this does not seem to be the case, as the vessel Hanjin Haypoint has a lower daily difference than the Baltic standard vessel. The differences are rather a result of different earnings compared to BCI. Due to

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[26] These are; Baltic Standard vessel with loading capacity of 172,000 dwt, Cape Azalea with loading capacity of 220,000dwt and Hanjin Haypoint with loading capacity of 150,302dwt. Each of the vessels has unequal fuel consumption and design speed. For more information see table 4.2.3

the basis risk timing and geography does the Baltic Standard vessel, on average, have a higher income relative to BCI. Hanjin Haypoint has on average a more similar income rate relative to BCI, due to is loading capacity. Cape Azalea, which has a higher loading capacity than the Baltic standard vessel, will have a significant higher income relative to BCI. The fact that vessels earn more than BCI relates to development in seaborne trade and the composition of BCI. Freight rates on Backhaul routes are low compared to the other major routes, which can be seen in appendix 9.3. Over the last decade the number of Backhaul voyages has been reduced significantly. According exhibit 2.1 the number of Backhauls has been reduced from 18.5% to only 4.7%. BCI are equally weighted of the four major routes, which means that 25% of its value is determined by Backhaul rates. Therefore, on average will daily income for a vessel be higher than BCI. A smaller vessel, like Hanjin Haypoint, has therefore an income, which is more similar to BCI.

It is expected that the difference in daily income would be reflected in terms of optimal hedge ratio and hedging efficiency. However, it is evident in exhibit 5.9 that there are only small differences between the three vessels.

Exhibit 5.9: Technical specifications influence on hedging performance
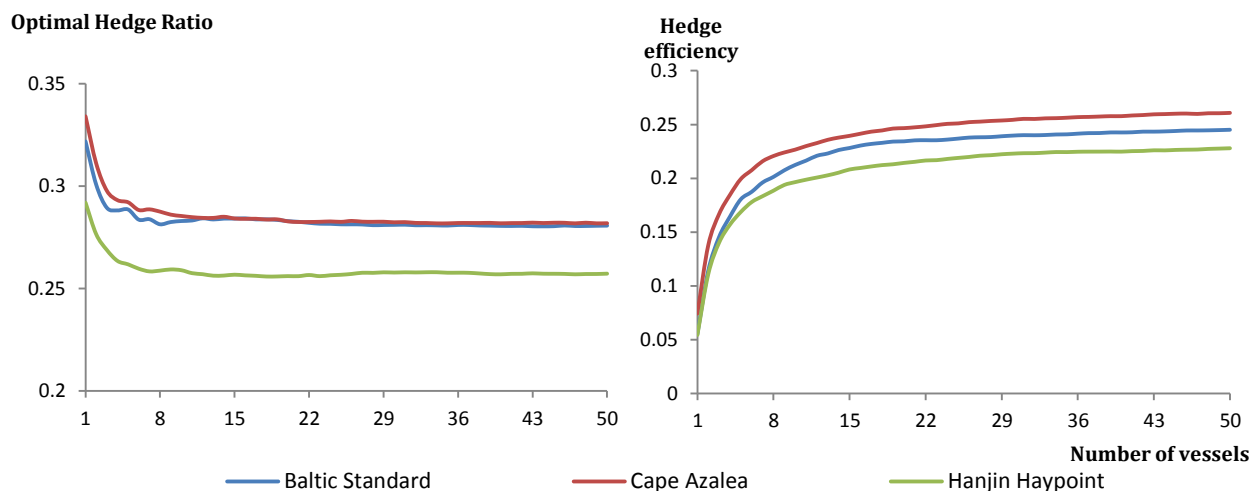
Presentation of optimal hedge ratio and hedging efficiency based on the three different vessels in the period 2009-2012

We have earlier stressed the fact that both the optimal hedge ratio and hedging efficiency is highly determined by correlation. Seen in exhibit 5.9, the difference in correlation between the vessels is relatively small, even though there are large technical differences. The most influential specification for actual earnings is loading capacity. Since vessels load constant at 95%, the capacity has little effect on the monthly simple return. The regression is based on simple returns, which do not change if all monthly averages are changed by the same amount. Also if vessels operate at the charterparty or optimal speed, the design speed will not affect the results. Technical specifications seem therefore to have a relatively small impact on the optimal hedge ratio and hedging efficiency, despite large differences between the three vessels.

Recall that the beta used when calculating the optimal speed is assumed to be constant and equal in all three calculations. Since beta determines the slope of the exponential function, seen in equation 28[27], the ratio between vessels will not be much affected by fuel consumption. In reality there might be larger differences, as the exponential function for fuel consumption varies in terms of beta.

5.5 A Realistic scenario

This section will examine a realistic scenario of how good BCI is as a proxy for actual earnings. The results presented are based on the three different vessels, including all basis risks described in previous sections. The vessels will operate at theoretical optimal speed. To emphasize the effect basis risk has, the results will be compared to the result in 5.2, where timing and geography are the only basis risks.

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[27] Representation of equation 28: $F = \alpha * V^{\beta}$ in the range $V_{min} < V < V_{max}$

Exhibit 5.10: Realistic hedging performance
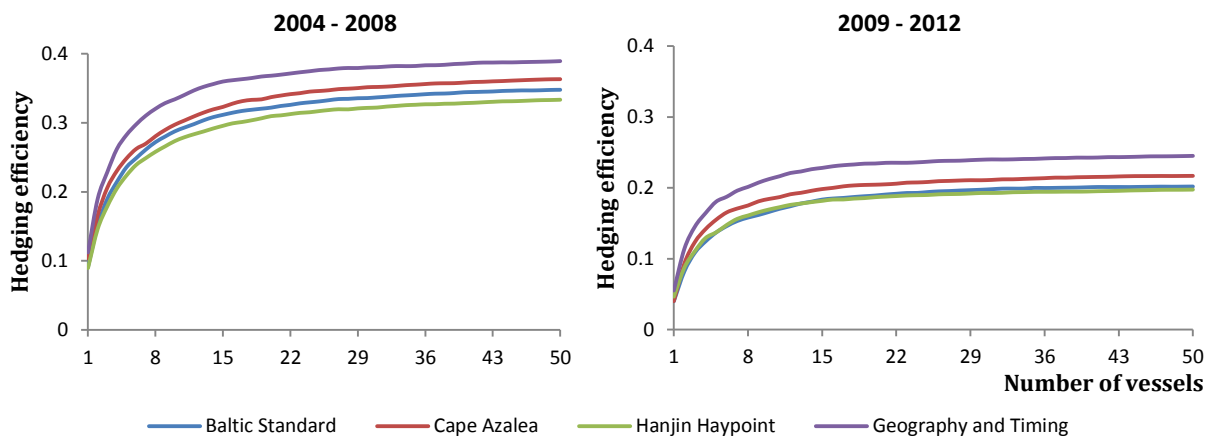
The exhibit highlights the effect that basis risk has on hedging effectiveness. The exhibit indicate that hedging performance when only the basis risk from geography and timing are present, yields a higher hedging efficiency than the realistic scenario. Note that Geography and Timing in 2009-2012 is based on optimal speed due to instability with Baltic standard speed

As seen from the previous results, the hedging effectiveness has gone down as it is implemented more basis risk into the simulation. The hedging efficiency dropped less than what is expected after examining each basis risk factor. This may be explained by the fact that some basis risk factors are offset by others.

If BCI is a perfect proxy for actual earnings, the hedging efficiency should be 100%. Results show that hedging efficiency with an optimal hedge ratio converges to 15 - 35% for larger fleet sizes. This indicates that BCI is not a good proxy for actual Capesize earnings.

5.6 One year hedging perspective

So far we have only looked at long hedging horizons, 4 and 5 years. To illustrate how market conditions affect the relationship between BCI and actual earnings, the following section will highlight earnings on a year-to-year basis. These simulations are based on a realistic view, where Baltic standard vessels operate at optimal speed in an environment with port congestion and a 5% sea margin.

In section 5.1.1 we discussed the "lag" effect and how this was affected by different market conditions. The Capesize market has been stable some years, and extremely volatile in others. It is by no surprise that the daily difference between annual periods differ significantly, seen in table 5.4. In 2008, when the market plummets, the "lag" in actual earnings yields the largest daily difference between earnings and BCI. The smallest difference is observed in the years prior to the financial crisis.

Table 5.4: Annual hedging performance

# Vessels	1	2	3	5	10	15	25	50
RMS								
Max, 2008	2.070	1.894	1.826	1.751	1.717	1.676	1.654	1.641
Min, 2006	0.310	0.241	0.215	0.189	0.167	0.160	0.153	0.148
Hedge ratio								
Max, 2005	0.631	0.588	0.598	0.594	0.585	0.583	0.579	0.574
Min, 2012	0.112	0.110	0.104	0.105	0.103	0.101	0.098	0.099
Hedge Efficiency								
Max, 2005	0.149	0.233	0.282	0.335	0.394	0.419	0.438	0.450
Min, 2010	0.013	0.024	0.026	0.036	0.043	0.046	0.043	0.046

Presentation of maximum and minimum observations on RMS, optimal hedge ratio and hedging efficiency based on year-to-year simulations

Hedging efficiency differ significantly on a year-to-year basis. BCI is best as a proxy on years where there are small fluctuations in freight rates. The maximum obtained hedging efficiency is seen in 2005, with 45% for larger fleets. This is in contrast to 2010, where the hedging efficiency is not more than 4.6% for larger fleets. This implies that BCI as a proxy on short horizons is not preferable compared to longer horizons, as the outcome is highly unpredictable.

5.7 Case: Atlantic or the Pacific basin?

An interesting study is to see if operating solely in one basin increases similarity between BCI and actual earnings. These simulations are based on a realistic view, where Baltic standard vessels operate at optimal speed in an environment with port congestion and a 5% sea margin.

To emphasize possible differences, four hypothetical shipowners are included in the simulation. One of them moves his fleet around the world, obtaining freight rates from both the Pacific and the Atlantic basin. Two of them operate solely in one basin, thus one operates in the Atlantic and the other in the Pacific basin. The last shipowner moves between the basins constantly, meaning that he is only fixed on Backhaul and Fronthaul voyages. Exhibit 5.11 shows the hedging efficiency for the two periods.

Exhibit 5.11: Hedging efficiency for voyages operating in different regions.
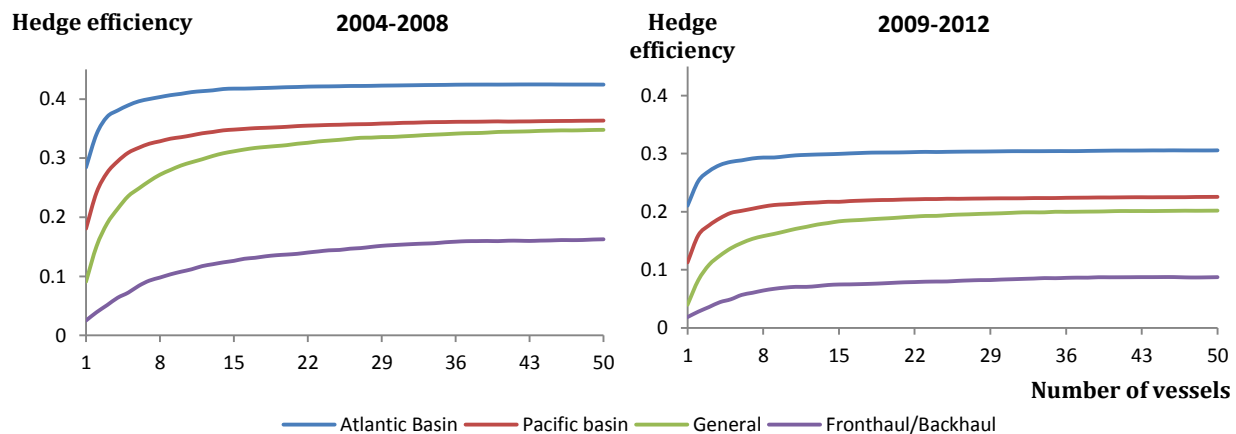
The exhibit shows hedging efficiency for the four shipowners for the periods 2004-2008 and 2009-2012

The results indicate a clear difference in hedging efficiency for the four shipowners. The two shipowners who operate in one basin obtain a higher hedging efficiency compared to the others. The shipowner who is only fixed on Front- or Backhauls has significantly lower hedge efficiency. This is likely due to different voyage durations between Fronthaul/Backhaul and Atlantic/Pacific round voyages. A Fronthaul or Backhaul voyage usually takes 60 - 70 days excluding port congestion, if the vessel operates at Baltic standard speed. While the duration on a Trans-

Pacific/Atlantic voyage is about 30- 40 days excluding port congestion, operating at Baltic standard speed. In other words, the duration on Fronthaul and Backhaul is almost the double. This implies that changed market conditions, BCI, will much sooner be reflected if the vessels avoid longer voyages. A reduced "lag" effect implies a higher correlation between BCI and daily income, which ultimately imply a higher hedging efficiency. Therefore it seems optimal for a shipowner to reduce longer voyages, such as Fronthaul and Backhaul, to a minimum in order to increase hedging efficiency. Hence, operating solely in one basin increases the similarity between BCI and actual earnings.

There is also a clear difference between operating in the Atlantic and Pacific basin. In general, there should not be large differences between the basins, as each is equally weighted in BCI. A possible explanation can be port congestion. Historically port congestion has been a larger problem in the Pacific basin, especially on major routes between Australia and China.

Exhibit 5.12: Hedging efficiency when port congestion is removed
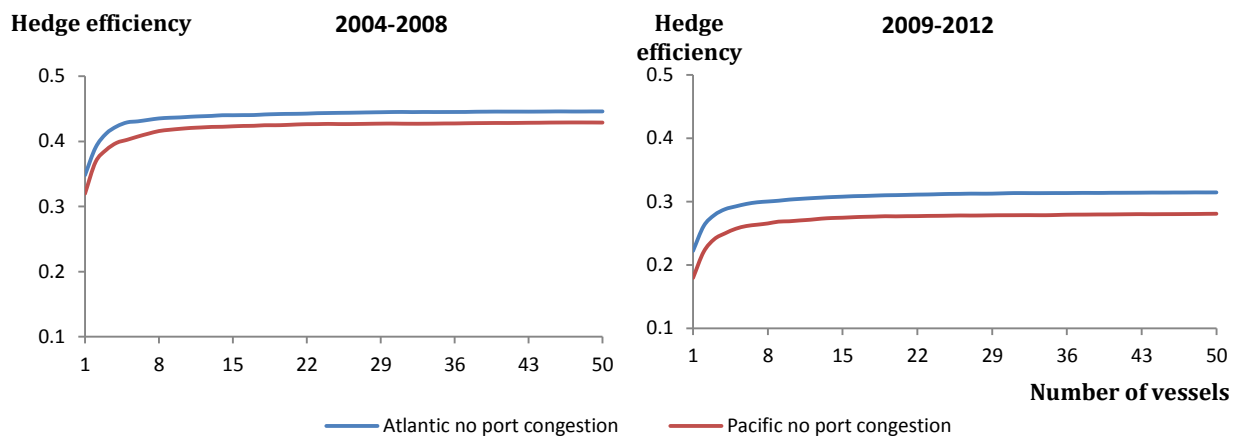
The exhibit shows hedging efficiency for two shipowners that operate in the Atlantic and Pacific basin, without port congestion

Exhibit 5.12 shows hedging efficiency in an environment without port congestion for the two periods, 2004 – 2008 and 2009-2012. It shows that the difference is more than halved, though not fully removed. The differences are not large enough to conclude that operating solely in the Atlantic basin will yield higher similarity between BCI and actual earnings, than operating solely in the Pacific basin.

5.8 The dollar-offset method

This section will present results from the dollar-offset method. To emphasize how the basis risks affect the earnings, we will compare result from a realistic scenario with a scenario with only geography and timing present. The realistic scenario is based on a Baltic standard vessel operating at optimal speed in an environment with port congestion and a sea margin of 5%.

As discussed in section 3.6 we find it appropriate to compare results based on linear regression, with a more practical approach. The dollar-offset method does not rely heavily on correlation, and it is therefore expected that results from the two methods deviate. Through the analysis based on regression there has been evident that correlation between actual earnings and BCI are low, which may yield artificial low hedge ratios and hedging efficiency. Exhibit 5.13 shows a graphical plot of the implied efficiency for different hedge ratios.

Exhibit 5.13: Hedging performance with the dollar-offset method
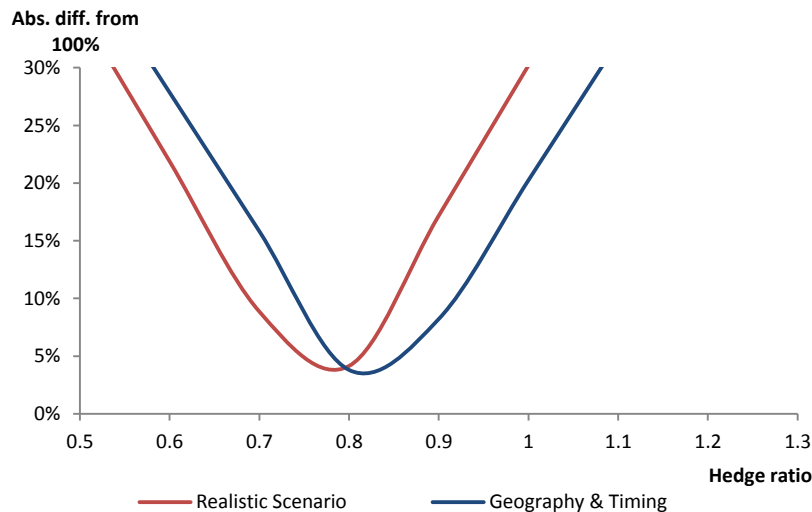
The exhibit shows hedging efficiency for a scenario with only geography and timing present and a realistic scenario, for different hedge ratios for the period 2009-2012

If BCI is a perfect proxy for actual earnings, the absolute change in BCI and actual earnings should be similar. The cumulative changes in earnings would then be completely offset by the cumulative changes in BCI, and the graph would have an absolute difference of 0% at a hedge ratio of 1.0. Any deviation from this point is a result of basis risks, the "lag" effect and the fact

that actual earnings are based on a fleet average. The latter imply that changes in actual earnings will be smaller compared to BCI, and the dollar-offset ratio will then be larger than 1.0. To obtain a dollar-offset ratio of 1.0, the optimal hedge ratio must therefore be lower than 1.0. From exhibit 5.13, it is clear that the "lag" effect, the fact that actual earnings is based on an average and the basis risks geography and timing has the largest impact on actual earnings. At this point, the optimal hedge ratio is reduced to just above 0.80. The red line illustrates a scenario when also port congestion and operating speed are present. Port congestion and operating speed does not seem to have major impact on actual earnings, as the optimal hedge ratio only changes slightly. This is consistent with results found using single linear regression.

Since the correlation between BCI and actual earnings is low, the linear regression implies that BCI is not a good proxy for actual earnings. This is in contrast to the dollar-offset method were results based on a realistic scenario suggests that a hedge ratio of about 0.8 in 2009-2012 is only 5% away from 100% hedging efficiency. This implies that BCI is a good proxy for actual earnings.

Recall from section 4.2.8 that all results are based on 500 fleets, and that income among these will vary. Hence, there will be fleets that fall out of the standard range, even when the average hedging efficiency is maximized. Exhibit 5.14 shows the percentage of fleets that fall out of the standardized 0.80 - 1.25 efficiency range. As the fleet sizes increases, the number of inefficient fleet will eventually be zero. In 2004-2008, the revenue was more stable than 2009-2012, and fleets containing of 5 or more vessels were all inside the efficient range. In 2009-2012, it was necessary with a fleet size of 43 vessels to obtain a similar result.

Exhibit 5.14: Percentage inefficient fleet based on optimal hedge ratio
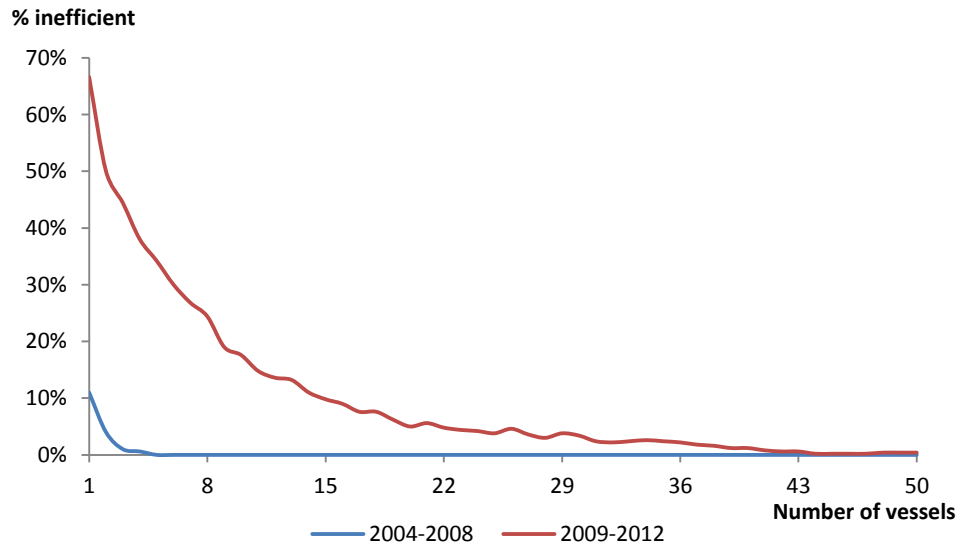
The exhibit shows percentage inefficient fleets in 2004-2008 and 2009-2012. In 2004-2008, the optimal hedge ratio was about 0.9, while in 2009-2012, the optimal hedge ratio was about 0.8

5.8.1 Technical specifications influence on the dollar-offset method

The influence of technical specifications on actual earnings is important, as in reality most vessels deviate significantly from the Baltic standard vessel. Results from the linear regression suggested that different technical specifications had only a small effect on the optimal hedge ratio and hedging efficiency, as the correlation was only slightly affected. The daily differences between actual earnings and BCI differed clearly between the three vessels, evident in exhibit 5.8. Therefore, as the dollar-offset method is based on cumulative differences, results should be more affected by different technical specifications.

Exhibit 5.15: Technical specifications impact on hedging performance
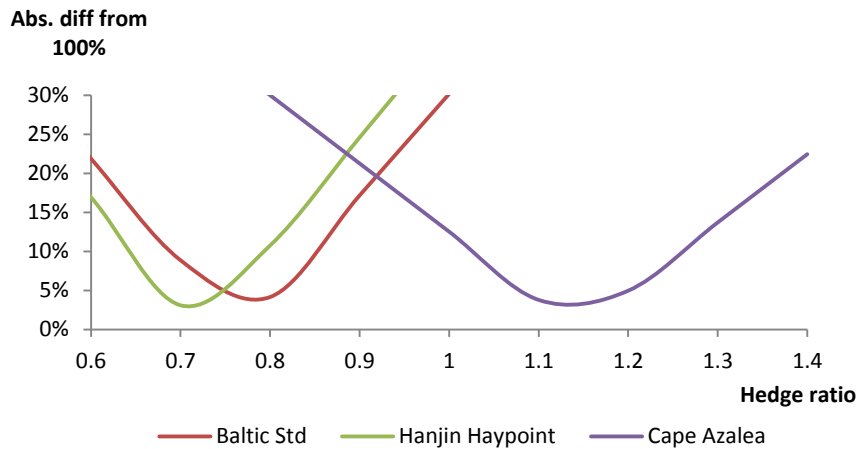
The exhibit shows the absolute difference from 100% efficiency for the Baltic standard vessel, Hanjin Haypoint and Cape Azalea for the period 2009-2012

Exhibit 5.15 shows the absolute difference from 100% hedging efficiency for the three vessels. It is evident that the hedge ratio that maximizes the efficiency clearly deviates between the three vessels. Cape Azalea, which has a higher loading capacity than the standard vessel, maximizes efficiency on a hedge ratio of 1.15. While the smaller vessel in terms of loading capacity, Hanjin Haypoint, optimizes hedging efficiency by a hedge ratio of 0.7. The difference seen in hedge ratio between the three vessels is rather intuitive. BCI is based on the Baltic standard vessel, with dwt of 172,000 tonnes. If a shipowner has a larger vessel than the standard vessel, the cumulative changes in earnings will be larger. The shipowner will therefore need more contracts per vessel, than if he had a vessel with similar dwt. The same discussion applies for the smaller vessel, Hanjin Haypoint. Here the cumulative differences are smaller in actual earnings compared to BCI, and to offset these changes you need fewer contracts.

Exhibit 5.16 shows the percentage inefficient fleet for the different types of vessels based on optimal hedge ratios.

Exhibit 5.16: Percentage inefficient fleet based on optimal hedge ratio
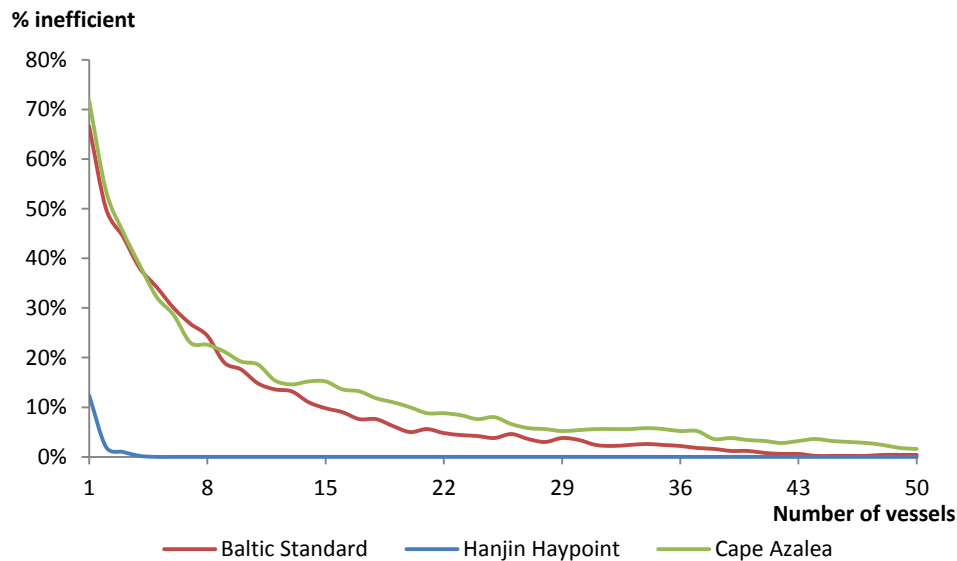
The exhibit shows percentage inefficient fleets in 2009-2012 for the Baltic standard vessel, Hanjin Haypoint and Cape Azalea. The optimal hedge ratio was about 0.8, 0.7 and 1.15 respectively

5.9 Concluding remarks

We first introduced some general observations about actual earnings, unaffected by different basis risks. The difference between actual earnings and BCI can in large part be explained by the "lag" in actual earnings, due to duration of voyages. It has also been evident that the daily difference between actual earnings and BCI stabilizes at fleet sizes of 10 vessels. Hence, increasing the fleet size will not reduce the difference significantly. The stabilization is mainly due to the fact that daily income to a shipowner is calculated based on moving averages. In addition, the results show that the correlation between actual earnings and BCI is low. This implies low optimal hedge ratio and hedge efficiency, as these measures are highly determined by correlation.

In addition to the "lag" effect, the results suggests that the low hedging efficiency can be explained by the basis risk geography and timing. The effect from these factors is not separated, making it hard to conclude which factor has the largest impact. The other basis risks, such as technical specifications, operating speed and port congestion, have relatively low impact on

actual earnings. The results suggest that when incorporating more basis risk factors in the simulations, they offset each other out. Though, it seems that operating speed has a larger influence than the two others. Overall, the linear regression analysis indicates that BCI on a longer horizon is not a good proxy for actual Capesize earnings, as the hedging efficiency is low. BCI did not prove to be a better proxy on a year-to-year basis as the results were highly unpredictable and vulnerable for volatile market conditions.

We also analyzed if BCI was a better proxy if a shipowner were only operating in one basin. The hedging efficiency increased, due to shorter voyages. Longer voyages, such as Front- and Backhauls, increase the difference between BCI and daily income and reduce the overall hedging efficiency. Overall, the increase was not large enough to conclude that BCI is a good proxy.

Results from the dollar-offset method also suggested that the basis risk operating speed and port congestion had only a little effect on the hedging efficiency. Compared to the linear regression, the dollar-offset method implies that vessel specifications have a larger effect on optimal hedge ratio and hedging efficiency. The method suggests that the optimal hedge ratio for the two periods 2004-2008 and 2009-2012 are 0.9 and 0.8 respectively. With these hedge ratios, cumulative changes in actual earnings are almost completely offset by cumulative changes in BCI. This indicates that BCI is a good proxy for actual Capesize earnings.

6. Limitations and further research

Throughout this dissertation the reader has been provided with limitations regarding different aspects and calculations. In the following section we will summarize and elaborate on limitations regarding the model and our findings. The chapter will be divided into two sections. First, there will be a presentation of limitations related to the simulation model. Next, other limitations and further research will be discussed.

6.1 Limitations regarding simulations

There has been necessary to make several adjustments and assumptions when simulating physical cash flows, since simulating a complete realistic cash flow is almost impossible. Some assumptions will typically have a larger impact on the outcome than others and are presented below.

An important limitation is the implementation of just ten out of numerous different routes, and that these routes are randomly chosen based on historical trade flows in the period 2003 – 2012 for the four major routes. It is thought that ten routes are sufficient to simulate realistic cash flows, however it would be even more realistic if more routes were implemented. As we lack data on trade flows for each specific route, each route within a category has been given an equal weighting. Routes were randomly chosen on the basis of this probability.

There is not taken account for any strategic repositioning of vessels. This means that it is assumed a know-nothing behavior from the shipowner, as he does not believe that he can beat the market by optimizing chartering strategies. A more realistic assumption might be to assume that shipowner has developed a fairly detailed knowledge of the industry. Hence, his ability to predict voyage rates is above average. A solution might be to implement ideas from the Black-Litterman approach (Black & Litterman, 1992). The Black-Litterman model enables investors to combine their unique views regarding the performance of various assets with the implied returns in a manner that results in intuitive, diversified portfolios.

The model is based on an incomplete data set on port congestion. For some ports we lack historical data on certain periods, while on other ports we lack data for the entire period. A complete data set on port congestion is essential to obtain a realistic simulation. To overcome this problem we had to make estimates based on previous and later registrations. Thus, some of the ports might in reality have had a complete different congestion than implemented in the model. In addition, port congestion is typically larger on major routes. Since the model is only based on major routes in the Capesize segment, it is possible that port congestion has systematically been overestimated. Both these elements imply that the observed basis risk due to port congestion is at best inaccurate.

Another limitation is related to the optimal speed approach. The model does not include development in spot prices during a voyage when calculating optimal speed. The speed is only dependent on the freight rate when the vessel begins the laden or ballast voyage. As discussed before, the freight market is very volatile and the shipowner can therefore step into a contract at a point where the rates are well below levels that might be obtained on the next voyage. Expectancy of high freight rates on the next voyage should yield a higher optimal speed for the first voyage. Such "look ahead bias" could be implemented by using FFA contracts as a proxy for market expectations.

6.2 Other limitations and further research

The dissertation is based on the definition that forward prices converge to spot price at maturity. Since forward freight agreements in the Capesize segment are bought and hold trough maturity, what matters is the difference between spot index and actual earnings. However, if contracts are not held through maturity, this analysis is less relevant. We therefore find it appropriate to conduct a similar analysis on forward freight agreements.

There are limitations regarding the linear regression framework used for calculating optimal hedge ratio and hedging efficiency. In section 3.5.2 we introduced 5 assumptions that the method is based on. Because of our practical approach and the extensive test necessary, we have assumed that four of those assumptions hold. If one or more of these assumptions are violated the model

could encounter a combination of three problems; the coefficient estimates are wrong, the associated standard errors are wrong or the distributions that were assumed for the tests statistics are inappropriate (Brooks, 2008). Hence, it is possible that wrong conclusions are drawn from the regression analysis. A continuance would be to test these assumptions.

The regression analysis, derived from Ederington's framework, is based on the restriction that the hedge ratio is constant over time. Studies done by Baillie & Myers (1991) and Moschini & Myers (2002) recognized that spot-futures distribution is time- varying, and that hedge ratio therefore should be time-dependent. One way for addressing this problem is by using the multivariate generalized autoregressive conditional heteroscedasticity (GARCH) model to estimate the conditional second moments that are relevant for hedge ratio estimation (Myers, 1991). Since the hedge ratio changes as new information arrives to the markets, generally, this realistic ratio tends to outperform the static ordinary least squares in terms of risk reduction size (Sheu, Lee, & Lai, 2013).

A possible further study would be to examine whether the results are transferable to other sector and segments within shipping. For instance, there are several studies examining hedging efficiency in the Panamax segment. Though, as far as we know, no similar research has been conducted on the Panamax segment.

7. Summary and conclusion

The purpose of this dissertation is to examine if the Baltic Capesize Index is a good proxy for actual Capesize earnings, and highlight factors that influence earnings. In practice, forward freight agreements are bought and held through maturity, and forward prices will per definition converge to spot prices as they reach maturity. Therefore, the difference between spot index and actual earnings may implicate if forward freight agreements are suitable for revenue management in practice. To approach this problem we have simulated physical cash flows for different fleet sizes in the period 2004 to 2012. These physical cash flows are compared to the Baltic Capesize Index when different basis risk factors are present.

A key parameter with this approach is to simulate as realistic cash flows as possible. We have therefore devoted a major part of this dissertation to create a realistic model based on historical data. To evaluate if the Baltic Capesize Index is a good proxy, we have examined differences between actual earnings and the Baltic Capesize Index and implemented frameworks for hedging performance. The linear regression model, which is based on Ederington`s framework (1979), shows how it is possible to find a hedge ratio that minimizes a portfolio's variance, and its hedging efficiency. This framework is highly dependent of correlation, and may not be a suitable method in shipping. The freight market is a hard-to-define market, and an excessive degree of statistical accuracy in calculation of correlations may be misleading. We have therefore introduced the dollar-offset method as an alternative to the more accepted linear regression method. The dollar-offset method is not highly dependent on correlation, but rather absolute changes.

We have performed several simulations under variation of different basis risk factors, in order to determine what separates the Baltic Capesize Index from being a perfect proxy for actual earnings. Both methods applied suggest that large fleet sizes have little effect on hedging performance. It is in practice no difference in hedging performance for a fleet consisting of 10 vessels compared to a fleet of 100 vessels. The basis risk factors timing and geography together with the "lag" effect between actual earnings and Baltic Capesize Index has greatest influence on actual earnings. The "lag" effect is increased with long hauls, and higher efficiencies are obtained

if vessels operate solely in one basin. Basis risk coming from operating speed and port congestion have a relatively little impact on actual earnings. These factors yield a low correlation between Baltic Capesize Index and actual earnings, which result in a low hedging efficiency for the regression analysis. The two methods applied yields different results when analyzing technical specifications. In linear regression they have little impact, as they do not seem to affect the correlation. Though, they have a large effect on cash flows, which makes them more important according to the dollar-offset method.

Findings based on the regression analysis imply that Baltic Capesize Index is not a good proxy for actual earnings, as hedging efficiency is relatively low. This may indicate that forward freight agreements are not a suitable hedging instrument for revenue management in practice. This conclusion is in stark contrast to results obtained by the dollar-offset method. The dollar-offset method indicates that with an optimal hedge ratio, cumulative changes in actual earnings are almost completely offset by cumulative changes in the Baltic Capesize Index. This indicates that the Baltic Capesize Index is actually a good proxy for actual Capesize earnings, and that forward freight agreements are suitable for revenue management in practice.

Results from the two methods applied are in contrast to each other. Linear regression is a more common and accepted method within finance, but evidence suggests that it is not well suited within the shipping industry. The dollar-offset method seems to be more appropriate, but the method is less common and has clear weaknesses. No research has been conducted on which methods are preferable within shipping, and it is therefore difficult to conclude if the Baltic Capesize Index is a good proxy for actual Capesize earnings.

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9. Appendices

9.1 Trend in congestion

Exhibit 9.1: Observed trend in port congestion
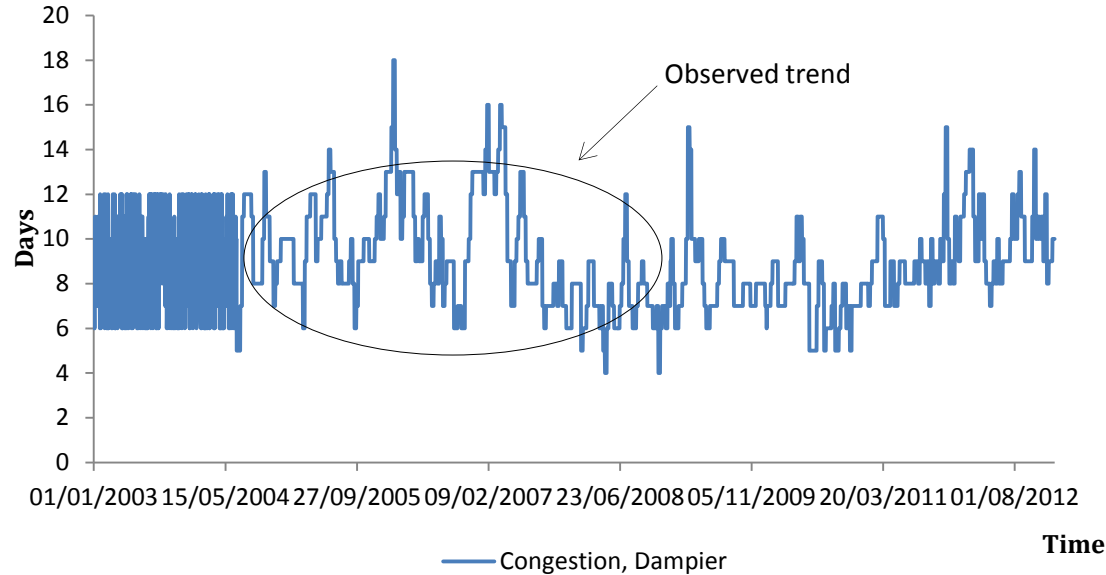
The exhibit shows observed trend in port congestion for port Dampier located in Australia

9.2 Results

In the following section all our results are presented. Each of the tables headlines which basis risk factor that is implemented in the simulation. There is also specified vessel type, operating speed and if sea margin or port congestion are present. All results are based on simulation where fleets contain up to 50 vessels.

BASIS RISK: OPERATING SPEED									
Vessel	Baltic std								
Operating speed	Changing								
Sea margin	0%								
Port Congestion	No								
		# of vessels	1	2	3	5	10	25	50
RMS	2004-2008	Baltic Std	0.913	0.815	0.777	0.752	0.709	0.686	0.676
		Optimal	0.986	0.882	0.834	0.812	0.769	0.747	0.743
		Charterparty	1.145	1.022	0.977	0.958	0.933	0.903	0.903
	2009-2012	Baltic Std	0.935	0.743	0.662	0.584	0.516	0.475	0.461
		Optimal	1.168	1.086	1.056	1.031	1.010	1.002	0.998
		Charterparty	1.126	1.004	0.964	0.931	0.902	0.886	0.881
Hedge ratio	2004-2008	Baltic Std	0.580	0.563	0.552	0.553	0.548	0.545	0.542
		Optimal	0.595	0.567	0.555	0.544	0.539	0.540	0.541
		Charterparty	0.441	0.428	0.422	0.430	0.430	0.424	0.423
	2009-2012	Baltic Std	0.360	0.521	0.229	0.654	0.295	0.532	0.509
		Optimal	0.322	0.301	0.289	0.289	0.283	0.281	0.281
		Charterparty	1.420	0.276	0.258	0.249	0.247	0.242	0.243
Hedging Efficiency	2004-2008	Baltic Std	0.112	0.189	0.228	0.283	0.334	0.377	0.389
		Optimal	0.124	0.193	0.233	0.278	0.327	0.370	0.390
		Charterparty	0.093	0.150	0.181	0.228	0.265	0.293	0.304
	2009-2012	Baltic Std	0.000	0.003	0.000	0.005	0.000	0.121	0.364
		Optimal	0.055	0.114	0.145	0.181	0.212	0.237	0.245
		Charterparty	0.000	0.007	0.035	0.160	0.200	0.225	0.237

The table shows the effect changes in operating speed has on RMS, Optimal Hedge Ratio and Hedging efficiency for a standard Baltic Capesize vessel for the two periods 2004-2008 and 2009-2012

BASIS RISK: PORT CONGESTION								
Vessel	Baltic std							
Operating speed	Optimal speed							
Sea margin	0%							
Port Congestion	Yes							
	# of vessels	1	2	3	5	10	25	50
RMS	2004-2008	1.006	0.869	0.824	0.796	0.774	0.759	0.747
	2009-2012	1.103	1.005	0.978	0.942	0.921	0.907	0.899
Hedge ratio	2004-2008	0.584	0.563	0.543	0.537	0.532	0.527	0.529
	2009-2012	1.103	1.005	0.978	0.942	0.921	0.907	0.899
Hedging Efficiency	2004-2008	0.096	0.161	0.195	0.244	0.299	0.345	0.368
	2009-2012	0.041	0.089	0.116	0.146	0.180	0.205	0.214

The table presents the effect port congestion has on RMS, Optimal Hedge Ratio and Hedging Efficiency for a standard Baltic Capesize vessel operating at optimal speed in the two periods 2004-2008 and 2009-2012

BASIS RISK: TECHNICAL SPECIFICATIONS									
Vessel	Baltic std								
Operating speed	Optimal speed								
Sea margin	0%								
Port Congestion	No								
		# of vessels	1	2	3	5	10	25	50
RMS	2004-2008	Baltic Std	0.986	0.882	0.834	0.812	0.769	0.747	0.743
		Cape Azalea	0.900	0.805	0.768	0.739	0.712	0.685	0.677
		Hanjin Haypoint	0.873	0.793	0.772	0.744	0.713	0.694	0.683
	2009-2012	Baltic Std	1.168	1.086	1.056	1.031	1.010	1.002	0.998
		Cape Azalea	1.787	1.689	1.652	1.628	1.607	1.593	1.588
		Hanjin Haypoint	0.966	0.892	0.863	0.840	0.825	0.817	0.811
Hedge ratio	2004-2008	Baltic Std	0.595	0.567	0.555	0.544	0.539	0.540	0.541
		Cape Azalea	0.560	0.533	0.525	0.518	0.511	0.508	0.509
		Hanjin Haypoint	0.553	0.530	0.520	0.513	0.510	0.509	0.508
	2009-2012	Baltic Std	0.322	0.301	0.289	0.289	0.283	0.281	0.281
		Cape Azalea	0.334	0.311	0.298	0.292	0.285	0.283	0.282
		Hanjin Haypoint	0.292	0.277	0.269	0.262	0.259	0.257	0.257
Hedging Efficiency	2004-2008	Baltic Std	0.124	0.193	0.233	0.278	0.327	0.370	0.390
		Cape Azalea	0.118	0.189	0.226	0.272	0.317	0.351	0.366
		Hanjin Haypoint	0.113	0.185	0.221	0.268	0.315	0.353	0.367
	2009-2012	Baltic Std	0.055	0.114	0.145	0.181	0.212	0.237	0.245
		Cape Azalea	0.074	0.138	0.167	0.199	0.227	0.251	0.261
		Hanjin Haypoint	0.054	0.111	0.140	0.169	0.196	0.219	0.228

The table presents the effect that technical differences has on RMS, Optimal Hedge Ratio and Hedging Efficiency for a standard Baltic Capesize vessel operating at optimal speed in the two periods 2004-2008 and 2009-2012

		# of vessels	1	2	3	5	10	25	50
BASIS RISK: REALISTIC APPROACH									
Vessel	Different								
Operating speed	Optimal speed								
Sea margin	5%								
Port Congestion	Yes								
RMS	2004-2008	Baltic Std	0.990	0.878	0.829	0.807	0.771	0.743	0.740
		Cape Azalea	1.314	1.188	1.154	1.098	1.065	1.055	1.049
		Hanjin Haypoint	0.935	0.841	0.804	0.767	0.730	0.713	0.699
	2009-2012	Baltic Std	1.023	0.929	0.892	0.863	0.834	0.818	0.813
		Cape Azalea	1.519	1.415	1.373	1.338	1.311	1.291	1.287
		Hanjin Haypoint	0.861	0.778	0.748	0.722	0.699	0.688	0.684
Hedge ratio	2004-2008	Baltic Std	0.563	0.539	0.531	0.524	0.519	0.516	0.513
		Cape Azalea	0.585	0.558	0.546	0.530	0.516	0.515	0.512
		Hanjin Haypoint	0.531	0.503	0.497	0.496	0.489	0.487	0.486
	2009-2012	Baltic Std	0.302	0.276	0.269	0.265	0.260	0.262	0.260
		Cape Azalea	0.277	0.274	0.273	0.269	0.263	0.260	0.259
		Hanjin Haypoint	0.299	0.258	0.254	0.249	0.247	0.245	0.244
Hedging Efficiency	2004-2008	Baltic Std	0.091	0.151	0.190	0.236	0.288	0.331	0.348
		Cape Azalea	0.103	0.166	0.206	0.248	0.297	0.346	0.363
		Hanjin Haypoint	0.089	0.146	0.179	0.224	0.273	0.317	0.333
	2009-2012	Baltic Std	0.040	0.082	0.109	0.137	0.166	0.194	0.202
		Cape Azalea	0.040	0.093	0.124	0.155	0.184	0.208	0.217
		Hanjin Haypoint	0.046	0.087	0.111	0.137	0.169	0.190	0.198

The table presents results for a realistic simulation where different vessels operate at optimal speed, with port congestion and obtain a 5% sea margin for the two periods 2004-2008 and 2009-2012.

|	# of vessels	1	2	3	5	10	25	50
ANNUAL								
Vessel	Baltic Standard							
Operating speed	Optimal speed							
Sea margin	5%							
Port Congestion	Yes							
	2004	0.285	0.228	0.206	0.185	0.169	0.157	0.153
	2005	0.379	0.309	0.280	0.257	0.235	0.222	0.218
	2006	0.310	0.241	0.215	0.189	0.167	0.153	0.148
	2007	0.289	0.246	0.229	0.215	0.204	0.196	0.194
RMS	2008	2.070	1.894	1.826	1.751	1.717	1.654	1.641
	2009	0.517	0.433	0.400	0.372	0.348	0.334	0.328
	2010	0.518	0.431	0.401	0.366	0.343	0.329	0.323
	2011	0.780	0.697	0.659	0.635	0.617	0.607	0.602
	2012	1.888	1.752	1.719	1.680	1.648	1.624	1.622
	2004	0.401	0.395	0.388	0.383	0.396	0.395	0.393
	2005	0.631	0.588	0.598	0.594	0.585	0.579	0.574
	2006	0.324	0.346	0.354	0.365	0.363	0.357	0.347
	2007	0.509	0.466	0.454	0.440	0.425	0.402	0.396
Hedge ratio	2008	0.295	0.254	0.241	0.229	0.224	0.218	0.215
	2009	0.507	0.436	0.430	0.424	0.413	0.405	0.405
	2010	0.172	0.163	0.144	0.143	0.137	0.128	0.128
	2011	0.200	0.213	0.223	0.213	0.210	0.210	0.211
	2012	0.112	0.110	0.104	0.105	0.103	0.098	0.099
	2004	0.062	0.107	0.130	0.156	0.201	0.227	0.236
	2005	0.149	0.233	0.282	0.335	0.394	0.438	0.450
	2006	0.018	0.037	0.053	0.081	0.107	0.133	0.140
	2007	0.038	0.065	0.090	0.131	0.184	0.236	0.267
Hedging Efficiency	2008	0.093	0.097	0.099	0.098	0.104	0.104	0.103
	2009	0.074	0.143	0.186	0.241	0.281	0.307	0.318
	2010	0.013	0.024	0.026	0.036	0.043	0.043	0.046
	2011	0.032	0.068	0.101	0.127	0.169	0.215	0.237
	2012	0.010	0.033	0.049	0.071	0.094	0.107	0.117

The table presents RMS, Optimal Hedge Ratio and Hedging Efficiency for a Baltic standard Capesize vessel operating at optimal speed, obtaining port congestion and a 5% sea margin. The results show that BCI is best as a proxy on years where there are small fluctuations in freight rates

BASIS RISK: Geography									
Vessel	Baltic Std								
Operating speed	Optimal speed								
Sea margin	5%								
Port Congestion	Yes								
		# of vessels	1	2	3	5	10	25	50
RMS	Atlantic	2004-2008	0.628	0.576	0.557	0.538	0.528	0.521	0.518
		2009-2012	0.807	0.765	0.750	0.739	0.728	0.724	0.723
	Pacific	2004-2008	0.514	0.455	0.436	0.422	0.408	0.402	0.399
		2009-2012	0.694	0.662	0.652	0.644	0.638	0.632	0.631
	FHC-BHC	2004-2008	1.633	1.467	1.413	1.364	1.322	1.288	1.282
		2009-2012	1.397	1.274	1.227	1.191	1.167	1.152	1.146
Hedge ratio	Atlantic	2004-2008	0.666	0.659	0.659	0.657	0.655	0.654	0.653
		2009-2012	0.485	0.476	0.474	0.470	0.466	0.466	0.465
	Pacific	2004-2008	0.654	0.642	0.638	0.639	0.637	0.637	0.637
		2009-2012	0.370	0.366	0.363	0.363	0.361	0.360	0.360
	FHC-BHC	2004-2008	0.448	0.369	0.349	0.333	0.326	0.318	0.316
		2009-2012	0.311	0.202	0.176	0.165	0.161	0.152	0.150
Hedging efficiency	Atlantic	2004-2008	0.284	0.341	0.370	0.389	0.409	0.422	0.425
		2009-2012	0.210	0.253	0.270	0.286	0.295	0.303	0.306
	Pacific	2004-2008	0.181	0.242	0.275	0.309	0.336	0.357	0.364
		2009-2012	0.113	0.159	0.177	0.198	0.213	0.222	0.226
	FHC-BHC	2004-2008	0.025	0.039	0.051	0.072	0.108	0.145	0.163
		2009-2012	0.019	0.028	0.036	0.049	0.069	0.080	0.087

The table presents a Baltic standard Capesize vessel that operates at optimal speed solely in one basin with port congestion and a 5% sea margin

9.3 Historic development in freight rates

Exhibit 9.2: Historical development in freight rates
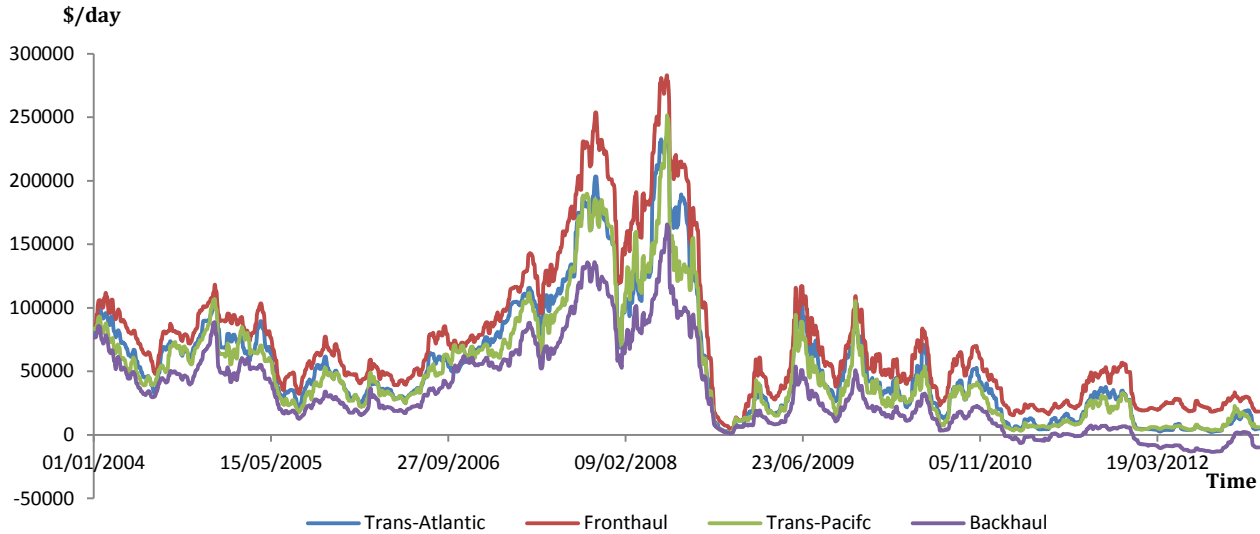
The exhibit shows time charter rates for the major routes. It is evident that Backhaul rates are consistently lower than the rates for other routes