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The Baltic Dry Index: A predictor of stock market returns?

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''God must have been a shipowner. He placed the raw materials far from where they were needed and covered two thirds of the earth with water''

(Erling Naess)

1. Introduction

The Baltic Dry Index[1] (BDI) was established in 1985 and owes its name to the Baltic Coffeehouse, where merchants and sea captains gathered to negotiate the price of cargo shipping services. From that moment the index published daily shipping rates of several vessel sizes on multiple sea routes across the globe, transporting different dry bulk goods. The index has always been a benchmark for the world freight market and is highly valued by practitioners within the shipping industry because it is a reliable and independent source of information.

During the year 2008, the financial crisis and credit crunch controlled all markets. Many industrial producers reduced or stopped their production because of the unsecure time. As a result, global trading levels declined sharply. On May 20th 2008 the BDI reached 11,793 points, its all time high. A few months later, the Baltic Dry Index began to fall and reached its lowest point since 1986 on December 5th 2008. In those 7 months the BDI lost 95% of its value (11,130 points), dropping to 663 points. Roughly three months after the BDI reached its lowest value; the stock markets in the USA reached their lowest level. After a huge plunge, the Dow Jones Index and the S&P500 reached their lowest value in March 2009. Hence, the BDI reached its lowest point months before the stock market indices. In this study, we empirically examine the predictive relation between the BDI and global stock indices. This relation is broadly discussed in the literature; however there is little empirical research on this matter.

The dry bulk market is mainly controlled by five main bulks; iron ore, coal, phosphate, grain and bauxite/alumina. These bulks are used for steel production, generation of electricity, cement production and other forms of construction and manufacturing. These raw materials are thus used in the first stage of the production cycle, primarily for the production of intermediates. These bulks are mainly transported by large bulk carriers over sea. Since the fleet supply is constant, these freight rates are considered to represent the demand for raw materials. In case of economic growth, the production of goods is expected to increase. This leads to a higher demand for raw materials and therefore also to a higher demand for shipping services. This positive relation between seaborne trade and industrial

[1] The original name was the Baltic Freight Index and had multiple names since its inception. This study will always refer to the BDI. Appendix C gives an extensive summary of the history of the index.

production and economic growth is proven to be right in the studies of, amongst others, Radelet and Sachs (1998), Stopford (2003), Klovland (2004) and Kilian (2009). The fact that economic growth and stock market performance are also related is shown by Levine and Zervos (1996), Mohtadi and Agarwal (2001) and Antonios (2010).

Following Alizadeh and Muradoglu (2010) and Bakshi, Panayotov and Skoulakis (2011), this study directly examines the relation between freight rates and stock market performance. More specific, we look into the relation between the returns of the BDI and the market returns of 23 developed and 25 undeveloped countries. We expect to find evidence that changes in the stock markets can be predicted by changes in the BDI. Raw materials are the inputs for the production process and the BDI reflects the urge for these materials. Therefore, Alizadeh and Muradoglu (2010) and Bakshi et al. (2011) argue that there is some delay between the BDI changes and the time this information is incorporated in the stock markets. The information availability bias has also a role in this, which we try to point out with a sector analysis. Sectors dealing with shipping related products or services probably will incorporate the BDI information quicker than more unrelated sectors. In both the country and sector analysis, the most common stock predictor, namely oil, is included to check whether the BDI holds its value as a potential predictor of stock market returns. To check whether the BDI returns are a reliable and robust indicator, we divide the sample into sub periods and examine the BDI's performance between several common stock return predictors.

The main findings of this paper can be summarized by three points. First, we present statistically and economically significant predictability of stock market returns using BDI returns. Both the returns of MSCI and sector indices show similar results. We show that these results hold in the presence of common stock market predictors such as oil, an important economic indicator. Second, we conclude that in developed countries the predictive power of the BDI returns is limited to the period 2001-2007, possibly due to the economic boom effect in that period and the revision of the BDI in 1999. Undeveloped countries only show significant results in the periods 2001-2007 and 2008-2011. Third, we conclude that the predictability of the BDI is mainly driven by the Panamax Index, and partly the Capesize Index.

The rest of the paper continues as follows. Section 2 describes the dry bulk market and its main determinations. Section 3 contains the hypotheses and data description of the whole data set. In Section 4 the results of the empirical research are discussed and Section 5 contains the conclusion and points out some areas for future research.

2. Dry Bulk Market

2.1. Seaborne trade

According to UNCTAD (2011), more than 80 percent of the volume of world trade is transported over sea by ship and the world seaborne trade totalled 8,4 billion tons[2] in 2010. This points out what a significant role the shipping industry plays within global trade. Container transport accounted for 1,3 billion tons (16 percent) and crude oil and chemical products accounted for 2,8 billion tons (33 percent). The international seaborne trade is dominated by dry bulk cargoes (excluding container shipments), whereas it amounts 4,3 billion tons (the remaining 51 percent). Within this 'dry category', a big part can be assigned to the five main bulks which together amount 2,3 billion ton (53 percent of the dry cargoes or 28 percent of the total world seaborne trade).

Within the five main dry bulks, iron ore accounts for 42 percent and coal for 39 percent. Because iron ore and coal are mainly used for the production of steel, it is known as one of the main drivers of dry bulk shipping. Because of the growth in steel production, mainly in China, the demand for these commodities increased a lot the last decades. In 2011, China accounted for almost 50 percent of the world's total steel production. Coal is also used to generate electricity. The growing urbanization, mainly in China and India, results also in an increased demand for coal[3]. China has the highest level of industrial production and the highest demand for commodities. China, among other developing countries with high industrial production, has a big influence on the dry bulk market (see also Kim, 2011).

UNCTAD (2011) shows how the world fleet is composed out of various types of vessels. The three most important types are (oil) tankers, bulk carriers and container ships. Tankers transport mainly oil, but also chemicals and other liquids. Container ships carry semi-finished and manufactured goods. Bulk carriers are used for the shipment of raw materials, or dry bulks as discussed above. The booming demand for, mainly, iron ore and coal also resulted in changes on the supply side. At the beginning of 2011, the world fleet had a combined tonnage of 1,395,743 thousand deadweight ton (dwt). The dry bulk fleet accounted for 532 millions dwt, which means it almost doubled since 2000. The world fleet now consists for 38 percent out of bulk carriers, among oil tankers (34 percent), container ships (13 percent) and other types of (cargo) ships.

[2] Reflecting the total of goods loaded (exports).

[3] Coking coal is used for steel production and thermal/steam coal is used to generate electricity.

A distinction can be made between the various bulk carriers, based on the different commodities that are transported and by the various vessel sizes. Table 1 categorizes the different vessel types and their capacity, measured by dwt, according to shipping terminology,

Table 1
Approximate vessel sizes, based on UNCTAD (2011).

Vessel type	Deadweight tonnage capacity
Capesize	80,000 dwt plus (maximum capacity ca. 200,000 dwt)
Panamax	55,000 – 84,999 dwt
Supramax	50,000 – 60,000 dwt[4]
Handymax	35,000 – 54,999 dwt
Handysize	10,000 – 34,999 dwt

Iron ore and coal are mainly transported by Panamax or Capesize vessels. Panamax vessels are called like this as they have the maximum dimensions that are allowed to pass through the Panama-canal. Because of their size, Capesize vessels cannot pass through the Panama- and Suez-canal[5], so they have to go around Cape Horn and/or Cape of Good Hope in order to voyage between the oceans. Grain is also transported by Panamax, but mainly by Supramax. Bauxite/alumina, phosphate and the other minor bulks[6] are mainly transported by Supramax, Handymax and Handysize ships.

Capesize currently is the biggest bulk carrier category, but this market is still developing and open for innovations. The Brazilian company Vale illustrates this, whereas Vale ordered a fleet of very large ore carriers (VLOCs) in 2010. These VLOCs will be able to carry 400,000 dwt, which doubles the capacity of the former biggest Capesize carriers. Vale, the world's second biggest mining company, will use this fleet of ore carriers mainly for its exports to China and hopes to be more competitive with the Australian iron ore which is closer to the important Asian market. One third of Vale's turnover is generated by trades with China, according to their 2010's annual report.

[4] Based on a statement of Eagle Bulk Shipping Inc.

[5] Capesize ships are physically too large to transit the Panama- and Suez-canal, not especially due to their tonnage. They mainly serve deepwater terminals and therefore also need deepwater ports.

[6] Minor bulks are for example sugars, cements, minerals, agribulks and metals.

2.2. Freight rates

As every product or service in the market, sea transport rates are determined by demand and supply. In this section the factors which influence each side will be discussed and explained. According to The Baltic Exchange[7], the freight market is mainly driven by the following factors:

Fleet supply

The total number of dry bulk carriers, available for transport. The fleet size varies with the amount of delivered and scrapped vessels. If there is a large overcapacity of these cargo vessels the freight rates would decrease, because there is simply too much supply for the demanded transport volume. More insight will be given in Section 2.3.

Commodity demand

Commodity demand is driven by industrial production. For example, demand for iron ore and coal increases if China is planning to increase its steel production. If the production is increasing, the demand for commodities is high and thus also more shipping services are required.

Seasonal pressures

This factor has many potential influences on commodity, and thus shipping, demand. First of all, weather has its impact on the harvest and thus on the amount of traded commodities. Since some commodities cannot be stored on a long-term, an early harvest immediately increases the need for shipping transportation. In case of very cold weather, there will be a higher demand for energy creating raw materials, such as coal. Also the water level in rivers or a delay due to icing in ports has impact on freight rates.

Fuel prices

Freight rates are heavily dependent on oil prices. UNCTAD (2010) states that fuel costs can account for 50-60 % of the operating costs of a ship. There are no direct alternatives that can be used to power a ship.

Choke points

The street of Malacca, the Panama canal or Suez canal are the most importing global shipping lanes. If one of these lanes is blocked, it potentially has huge impact on the shipping distance, time and thus

[7] Balticexchange.com

costs. Shipping lanes have a certain capacity and can be overcrowded. Other possible reasons for the closure of such choke points are for example (political) conflicts or terrorist attacks.

Market sentiment

If companies/producers expect the economic growth to slow down, the demand for raw materials will decrease because they are planning to produce less.

Denning (1994) and Lun, Lai and Cheng (2010) add political factors (governments' measures to protect domestic products as well as wars, revolutions, national crises or strikes), average haul (if, for any reason, it becomes impossible to transport iron ore from Australia to China and it has to come from Brazil, for example, it generates more shipping service demand and this particular carrier cannot be used for another cargo on another route) and changes in currency value (these fluctuations can increase or decrease shipping costs for a foreign shipowner or importer).

2.3. Fleet size

As stated earlier, freight rates are determined by both demand and supply. The factors influencing the freight rates of dry bulk shipping are discussed earlier. In this section, the focus will be on one of these factors, namely the fleet supply. The level of demand for dry bulk shipping determines freight rates, which can also affect fleet size as shipowners expand their fleet to be able to meet the demand. These relations, and other factors influencing the world fleet, shall be discussed in this section.

Among others, Stopford (2003), Lun and Quaddus (2009) and Lun et al. (2010) show that there are four interrelated markets in shipping, namely the freight market, the new building market, the second hand market and the demolition market. For each market a short description and its relation to fleet size will be given.

The freight market is the place where demand and supply meets. The freight rate moves up or down until equilibrium is achieved and the demand for seaborne trade is equal to the supply of ships in the market. As seen before, an increase in seaborne trade will result in higher freight rates, because there is more demand for shipping services with an unchanged fleet size. Lun and Quaddus (2009) show a positive relationship between freight rates and fleet size in their empirical study, indicating that shipowners increase their fleet capacity when they receive a higher compensation for their existing fleet. Lun and Quaddus (2009) also showed a positive relationship between seaborne trade and fleet size, indicating that shipowners also increase their fleet size if there is enough cargo to move. As a result of increasing seaborne trade and/or increasing freight rates, shipowners would be encouraged to increase their fleet size to benefit from the demand oversupply and/or high freight rates.

On the newbuilding market, it will take 2 or 3 years to build a ship, a period in which many things can change and market conditions can be entirely different. Demand for newly built vessels depends on freight rates, price of alternatives (second-hand ships for example), the financial resources of the buyers, the availability of credit and of course the market expectations of shipowners / potential ship buyers (Stopford, 2003). Shipyards, the supply side in this matter, have to take their orderbook and the capacity on their yard into account. Shipyards without a future orderbook will be more eager to find new business. The (future) capacity of shipyards in combination with their (current) orderbook determines the price of a newly built ship. Lun and Quaddus (2009) conclude that the price of newly built vessels is not related to the fleet size, indicating that shipping firms do not buy newly built ships just because the vessels prices are low. Unlike the freight rates, the prices of vessels do not have a direct influence on the fleet size. But, freight rates are a determinant of the prices of newly built vessels since high freight rates encourage shipowners to expand their fleet. As a result of this increasing demand, shipyards will set higher prices for their new buildings (Stopford, 2003). Hence, (low) freight rates coincide with (low) vessel prices. At this point, buying new vessels is not attractive for shipowners, since they probably are dealing with excessive capacity anyway. A certain situation can be a good opportunity for investors to buy vessels and sell them when prices are higher (Tsolakis, Cridland and Haralambides, 2003).

In the second-hand ship market, the shipping firms are sellers instead of buyers. These firms are selling their vessels because of their expectations the prices are going to fall, their policy of replacing ships at a certain age or because of their need for liquidity. The value of a (second-hand) ship is affected by the expected future return of that ship. Especially the price of second-hand ships are heavily depending on current freight rates, since they can be immediately operational whereas newly built ships have a construction time of 2 or 3 years. Beenstock (1985) already noted second-hand and new building ships are substitutes as they are the same asset; the only difference is their age.

The last stop of a vessel is the demolition, or scrap market. Prices are volatile because the availability of suitable ships and the demand for scrap metal also fluctuate (Stopford, 2003). The conclusion of Luc and Quaddus (2009) that fleet size is not depending on the prices for newly built (and/or second-hand) ships, is also relevant for ships' scrapping prices. When deciding to bring their ships to the demolition market, shipowners do not seem to take scrapping prices into account. The only consideration shipowners make in order to expand or reduce their capacity is the fact that there is significant cargo volume to move.

Lun and Quaddus (2009) conclude that especially seaborne trade and freight rates are determinants of fleet size. Especially seaborne trade, which shows the biggest significant effect, is considered to be influential. This indicates that shipowners want to be able to meet the demand for shipping services (sufficient cargo volume), rather than expand their fleet due to the expectation to receive a high return on that extra capacity.

Prices of shipping services are determined by the demand to move cargo and the supply of vessels which are able to move this cargo. As in every market, prices go up if there is scarcity but fall if there is an oversupply. Thus, when freight rates are booming, it could be a consequence of a shortage of vessels instead of an increase in demand for seaborne trade. The Baltic Dry Index publishes freight rates, which are considered to be a representation for the fluctuation in seaborne trade, because the supply side is rather stable with a building time of a couple of years for a new vessel. Due to a lack of proper supply side management it could disturb and shake up the market heavily. When there is enough cargo volume and shipowners en masse decide to expand their deadweight tonnage capacity by building more ships, this could result in a huge plunge in freight rates when all those vessels become operational at the same time. Freight rates would plunge, irrespective of the fluctuations in demand. So, freight rates could increase or decrease, even when the absolute demand has not changed. For the Baltic Dry Index and its potential to represent a gauge for industrial production and economic growth this is disastrous.

Some shipping literature states that the BDI could not plunge under a certain minimum. A decrease in freight rates and cargo demand could lead to cash problems for shipowners. At a given moment they are forced to scrap a certain amount of vessels, which saves the shipowner from bankruptcy. At the same time, it has a positive effect on the BDI since the glut of dry bulk vessels is reduced. In case of a surplus of vessels, many shipowners also start slow steaming. Slow steaming means that the cruising speed of vessels is reduced. In this way, every voyage takes a few days longer and thus reduces the amount of available vessels.

From 2006 freight rates skyrocketed due to increased commodity demand from all over the world. In that period every shipowner wanted to benefit from the good prospects in commodity demand in the upcoming years and since it was relatively easy and cheap to receive credit, many shipowners ordered new vessels. When all these additional tonnage became available around 2008, there was a huge glut of vessels[8]. Naturally, in the meanwhile the financial system had collapsed, resulting in an immediate plunge in every sector's services and/or products.

So the last decade, and especially between 2008 and 2011, the capacity of the bulk carrier fleet heavily increased[9]. According to extensive literature, the plunge of the Baltic Dry Index in the beginning of the financial crisis was a combination of a slowdown in dry bulk demand and the expanded world fleet. Also Geman and Smith (2012) claim the change at the supply side had the greatest impact on the Baltic Dry Index during the recent financial crisis. In our conjecture that the BDI represents the level of demand for dry bulk cargo, we assume that the fleet size is stable. However, the fleet supply became very volatile after 2008. If the statement of Geman and Smith (2012) holds, the BDI would be a better predictor of stock market returns before 2007, but then lose its predictive power due to the inelastic supply side. To examine this conjecture, we divide our sample in sub samples. See Section 4.4.1 for the analysis.

2.4. Hedging against freight rates

Denning et al. (1994), Kavussanos and Nomikos (1999) and Prokopczuk (2010), among others, state that the BDI was originated because of the need for an index on which future contracts could be based. These studies examine the Baltic International Freight Futures Exchange (BIFFEX) contracts and investigate their effectiveness.

Prokopczuk (2010) state that shipowners and charterers are dealing with a lot of risk, as the freight spot market is very volatile. To meet the demand for hedging this volatility, appropriate future contracts had to become available for the involved parties. Therefore, a proper valuation model or index had to be established. In May 1985, the Baltic Exchange established the Baltic Dry Index on which the BIFFEX contracts could be written. This were the first global freight future contracts. Shipowners and charterers could sell or buy these contracts in order to decrease their exposure to volatile freight rates and in this way monitor their revenue and/or costs (Haigh, 2004).

Where nowadays the BDI contains 20 dry cargo routes, in that time there were only 11 routes. For that reason, hedging effectiveness was limited since practitioners were only exposed to a couple of routes. As a result, the cross-hedge quality was extremely limited and the BIFFEX contracts were terminated in 2002, after years of less trading. Prokopczuk (2010) acknowledges and confirms the poor hedging

[8] The disorder of the demand/supply ratio, due to an in- or decrease of the fleet size, is known as a classic avocado effect or hog cycle. Stopford (2003) refers to it as a shipping cycle.
[9] Data received from Clarksons PLC.

effectiveness of these BIFFEX contracts compared to contracts written on individual freight routes. His empirical study focuses on dry bulk freight futures traded on the newly established International Maritime Exchange (Imarex) and is the first who studied these specific futures contracts.

Kavussanos and Nomikos (2000) describe the BIFFEX as a mechanism for hedging freight rate risk, where the practitioners could buy or sell future contracts which represent the expected future value of the BDI. The BDI was an average index based on different types of cargoes, multiple routes and various vessel sizes. Kavussanos and Nomikos (2000) also argue that this results in poor hedging performance of the BIFFEX contracts. The BDI was revised multiple times, to increase the functionality of the BDI as a hedging platform for BIFFEX contracts[10]. Kavussanos and Nomikos (2000) conclude that the hedging effectiveness increased due to these revisions, but would be further improved if futures contracts are based on individual routes and other specific terms rather than on a broad index. BIFFEX contracts prices did not take different vessel size and different routes into account, which made hedging with those contracts inefficient.

Next to Kavussanos and Nomikos (2000) and Prokopczuk (2010) also Groder (2010) claimed that the BIFFEX contracts had a poor hedging performance, compared to contracts written on individual terms. Groder (2010) empirically showed that individual contracts performed better than BIFFEX contracts, since negotiation on every part of the deal became possible. Both parties could hedge more effectively in this way. These individual contracts are called Forward Freight Agreements (FFA's) and were tradable since 1992, but the use of FFA's increased significantly after 2002, when the BIFFEX contract were not traded anymore.

With the abolition of the BIFFEX contracts, the BDI seemed to have lost its initial hedging purpose as being a good representation for global shipping rates of dry bulks. Still, the BDI is widely used by shipping agents and brokers in order to provide them with a proxy for global shipping activity. Brokers have to look into specific contracts, each with their specific terms, so they use the BDI information including some bandwidth. The BDI is so highly valued because it is presumed to have no speculative aspect in it. This is because only shipping practitioners (shipowners or people with cargo to move) can access the Baltic Exchange and influence the BDI.

[10] Gray (1990), Cullinane et al. (1999) and Haigh et al. (2001) claim that most revisions have been implemented due to pressure from market agents, who want to increase the effectiveness and performance of their own specific shipping hedges.

2.5. Baltic Dry Index

The Baltic Dry Index displays ship freight rates to transport raw materials, like iron ore, coal, grain, bauxite/alumina, phosphate, steel, copper, cement, sand and gravel. The price of this index is made available daily by the Baltic Exchange in London. Each day, ship brokers, shipowners and charterers are asked what their services costs, for example the price of transporting 200,000 dwt iron ore from Brazil to China. Out of the information from these market practitioners, the Baltic Exchange computes the level of the Baltic Dry Index and some sub indices.

Capesize, Panamax, Supramax and Handsize are four vessel types which ship these raw materials, or dry bulk commodities, and are the basis for the composition of the BDI. As seen before, these four types all have a certain capacity of deadweight which makes them suitable for the transportation of different (quantities of) raw materials. These four types all have separate indices[11] which are based on the costs of transporting raw materials across various ocean routes. The Baltic Dry Index is the weighted average of these four separate indices[12].

So, the value of the BDI is an equilibrium price which is specified by the demand for shipping raw materials and the supply of cargo vessels to transport it. Unlike in stock markets the BDI is only operated by members; actual buyers and/or sellers, respectively with cargo to move or a ship to move it. Because the index is only determined by involved parties, there is no speculative part concerning the BDI. Next to that, the BDI is not revised and it is highly accurate with the daily updates.

The Baltic Dry Index is globally seen as the main representation of the dry bulk shipping market. It records the level of freight rates across different shipping routes and is therefore a global source of information which practitioners use to make daily decisions on their trades. The index is extremely valuable for the agents and brokers since it is the only method which gives them a good proxy of shipping rates across the globe[13]. The shipping market agents have to monitor the level of activity worldwide to be able to generate trade since shipping is in particular a global business (Haigh 2004).

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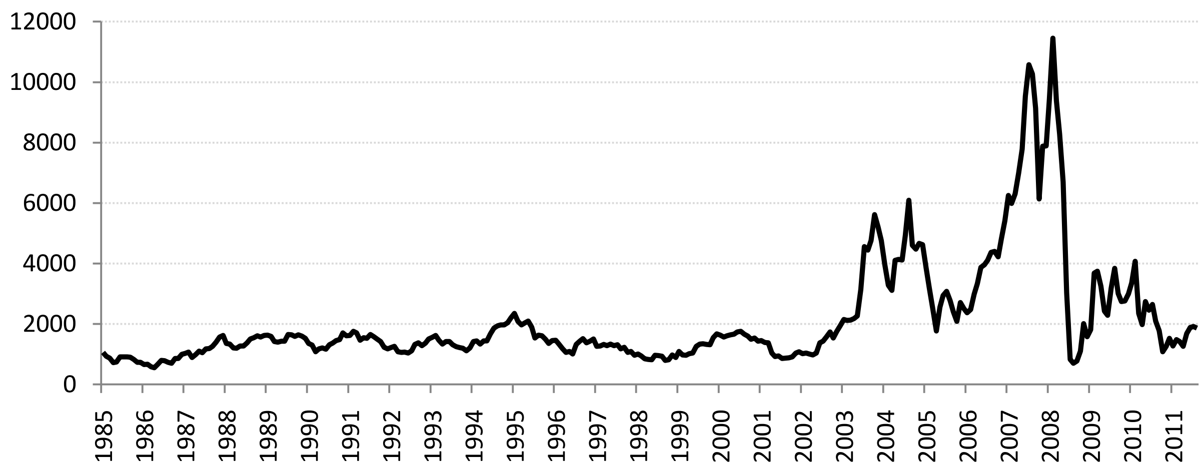
[11] Respectively the Baltic Capesize Index (BCI), the Baltic Panamax Index (BPI), the Baltic Supramax Index (BSI) and the Baltic Handysize Index (BHSI).

[12] See Appendix C for the exact composition of the BDI, based on these four indices.

[13] Every trade has its own specific characteristics, such as duration, cargo volume and route. The BDI is an average of general specifications, so a practitioner has to interpret the index very carefully.

Figure 1 presents the development of the Baltic Dry Index since its start in 1985 to 2011. Notice that the index is extremely volatile in the last decade compared to the first 18 years of its existence. Of course, the index was heavily revised during its whole lifetime and worldwide trading levels increased due to globalisation, but the main reason for a volatile BDI are worldwide economic booms and recessions. Figure 1 clearly shows the development of the index during and after the financial crisis. As most financial indices, the BDI strongly increased from 2006 and plunged in 2008.

Figure 1. Graphical development of the Baltic Dry Index, 1985-2011



3. Hypotheses and Description of Data

In this section, the hypotheses will be formulated. Based on existing literature, we have certain expectations regarding our analysis. Then, the data which will be used in the analyses throughout this study will be described and also the econometric model will be introduced.

3.1. Hypotheses

Theoretically, a change in the BDI would be largely due to a change in demand for raw materials, because of the rather inelastic and constant fleet supply. My conjecture is that in a situation of economic growth the trade volume increases since there is more demand for materials which can be used as inputs for production. Raw materials, especially dry bulks, are used in the production of concrete, steel, electricity and food. Hence, these commodities are the inputs for intermediate or finished products such as cars or houses. Shipping transportation is obviously completed even before the production cycle begins. A higher demand for shipping services in the dry bulk market therefore indicates an increase in production levels and economic growth. Countries, companies or other producers import more commodities when they want to increase their production, which is an indication they have confidence in the economic situation. The changes in demand for and trade in these raw materials are reflected by the changes in freight rates (Alizadeh and Muradoglu, 2010). Naturally a higher demand for shipping services results in a higher price for it. This also works the other way around. If producers are not optimistic about economic growth, the production level decreases and demand for commodities drops. A plunge in freight rates is the result. So, the urge for raw materials provides a gauge for global economic growth and industrial production. Many studies, f.e. Isserlis (1938), Tinbergen (1958), Radelet and Sachs (1998), Stopford (2003), Klovland (2004) and Kilian (2009) confirm this relationship[14]. Radelet and Sachs (1998) also find evidence for the opposite. Higher transport costs slow down the import of commodities, simply because it costs more to receive them and thus the importers are reticent to order them.

Theoretically, an increase in industrial production leads to more activity, employment and liquidity in the economy. Because more cash is available, there is a better change it is invested in the stock market and that as a consequence the stock prices will increase. Levine and Zervos (1998) conclude that stock market liquidity is positively correlated with economic and productivity growth. Levine and Zervos

[14] Kilian (2009) argues that this relation can be weakened, in the long-run, by ship-building and the scrapping of vessels.

(1996), Mohtadi and Agarwal (2001) and Antonios (2010)[15] show a positive relation between stock market development and economic growth. These studies especially show that stock market performance leads to economic growth, for example due to boosted investment behaviour. Shahbaz, Ahmed and Ali (2008) also find empirical evidence for this strong relation, but also conclude that there is bi-directional causality between stock market performance and economic growth in the long run[16], which means that stock market development also can be the consequence (instead of the cause) of economic growth.

Assuming the relation between shipping costs and economic growth, and the relation between economic growth and stock market development, this study does not examine economic growth or productivity as an intermediate step. If the above assumptions hold, the freight rates would be an indicator of stock market performance. In the end, we have to be able to respond to the predictive literature which states that the BDI is one of the most reliable predictors of global stock returns. In order to do so, a comparison is made between the BDI and several MSCI Indices. The shipping market notices an increase or decrease in the demand for raw materials before it is translated in industrial production levels. Consequently, the information which can be obtained from shipping costs will need some time to be translated and adopted into the stock markets. This is conform the availability bias which states it will take more time for investors to receive and process information concerning a market or industry they are less familiar with. Hong, Torous & Valkanov (2007) and Alizadeh and Muradoglu (2010) explain that due to this gradual diffusion of information it is possible for the BDI to predict the stock returns. The Efficient Market Hypothesis (EMH) states that all the available market information is incorporated in the stock prices immediately. My conjecture is that the BDI changes predict the future stock market returns, which assumes that the freight information is not adapted immediately. In line with Driesprong, Jacobsen and Maat (2008) and Alizadeh and Muradoglu (2010), we expect an optimal lag for the BDI of one month (*Hypothesis I*). These BDI changes in month $t-i$ will predict the stock market returns in month t (*Hypothesis II*).

To have a better understanding of the way the BDI influences the stock market in a specific country, we perform an analysis which examines the relation between the BDI and several sectors within that countries' market. The study of Alizadeh and Muradoglu (2010) is to our full knowledge the only study

[15] Antonios (2010) is an analysis for Germany, where Levine and Zervos (1996) and Mohtadi and Agarwal (2001) cover multiple markets across the globe.

[16] In the short run, it is only the stock market influences the economic growth.

which investigates this relation. They performed their study only with US data. In this study, we examine if their findings hold in an international context. Consequently, their findings are the bases for our conjectures.

As we discussed above, it will take some time before the information from the BDI is adopted in stock markets. Alizadeh and Muradoglu (2010) point out that this relation differs among different sectors. Some sectors, for example the Oil & Gas[17] and Basic Material sector, are more closely related to the shipping services because they have mutual interests and thus incorporate the information immediately or at least faster than other sectors which are relatively unrelated with sea transport, for example the Health Services or Consumer Services. My conjecture is that the BDI changes in month $t - i$ predict the future sector returns in month t, except for the Oil & Gas sector which we assume to react immediately (*Hypothesis III*).

The last part of this research contains a robustness analysis, looking if the BDI maintains its value as a reliable stock market predictor in sub periods. In Section 2.3, we discussed the influence of the inelastic fleet supply after 2008. My conjecture is that it plays such a big role that the BDI predicts the stock market returns less precisely in this period of volatile fleet supply. Then, we include some common stock market predictors. Several studies concluded that these variables are significant and are able to predict stock market returns. Still, the BDI focuses on different developments and properties of the market. In this light, we expect that the BDI contains additional information and thus that the BDI returns will be a strong predictor of future stock market returns among these other variables.

3.2. Data description

3.2.1. Baltic Dry Index

The freight data of the Baltic Dry Index is collected from Thompson Reuters DataStream, but is also available on the website of the Baltic Exchange. Information about the historical development can be found in Appendix C and the price movements of the index are presented in Figure 1. Since the Baltic Dry Index was established in May 1985, all the analyses in this study start on May 1985 and end on December 2011 (320 observations)[18]. Following Driesprong et al. (2008) and Bakshi et al. (2011)

[17] 60% of the operational costs of a ship are determined by the oil price.

[18] Some MSCI Indices started after May 1985 and consequently have fewer observations.

logarithmic returns are calculated and are the basis for the predictive regressions. Table 2 shows the descriptive statistics of this variable. In line with Alizadeh and Muradoglu (2010) the data is collected on the first of the month. The t -month logarithmic returns are calculated as follows,

$$r_t^{BDI} = ln(BDI_t) - ln(BDI_{t-i}) \quad (1)$$

3.2.2. Arab Light Oil

There are multiple oil variables which can be used in our analysis; Brent oil, West Texas Intermediate and Arabian Gulf Arab Light Crude Oil, for example. In line with Driesprong et al. (2008), we use the Arab Light Crude Oil. They argue that this series give a good indication for their average results. The data for this variable is obtained from Bloomberg. Table 2 also shows the descriptive statistics of this variable and Figure 3 in Appendix B shows the historical development of the Arab Light Oil prices.

Table 2
Descriptive statistics of the beginning-of-the-month logarithmic returns of the shipping indices; the Baltic Dry Index, Capesize Index, Panamax Index and the Arab Light Oil prices. The BDI and the Arab Light Oil series are available from June 1985 until December 2011. The Panamax Index was only introduced in June 1998 and the Capesize Index in April 1999. The mean is measured in percentages.

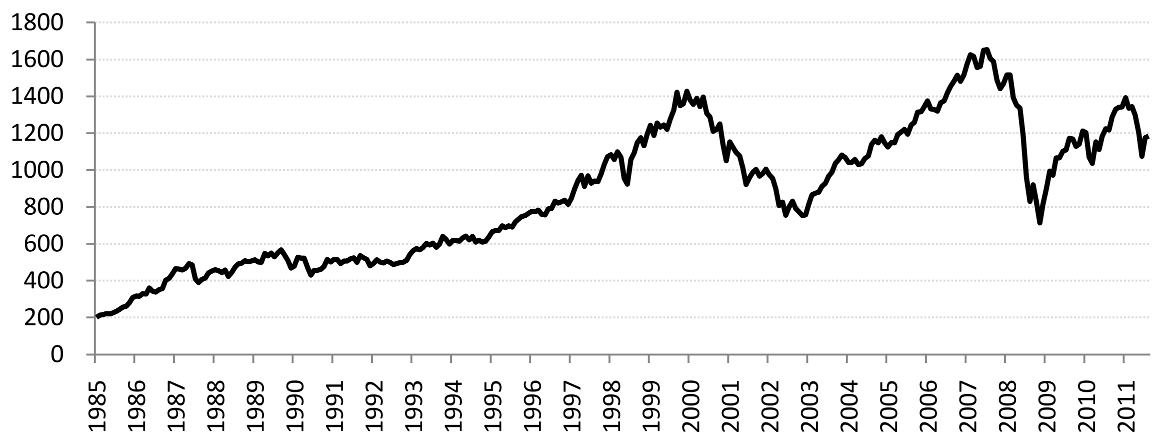
	No. of observations	Minimum	Maximum	Mean	Std. dev.	Skewness	Kurtosis
Baltic Dry Index	320	-1,297	0,712	0,154	0,162	-1,671	18,562
Capesize Index	154	-1,217	1,014	0,773	0,261	-0,605	7,364
Panamax Index	163	-1,155	0,687	0,337	0,215	-1,378	11,133
Arab Light Oil	320	-0,485	0,487	0,428	0,108	-0,192	8,329

3.2.3. MSCI stock market indices

For the stock market indices, Morgan Stanley Capital International (MSCI) regional indices are used. The World Index, the G-7 Index, the EAFE Index, 23 developed countries which are part of the World Index and 25 undeveloped countries are employed. Returns are obtained in the same manner as the BDI returns, in a logarithmic way and with beginning-of-the-month observations. Descriptive statistics of the MSCI Indices are shown in Table 4 and the historical development of the MSCI World Index is presented in Figure 2.

Note that, while the average (logarithmic) change of the BDI is relatively low, it is far more volatile than the MSCI Indices. This higher volatility, especially compared with the developed countries, is inherent to the shipping market. The BDI returns show also a significant higher kurtosis and lower skewness, which points out its movement away from normality. Table 4 also shows that developed countries are less volatile than undeveloped countries and that they have a lower average return.

Figure 2. Historical development of the MSCI World Index, 1985-2011



3.2.4. Sectors

Following Alizadeh and Muradoglu (2010), data of ten different DataStream industry sectors is collected for 22 developed countries[19] which are part of the World Index. The sectors are Oil & Gas (OILG), Basic Material (BMAT), Industrial (INDU), Consumer Goods (CSNG), Health Services (HLTH), Consumer Services (CSMS), Telecommunication (TELC), Utility (UTIL), Financials (FINA) and Technology (TECN). In line with the analysis on global stock market returns in this study, we calculate beginning-of-the-month returns for the different sectors. Descriptive statistics of the US sectors are shown in Table 3 below,

Table 3
Descriptive statistics of the ten USA sectors. The mean is measured in percentages.

USA Sector	No. of observations	Minimum	Maximum	Mean	Std. dev.	Skewness	Kurtosis
Oil & Gas	320	-0,204	0,182	0,706	0,058	-0,514	4,737
Basic Materials	320	-0,323	0,256	0,673	0,068	-0,866	7,647
Industrial	320	-0,307	0,167	0,734	0,057	-1,009	7,050
Consumer Goods	320	-0,318	0,173	0,483	0,056	-0,956	6,660
Health Services	320	-0,210	0,146	0,873	0,046	-0,674	5,759
Consumer Services	320	-0,324	0,149	0,708	0,055	-0,957	6,873
Telecommunication	320	-0,171	0,262	0,372	0,056	-0,195	4,395
Utility	320	-0,187	0,116	0,363	0,044	-0,722	4,569
Financials	320	-0,337	0,212	0,557	0,064	-1,153	7,866
Technology	320	-0,296	0,221	0,748	0,078	-0,554	4,609

[19] For Switzerland no data is available, therefore this country is left out of this analysis.

Table 4

Descriptive statistics of the beginning-of-the-month logarithmic returns of MSCI Indices of the World, G-7, EAFE, 23 developed countries and 25 undeveloped countries. All country series end on December 2011. The data of most developed countries start on June 1985. The MSCI series of Greece, Ireland, Portugal and the undeveloped countries start later. The mean is measured in percentages.

Country / Area	No. of Observations	Minimum	Maximum	Mean	Std. dev.	Skewness	Kurtosis
World	320	-0,208	0,136	0,556	0,048	-0,733	5,035
G-7	320	-0,203	0,133	0,535	0,047	-0,656	4,811
EAFE	320	-0,224	0,154	0,532	0,055	-0,479	3,970
Developed Countries							
Australia	320	-0,468	0,142	0,508	0,051	-2,583	24,666
Austria	320	-0,331	0,228	0,230	0,075	-0,819	6,077
Belgium	320	-0,346	0,240	0,386	0,060	-1,329	9,413
Canada	320	-0,228	0,164	0,516	0,048	-0,919	6,707
Denmark	320	-0,186	0,142	0,688	0,055	-0,568	3,767
France	320	-0,248	0,199	0,502	0,060	-0,465	4,110
Germany	320	-0,287	0,170	0,416	0,066	-0,847	4,666
Hong Kong	320	-0,585	0,282	0,714	0,083	-1,257	11,571
Italy	320	-0,180	0,263	0,315	0,068	0,141	3,934
Japan	320	-0,250	0,172	-0,067	0,059	-0,364	4,535
Netherlands	320	-0,288	0,117	0,394	0,056	-1,217	6,559
New Zealand	320	-0,406	0,220	0,092	0,063	-0,891	9,408
Norway	320	-0,339	0,191	0,531	0,075	-1,210	6,225
Singapore	320	-0,465	0,238	0,341	0,072	-0,968	9,197
Spain	320	-0,252	0,237	0,664	0,068	-0,341	4,557
Sweden	320	-0,250	0,282	0,880	0,070	-0,392	4,131
Switzerland	320	-0,271	0,174	0,553	0,052	-0,989	6,416
United Kingdom	320	-0,322	0,128	0,461	0,049	-1,171	8,670
USA	320	-0,244	0,145	0,613	0,047	-1,017	6,546
Finland	320	-0,344	0,320	0,734	0,092	-0,245	4,389
Greece	288	-0,329	0,405	0,180	0,101	0,501	5,337
Ireland	288	-0,264	0,183	0,062	0,069	-0,823	4,618
Portugal	288	-0,221	0,246	0,038	0,061	0,000	4,999
Undeveloped Countries							
Argentina	288	-0,544	1,446	4,140	0,203	3,020	19,521
Brazil	263	-0,693	0,750	5,524	0,174	0,839	8,588
Chile	288	-0,292	0,191	1,361	0,064	-0,086	4,435
China	228	-0,300	0,348	-0,279	0,102	-0,012	3,739
Colombia	228	-0,305	0,315	1,450	0,083	-0,178	4,870
India	228	-0,249	0,271	0,785	0,085	-0,123	3,153
Indonesia	288	-0,490	0,669	1,340	0,115	0,656	10,314
Israel	228	-0,240	0,224	0,423	0,069	-0,429	4,338
Jordan	288	-0,214	0,166	0,288	0,053	-0,131	5,155
Korea	288	-0,257	0,392	0,573	0,089	0,395	4,711
Malaysia	288	-0,407	0,311	0,598	0,079	-0,428	7,552
Mexico	288	-0,275	0,396	2,035	0,081	0,089	4,769
Philippines	288	-0,334	0,332	0,686	0,083	-0,018	4,590
Taiwan	288	-0,450	0,362	0,318	0,103	-0,193	5,375
Thailand	288	-0,337	0,532	0,487	0,106	0,165	5,943
Turkey	288	-0,550	0,624	3,091	0,150	0,401	5,051
Pakistan	228	-0,660	0,292	0,459	0,113	-1,547	11,708
Peru	228	-0,376	0,323	1,428	0,095	-0,346	5,103
Poland	228	-0,399	0,764	1,194	0,121	0,953	9,882
South Africa	228	-0,308	0,182	0,933	0,060	-0,650	6,026
Czech Republic	204	-0,279	0,215	0,565	0,075	-0,470	4,384
Egypt	204	-0,293	0,345	1,015	0,096	0,186	4,278
Hungary	204	-0,416	0,424	1,097	0,101	-0,210	6,510
Morocco	204	-0,141	0,221	0,626	0,049	0,387	4,970
Russia	204	-0,854	0,613	0,974	0,168	-0,968	8,449

3.3. Econometric model

Following the extensive predictability literature[20], we use predictive regressions to examine the conjectures stated in Section 3.1. Testing whether the logarithmic returns of the Baltic Dry Index have a predictive power towards the future stock market returns we use the following basic regression,

$$r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-i} + \alpha_2 r_{t-i}^{BDI} + \varepsilon_{m,t} \tag{2}$$

Where $r_{m,t}$ is the beginning-of-the-month logarithmic return of a countries' MSCI Index, m, at time t. The independent variable r_{t-i}^{BDI} is the beginning-of-the-month logarithmic return of the Baltic Dry Index, included in the regression at time $t-i$ months. Moreover, α_0 is the constant and $\varepsilon_{m,t}$ is the error term. Based on the estimation results we test whether the estimate for α_2, the coefficient of the BDI return, is significant different from zero. The expectation, according to the hypothesis, is that the analysis gives a positive coefficient. This would mean that a higher return of the BDI in month t results indeed in a higher stock market return $t+i$ months later.

In line with Driesprong et al. (2008), the t-values of all the predictive regressions in this study are based on heteroscedasticity consistent or White[21] standard errors. As well as Driesprong et al. (2008), we find little evidence for first-order autocorrelation in the MSCI series. To fully eliminate the autocorrelation of the residuals and to be consistent for comparing purposes, we include the $t-i$ month lag of the dependent variable in every predictive regression in this study.

[20] For example Lewellen (2004) and Ang and Bekaert (2007).
[21] Influential paper by H. White (1980), who presented a parameter covariance matrix estimator which is consistent.

4. Empirical Results

In this section, we present the empirical results and try to accept or reject the hypotheses which are formulated in Section 3. First, we determine the optimal lag regarding the BDI returns which will be the independent variable in all predictive regressions in this study. Second, we examine whether these lagged BDI returns explain future global stock market returns. Third, we test whether this relation can be explained by different sectors within a country. Finally, a couple of robustness tests are performed to test whether the lagged BDI returns are a common and reliable predictor.

4.1. Testing for lag size

An analysis is done to determine the optimal lag which should be used to detect whether the Baltic Dry Index has a predictability effect on global stock market returns. The determination of the optimal lag in this way is in line with Alizadeh and Muradoglu (2010), who regressed monthly USA sector returns on lagged BDI returns and Driesprong et al. (2008), who regressed market returns on monthly oil returns[22]. Using the same method, we include lagged BDI returns for one, two and three months to test *Hypothesis I*. Table 5 presents the results of stock market returns on lagged returns of the BDI, based on the equation,

$$r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-2}^{BDI} + \alpha_4 r_{t-3}^{BDI} + \varepsilon_{m,t} \quad (3)$$

The results show that significance levels decrease for longer lags and thus that predictability is short lived. The one-month lag shows the most significant effect on the MSCI returns which is evidence in favor of *Hypothesis I*. In all the regressions used in this study where the BDI return is used as an independent variable, the BDI returns will be lagged one month.

An explanation for the fact that stock markets react later on information, which can be derived from freight rate movements, is the delayed reaction hypothesis. As hypothesized in Section 3.1, the BDI contains information about global economic activity, since it reflects freight rates of raw materials. This information is not instantly adapted by all stock markets in different countries, but reaches it with a certain lag. This information also does not reach all countries at the same moment, but with some discrepancies. This explains the different results in Table 5. The delayed reaction hypothesis can be explained by several biases. The availability bias, which points out that information reaches stock market with a (different) delay, is already discussed above. In addition, the shipping freight market is a rather specialized market, which means it lies under the scope of some countries/investors. Consequently, due

[22] To specify the optimal lag, Driesprong (2008) included a regression with lags of several weeks. This study uses the same method to determine the optimal monthly lag.

to lack of attention and processing capacity, a stock market can have some delay to process such information. Finally, the familiarity bias which claims investors only act on information out of markets they are familiar with. One country can be more familiar to the shipping market than the other, since it relies more on exports/imports of raw materials, which explains other levels of significance across countries.

Table 5

Estimation results of regression (3): $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-2}^{BDI} + \alpha_4 r_{t-3}^{BDI} + \varepsilon_{m,t}$, to determine the optimal lag for the BDI returns. The bolded t-values are significant different from zero at a 10% level.

Country / Area	Constant	MSCI_{t-1}		BDI_{t-1}		BDI_{t-2}		BDI_{t-3}	
	α_0	α_1	t-value	α_2	t-value	α_3	t-value	α_4	t-value
World	0,005	0,074	0,96	0,045	**1,69**	0,018	0,64	0,017	0,74
G-7	0,005	0,070	0,91	0,045	**1,70**	0,018	0,66	0,016	0,71
EAFE	0,004	0,092	1,28	0,040	1,43	0,014	0,49	0,024	0,88
Developed Countries									
Australia	0,005	0,035	0,74	0,029	1,33	0,023	1,32	0,002	0,15
Austria	0,002	0,136	**1,70**	0,055	1,42	0,031	1,01	0,039	1,65
Belgium	0,003	0,204	**2,81**	0,064	**2,04**	0,000	-0,02	0,008	0,42
Canada	0,004	0,077	1,09	0,047	**1,93**	0,007	0,32	0,023	1,37
Denmark	0,006	0,034	0,58	0,037	1,63	0,031	**1,79**	0,032	1,65
France	0,005	0,098	1,47	0,025	1,02	0,021	0,86	0,024	1,21
Germany	0,003	0,085	1,26	0,041	1,63	0,031	0,99	0,016	0,57
Hong Kong	0,006	0,037	0,63	0,052	**1,69**	0,044	1,44	-0,025	-0,90
Italy	0,002	0,073	1,10	0,019	0,68	0,032	1,14	0,027	1,30
Japan	-0,001	0,105	1,46	0,045	**1,70**	0,008	0,38	0,015	0,67
Netherlands	0,004	0,059	0,86	0,033	1,36	0,028	1,14	0,009	0,55
New Zealand	0,000	0,075	0,89	0,008	0,38	0,013	0,69	-0,014	-0,98
Norway	0,005	0,090	1,21	0,052	1,40	0,025	0,67	-0,005	-0,18
Singapore	0,003	0,097	1,56	0,061	**2,15**	0,036	1,15	-0,002	-0,08
Spain	0,006	0,140	**2,04**	0,036	1,25	0,002	0,07	0,032	1,35
Sweden	0,008	0,129	**1,89**	0,043	**1,93**	0,022	0,74	0,013	0,50
Switzerland	0,004	0,140	**1,74**	0,034	**1,85**	0,025	1,44	0,019	1,31
United Kingdom	0,004	0,030	0,42	0,024	1,13	0,007	0,33	0,014	0,76
USA	0,006	0,028	0,34	0,049	**1,83**	0,024	0,92	0,008	0,39
Finland	0,006	0,178	**2,76**	0,050	1,54	0,031	0,95	0,021	0,65
Greece	0,001	0,159	**2,42**	-0,006	-0,13	0,050	1,32	0,071	**2,25**
Ireland	0,000	0,116	1,40	0,039	1,25	0,065	**2,71**	0,009	0,39
Portugal	0,000	0,131	1,44	0,027	1,21	0,007	0,38	0,020	1,16
Undeveloped Countries									
Argentina	0,035	0,143	0,89	0,055	0,93	0,017	0,38	0,001	0,03
Brazil	0,053	0,042	0,30	0,024	0,45	0,052	1,20	-0,027	-0,64
Chile	0,011	0,131	**2,10**	0,041	**1,90**	0,020	0,82	-0,009	-0,38
China	-0,002	0,121	1,40	0,035	0,78	0,055	1,32	-0,023	-0,53
Colombia	0,013	0,119	**1,94**	0,028	0,81	0,019	0,62	0,016	0,64
India	0,007	0,035	0,48	0,071	**2,03**	0,022	0,51	0,034	0,95
Indonesia	0,012	0,068	0,95	0,084	**2,29**	0,048	0,97	0,042	1,39
Israel	0,004	0,003	0,03	0,038	**2,14**	0,036	**1,86**	0,008	0,41
Jordan	0,002	0,188	**2,68**	0,061	**2,39**	0,024	1,40	0,017	1,07
Korea	0,005	0,067	1,19	0,062	**1,97**	0,051	1,59	-0,025	-1,05
Malaysia	0,005	0,101	0,86	0,011	0,53	0,055	**1,99**	-0,002	-0,13
Mexico	0,020	-0,002	-0,02	0,041	1,35	-0,006	-0,19	0,035	0,18
Philippines	0,006	0,098	1,57	0,036	1,30	0,033	1,17	0,026	1,04
Taiwan	0,002	0,074	0,94	0,046	1,55	0,047	1,39	0,019	0,69
Thailand	0,004	0,011	0,14	0,055	1,51	0,056	1,13	-0,001	-0,02
Turkey	0,029	0,024	0,37	0,050	1,35	0,107	**2,13**	0,003	0,06
Pakistan	0,004	-0,041	-0,59	0,011	0,30	0,134	**1,72**	0,060	1,31
Peru	0,016	-0,058	-0,79	0,066	1,22	-0,002	-0,04	0,016	0,36
Poland	0,011	0,062	0,64	0,021	0,54	0,047	1,25	0,011	0,28
South Africa	0,009	-0,019	-0,28	0,026	1,14	-0,003	-0,14	0,005	0,22
Czech Republic	0,007	-0,019	-0,25	0,058	1,67	0,027	0,83	0,038	1,66
Egypt	0,009	0,090	1,10	0,050	1,15	0,056	0,92	0,101	**2,30**
Hungary	0,012	0,058	0,87	0,047	1,01	0,038	1,14	0,042	1,21
Morocco	0,006	0,093	1,17	-0,012	-0,60	0,033	**1,85**	0,001	0,03
Russia	0,010	0,117	0,82	0,070	1,10	0,082	1,56	0,042	0,90

4.2. Country analysis

In this section the basic regression (2) is estimated over the sample period, May 1985 to December 2011. The estimated results are shown in the left part of Table 6. This table reveals that the coefficient α_2 is positive for all countries, indicating that the lagged BDI returns have a positive effect on stock market returns. At a 10% significance level, 11 of the 23 developed countries show a significant estimate. At the 5% significance level, there are 4 countries with a significant estimate. We would only expect 1 or 2 significant estimates in case of random results, consistent with the Efficient Market Hypothesis. The evidence is not very strong, but we can still conclude that BDI returns tend to be a precursor for stock market returns. Hence, the results support *Hypothesis II*. An increase of one standard deviation (16,2%) in the BDI return will one month later result in an increase in the MSCI World Index return of 0,78%. For the return of developed countries the effect of a 16,2% increase will lie between 0,05 and 1,13%, with an average of 0,70%.

4.2.1. Including oil variable

As stated earlier, oil is accountable for 60% of the operational costs of a ship. Therefore, oil price changes appear to be highly correlated with freight rates. Pollet (2004), Driesprong et al. (2008) and Sørensen (2009) show significant evidence for oil prices changes being a predictor for worldwide stock market returns. Because of these two reasons we also check whether the BDI has a significant influence on stock markets when an oil variable is included in the analysis and try to find evidence that the BDI provides additional information to predict stock market returns. Regarding the oil variable (Arab Light Oil), a negative coefficient is expected since oil is a major input for many industries. Therefore, an increase in oil prices would result in lower stock market returns. This conjecture is in line with Pollet (2004) and Driesprong et al. (2008). We try to find evidence for this with the following regression,

$$r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-1}^{OIL} + \varepsilon_{m,t} \tag{4}$$

Results of equation (4) also can be found in Table 6. In 15 of the 23 developed countries the results regarding Arab Light Oil is (negatively) statistically significant. This is in line with the findings of Driesprong et al. (2008); oil price changes have a statistically and economically significant negative effect on future stock market prices, especially in the developed countries and the MSCI World Index. At the same time, 17 of the 23 developed countries show significant results (at a 10% level) and, except for Morocco, positive coefficients regarding the BDI returns. At a 5% significance level, 11 of the 23 developed countries are statistically and economically significant. Comparing the results, more countries have significant results for BDI returns as explanatory variable when an oil variable is included in the regression. This states that the BDI returns contain additional information to predict future stock market returns and have a strong explanatory power.

Table 6

The columns 2 t/m 5, left of the dotted line, show the results of basic regression (2) with a one-month lag for BDI returns: $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \varepsilon_{m,t}$. Where available, the sample period is May 1985 to December 2011. The six most right columns, right of the dotted line, reflect regression (4): $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-1}^{OIL} + \varepsilon_{m,t}$. The bolded t-values are significant different from zero at a 10% level.

Country / Area	$\mathbf{MSCI}_{t-1}$		$\mathbf{BDI}_{t-1}$		$\mathbf{MSCI}_{t-1}$		$\mathbf{BDI}_{t-1}$		$\mathbf{Arab\ Light\ Oil}_{t-1}$	
	α_1	t-value	α_2	t-value	α_1	t-value	α_2	t-value	α_3	t-value
World	0,091	1,16	0,048	**1,77**	0,098	1,25	0,057	**2,04**	-0,059	**-2,03**
G-7	0,105	1,44	0,041	1,49	0,108	1,47	0,048	**1,71**	-0,048	-1,27
EAFE	0,087	1,11	0,047	**1,78**	0,093	1,2	0,057	**2,05**	-0,061	**-2,05**
Developed Countries										
Australia	0,041	0,87	0,034	1,48	0,050	1,09	0,042	**1,74**	-0,052	**-2,12**
Austria	0,156	**1,98**	0,061	1,52	0,158	**2,00**	0,068	1,66	-0,046	-1,03
Belgium	0,203	**2,86**	0,064	**2,13**	0,197	**2,76**	0,074	**2,43**	-0,063	**-2,13**
Canada	0,086	1,22	0,048	**1,91**	0,097	1,37	0,053	**2,07**	-0,038	-1,54
Denmark	0,060	1,02	0,041	**1,79**	0,065	1,11	0,046	**1,93**	-0,038	-1,12
France	0,108	1,63	0,031	1,21	0,104	1,57	0,042	1,58	-0,076	**-1,89**
Germany	0,100	1,50	0,047	**1,82**	0,103	1,57	0,063	**2,25**	-0,105	**-2,49**
Hong Kong	0,038	0,64	0,064	**2,31**	0,038	0,64	0,062	**2,18**	0,009	0,20
Italy	0,092	1,39	0,024	0,81	0,098	1,61	0,049	1,53	-0,167	**-4,14**
Japan	0,112	1,58	0,045	**1,80**	0,122	1,58	0,056	**2,21**	-0,073	-1,50
Netherlands	0,070	1,02	0,039	1,58	0,086	1,24	0,053	**2,00**	-0,092	**-3,03**
New Zealand	0,080	0,96	0,010	0,49	0,079	0,97	0,022	0,98	-0,077	**-1,99**
Norway	0,089	1,20	0,059	1,56	0,106	1,40	0,066	**1,73**	-0,057	-1,40
Singapore	0,107	**1,72**	0,070	**2,64**	0,112	**1,82**	0,079	**2,90**	-0,059	-1,24
Spain	0,145	**2,11**	0,035	1,29	0,131	**1,97**	0,052	**1,78**	-0,108	**-2,57**
Sweden	0,136	**2,00**	0,048	**2,22**	0,122	**1,82**	0,069	**2,87**	-0,133	**-3,50**
Switzerland	0,160	**2,03**	0,038	**1,97**	0,156	**1,98**	0,050	**2,37**	-0,079	**-2,88**
United Kingdom	0,030	0,41	0,026	1,23	0,031	0,44	0,037	1,67	-0,075	**-2,70**
USA	0,047	0,56	0,054	**1,95**	0,057	0,69	0,066	**2,27**	-0,076	**-2,95**
Finland	0,187	**2,87**	0,057	**1,75**	0,180	**2,83**	0,078	**2,20**	-0,134	**-2,61**
Greece	0,172	**2,62**	0,003	0,07	0,178	**2,68**	0,028	0,54	-0,184	**-2,37**
Ireland	0,142	**1,85**	0,055	1,63	0,143	**1,86**	0,060	**1,75**	-0,042	-0,82
Portugal	0,136	1,51	0,028	1,28	0,121	1,33	0,041	**1,77**	-0,095	**-2,46**
Undeveloped Countries										
Argentina	0,144	0,89	0,059	1,04	0,148	0,92	0,076	1,26	-0,126	-1,11
Brazil	0,042	0,29	0,039	0,75	0,040	0,29	0,079	1,27	-0,293	-1,42
Chile	0,135	**2,19**	0,046	**2,23**	0,138	**2,29**	0,056	**2,44**	-0,069	**-1,69**
China	0,122	1,40	0,051	1,21	0,125	1,44	0,054	1,27	-0,024	-0,28
Colombia	0,124	**2,04**	0,032	0,98	0,124	**2,04**	0,031	0,89	0,003	0,04
India	0,050	0,68	0,074	**2,15**	0,065	0,86	0,087	**2,41**	-0,101	-1,65
Indonesia	0,085	1,18	0,094	**2,68**	0,090	1,26	0,109	**2,86**	-0,112	-1,30
Israel	0,015	0,16	0,047	**2,75**	0,024	0,25	0,063	**3,34**	-0,124	**-2,54**
Jordan	0,214	**3,21**	0,065	**2,45**	0,217	**3,24**	0,070	**2,64**	-0,032	-1,09
Korea	0,074	1,32	0,076	**2,58**	0,090	1,57	0,091	**2,91**	-0,120	-1,51
Malaysia	0,104	0,89	0,025	1,32	0,103	0,89	0,027	1,26	-0,016	-0,25
Mexico	0,000	0,00	0,038	1,27	0,001	0,01	0,045	1,46	-0,055	-1,03
Philippines	0,108	**1,74**	0,043	1,65	0,099	1,60	0,054	**2,00**	-0,076	-1,15
Taiwan	0,083	1,07	0,056	**1,94**	0,078	1,05	0,076	**2,42**	-0,147	-1,64
Thailand	0,019	0,24	0,069	**2,00**	0,023	0,30	0,088	**2,16**	-0,143	-1,45
Turkey	0,032	0,50	0,077	**2,07**	0,033	0,51	0,088	**2,16**	-0,085	-1,08
Pakistan	0,000	0,00	0,044	1,32	0,000	0,00	0,043	1,34	0,002	0,02
Peru	-0,057	-0,79	0,065	1,23	-0,047	-0,63	0,073	1,37	-0,069	-0,85
Poland	0,066	0,68	0,033	0,87	0,066	0,68	0,031	0,80	0,014	0,19
South Africa	-0,019	-0,28	0,025	1,18	-0,012	-0,17	0,030	1,32	-0,036	-0,72
Czech Republic	0,003	0,04	0,062	**1,85**	-0,002	-0,02	0,058	**1,70**	0,032	0,62
Egypt	0,145	**1,69**	0,055	1,16	0,142	1,64	0,053	1,14	0,016	0,21
Hungary	0,075	1,09	0,054	1,17	0,071	1,05	0,048	1,06	0,047	0,65
Morocco	0,091	1,14	-0,003	-0,15	0,087	1,08	-0,007	-0,37	0,034	0,83
Russia	0,132	0,94	0,087	1,36	0,131	0,94	0,075	1,27	0,086	0,66

4.3. Sector analysis

Taken the fact that changes in shipping freight rates predict stock market returns, Alizadeh and Muradoglu (2010) investigate if these shipping freight rates have influence on specific sectors in the USA. They conclude that especially the Oil & Gas sector responds quickly to the information given by the freight rates and is reflected almost immediately in this sector. As stated, this sector is closely related to the ship industry and thus investors are able to gather this information quickly and respond to it. Also, the Basic Materials sector is related to the shipping industry, since this sector requires shipping services for transportation. All the other sectors, but also the Basic Material sector, show a significant effect when a lag of one month is used. The results are consistent when an oil variable[23] is included. Apparently it takes time for these sectors to collect and react to the freight rate information, because they are not familiar with the shipping industry. Hong et al. (2007) show empirical evidence for this gradual-information-diffusion hypothesis by showing that thirteen out of thirty-four industries can lead the market. Alizadeh and Muradoglu (2010) show that freight rate information diffuses gradually and that this information is adapted faster by some USA sectors. This study checks if their findings are consistent for other countries.

To be consistent with the previous sections and with Alizadeh and Muradoglu (2010), we also use one-month lagged BDI returns in this analysis. Table 14 shows that the Oil & Gas sector is the only USA sector which gives a significant coefficient for the BDI return without a lag. We already argued that this sector is closely correlated with the shipping industry, so this is no surprise. The one-month lagged BDI return has a significant effect on 5 sectors and the two-month lagged BDI return only on one sector. These results are in line with Alizadeh and Muradoglu (2010), although the Basic Material and Utility sector also show (slightly) significant effects for a one month lag in their study.

To find evidence for the relation, we estimate the following regression,

$$r_{s,c,t} = \alpha_0 + \alpha_1 r_{s,c,t-1} + \alpha_2 r_{t-1}^{BDI} + \varepsilon_{s,c,t} \quad (5)$$

Where $r_{s,c,t}$ is the beginning-of-the-month logarithmic return of a sector, s, of a country, c, at time t. We want to estimate α_2 and check whether it is statistically significant. For this part of the research we look only at developed countries. Table 7 presents the summary result of this regression with an overview of the number and percentage of countries which gave a coefficient for the lagged BDI return with a 10% significant level.

[23] Other than this study, Alizadeh and Muradoglu (2010) use West Texas Intermediate in their analysis.

4.3.1. *Including oil variable*

Again, we include Arab Light Oil in the regression to examine the predictive power of the BDI on sector returns in combination with oil prices. Table 7 provides an overview of the results. Both the BDI returns and oil returns are used as explanatory variables in the following regression,

$$r_{s,c,t} = \alpha_0 + \alpha_1 r_{s,c,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-1}^{OIL} + \varepsilon_{s,c,t} \tag{6}$$

Table 7

Summary results of equation (5): $\boldsymbol{r_{s,c,t} = \alpha_0 + \alpha_1 r_{s,c,t-1} + \alpha_2 r_{t-1}^{BDI} + \varepsilon_{s,c,t}}$ and (6): $\boldsymbol{r_{s,c,t} = \alpha_0 + \alpha_1 r_{s,c,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-1}^{OIL} + \varepsilon_{s,c,t}}$. No data is available for Switzerland, therefore only 22 developed countries are included. There are no observations for Ireland in the Utility sector and for Austria in the Technology sector. Where available, the sample period is May 1985 to December 2011.

Sector	No. of observations	Equation (5)		Equation (6)			
		$\mathbf{BDI}_{t-1}$		$\mathbf{BDI}_{t-1}$		$\mathbf{Arab\ Light\ Oil}_{t-1}$	
		No. of countries significant	Percentage significant	No. of countries significant	Percentage significant	No. of countries significant	Percentage significant
Oil & Gas	22	1	5%	1	5%	2	9%
Basic Materials	22	5	23%	8	36%	7	32%
Industrial	22	7	32%	9	41%	10	45%
Consumer Goods	22	6	27%	8	36%	10	45%
Health Services	22	4	18%	9	41%	8	36%
Consumer Services	22	6	27%	9	41%	14	64%
Telecommunication	22	8	36%	10	45%	11	50%
Utility	21	3	14%	4	19%	3	14%
Financials	22	5	23%	5	23%	8	36%
Technology	21	8	38%	13	62%	12	57%

Apart from a few exceptions, the coefficients of BDI returns are positive and the coefficients of the oil price changes are negative. This is line with the expectations and with the findings in Sector 4.2; an increase in shipping rates indicates higher market returns and higher oil prices have a negative effect on market returns. Looking at the amount of countries with significant returns, the results of equation (5) are not very convincing. When including an oil variable, in equation (6), we find stronger evidence for the BDI as precursor of all sector returns, except of the Oil & Gas sector. Again, when we adjust for the oil effect in the BDI returns, it becomes a stronger predictor for market returns. The Technology and Telecommunication sector show the strongest relation with shipping rate changes of one month earlier, while the Utility and Financials sector show less strong evidence for the BDI influence.

In line with Alizadeh and Muradoglu (2010), we see a clear exception in the Oil & Gas sector. The BDI (as well as the oil prices) are no good precursor for changes in this industry. If we regress the sector returns on the BDI returns without a lag, 13 of the 22 countries give a statistically significant coefficient for the Oil & Gas sector, confirming *Hypothesis III* that this sector is closely related to the shipping market and adapts its information quickly. Although the evidence presented by means of Equation (5) and (6) is not very strong, we have no sufficient reason to reject *Hypothesis III.*

4.4. Robustness tests

4.4.1. Sub samples for countries

To examine if there may be a stronger effect in a part of the sample, the sample is divided into four sub samples. This is done by looking at recession and recovery periods documented by the National Bureau of Economic Research (NBER), but also with global crises such as the Internet bubble and the current financial crisis in mind. The NBER declares a recession if for a few months there is a significant decline in activity across the economy. Especially the industrial production, employment and real income are the barometers they bear in mind. Based on their findings, the following sub samples are determined: 1985-1993, 1994-2000, 2001-2007 and 2008-2011. The descriptive statistics of the BDI in the different periods is shown in Table 8. The statistics of the MSCI World Index and Arab Light Oil are presented in Table 15.

Table 8
Descriptive statistics of the Baltic Dry Index in the four different sample periods. The mean is measured in percentages. See Table 15 for comparison with the MSCI World Index and Arab Light Oil prices.

	Baltic Dry Index			
Sample period	*1985-1993*	*1994-2000*	*2001-2007*	*2008-2011*
No. of observations	103	84	84	49
Minimum	-0,185	-0,209	-0,340	-1,297
Maximum	0,210	0,277	0,373	0,712
Mean	0,157	0,342	2,167	-3,625
Std. dev.	0,087	0,091	0,139	0,328
Skewness	0,031	0,273	0,054	-1,070
Kurtosis	2,858	3,403	3,432	6,563

Note that the standard deviation of the BDI returns, being 16,2% over the whole sample, is very high between 2008-2011. Apparently, the shipping rates were very volatile in those three years. The high kurtosis means that the observations lie further away from the sample's mean and thus the sample contains extreme values. Also notice the negative value for skewness which indicates that the sample mainly contains negative values. The BDI plunged after May 2008, explaining the extreme negative values indicated by the skewness and kurtosis values.

For this robustness test, we do not deviate from the basic regression. The results are presented in Table 9, which clearly show that for the developed countries only the period 2001-2007 provide significance.

With 12 of the 23 developed countries (plus the World, G-7 and EAFE Index) the coefficient is significant different from zero, at a 5% level. In the other periods, there are hardly any significant results for the developed countries. Apparently, the BDI returns only are a good precursor for stock market returns in developed countries during the economic boom of 2001-2007. For the undeveloped countries, in both period 2001-2007 and 2008-2011 there are 7 (of 25) countries with coefficients significant different from zero, at a 10% level. Notice that in these periods, there was either an economic boom or an economic recession. The evidence is less strong than for the developed countries but it seems the BDI returns only has predictive powers regarding future stock market returns since 2001. A possible explanation for the lack of predictive power during 1985-2000 could be that the index was heavily revised in 1999, when the index became a weighted average of some sub indices, and only from that moment reflected the bulk trading volumes accurately.

We conclude that the significance is due to the boom effect in the period 2001-2007. As many economic variables, the oil prices increased heavily in this period. Because shipping rates heavily depend on oil prices, we want to examine the performance of the BDI returns compared to an oil variable, in this period. Therefore, we include the Arab Light Oil prices changes in the analysis, as we did in Section 4.2.1. The results are presented in Table 16 in Appendix A. Not surprisingly, the oil price changes have a negative coefficient which is significant different from zero at a 10% level for 17 of the 23 developed countries (plus the World, G-7 and EAFE Index). Regarding the BDI returns, the same 13 of 23 developed countries as in the analysis without the oil variable, show a positive effect which is significant different from zero at a 10% level. We stated that the oil prices have a huge influence on shipping rates and an increase in oil prices has a negative effect on stock market returns. Taking this into account, the BDI apparently has another (positive) effect which is even stronger than the negative oil influence. Despite of the negative effect of oil price, the BDI has a positive effect on stock market returns, even in this economic boom period.

In Section 2.3, we discussed the assumption that the supply side, namely fleet supply, is inelastic and not stable anymore. We stated that the fleet size was very volatile after 2008 and that as a consequent the BDI would not represent the demand for dry bulk shipping precisely. This conjecture seems to be correct, but future research should reveal if this really is the reason for the insignificance in the period 2008-2012.

Table 9

Results of the basic regression (2) with a one-month lag: $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \varepsilon_{m,t}$ for the four different sub samples. The bolded t-values are significant different from zero at a 10% level.

Country / Area	1985-1993				1994-2000				2001-2007				2008-2011			
	$MSCI_{t-1}$		BDI_{t-1}		$MSCI_{t-1}$		BDI_{t-1}		$MSCI_{t-1}$		BDI_{t-1}		$MSCI_{t-1}$		BDI_{t-1}	
	α_1	t-value	α_2	t-value	α_1	t-value	α_2	t-value	α_1	t-value	α_2	t-value	α_1	t-value	α_2	t-value
World	0,120	1,19	-0,033	-0,69	-0,096	-0,79	0,038	0,76	0,097	0,68	0,058	**2,46**	0,129	0,68	0,053	1,25
G-7	0,120	1,15	-0,035	-0,72	-0,099	-0,82	0,043	0,85	0,099	0,70	0,054	**2,36**	0,121	0,64	0,053	1,28
EAFE	0,134	1,14	-0,037	-0,58	-0,146	-1,18	0,029	0,56	0,114	0,92	0,061	**2,39**	0,178	1,02	0,038	0,90
Developed Countries																
Australia	0,057	1,07	0,012	0,16	-0,238	-2,21	-0,032	-0,78	0,026	0,22	0,018	0,71	0,165	1,19	0,045	1,58
Austria	0,134	1,22	-0,083	-1,13	-0,087	-0,45	0,044	0,61	0,108	1,05	0,021	0,62	0,234	1,33	0,077	1,20
Belgium	0,216	**2,15**	0,047	0,72	-0,033	-0,25	0,044	0,88	0,136	1,00	0,063	**2,18**	0,343	**1,78**	0,044	0,89
Canada	-0,010	-0,10	-0,019	-0,46	0,126	0,98	0,040	0,64	0,128	1,09	0,034	1,31	0,049	0,24	0,064	1,55
Denmark	0,049	0,52	0,020	0,33	-0,102	-0,75	0,006	0,10	-0,008	-0,07	0,058	1,48	0,309	**2,32**	0,022	0,78
France	0,146	1,39	-0,107	-1,47	-0,052	-0,35	0,072	1,13	0,091	0,71	0,077	**2,16**	0,170	1,11	0,025	0,68
Germany	0,163	1,54	-0,057	-0,78	-0,080	-0,53	-0,016	-0,26	0,078	0,64	0,097	**2,10**	0,132	0,81	0,050	1,42
Hong Kong	-0,006	-0,06	0,095	1,24	-0,014	-0,13	0,126	1,15	0,189	**1,72**	0,097	**2,68**	0,134	0,61	0,026	0,58
Italy	0,114	1,06	-0,164	-2,04	-0,051	-0,40	0,095	1,22	-0,057	-0,47	0,066	**2,12**	0,220	1,39	0,019	0,47
Japan	0,075	0,48	0,000	0,00	0,014	0,16	0,063	0,94	0,238	**2,17**	0,048	1,30	0,189	1,50	0,041	1,14
Netherlands	0,120	1,17	-0,053	-1,17	-0,113	-0,68	0,041	0,73	0,034	0,26	0,075	**1,96**	0,161	1,15	0,034	0,99
New Zealand	0,182	1,57	-0,061	-0,70	-0,120	-0,94	0,000	0,00	-0,169	-1,39	0,016	0,56	0,018	0,13	0,017	0,69
Norway	0,166	1,19	-0,012	-0,14	-0,030	-0,23	0,054	0,71	0,094	0,92	0,036	0,80	0,028	0,16	0,080	1,46
Singapore	0,145	1,56	0,037	0,44	-0,014	-0,11	0,127	1,42	0,165	1,41	0,048	1,35	0,170	0,99	0,067	**1,68**
Spain	0,307	**2,93**	-0,129	-1,81	0,035	0,22	0,083	1,05	-0,062	-0,39	0,086	**2,45**	0,155	1,22	0,030	0,76
Sweden	0,233	**2,35**	0,009	0,12	0,037	0,24	0,066	0,88	0,051	0,35	0,083	**1,84**	0,137	0,92	0,040	1,37
Switzerland	0,186	**1,73**	-0,035	-0,56	0,018	0,09	0,037	0,59	0,207	**1,70**	0,072	**2,64**	0,192	0,94	0,034	1,14
United Kingdom	0,033	0,28	0,015	0,25	-0,072	-0,60	0,028	0,59	0,027	0,18	0,045	**1,96**	0,075	0,41	0,017	0,55
USA	-0,001	-0,01	-0,039	-0,80	-0,058	-0,48	0,051	0,94	0,081	0,56	0,055	**2,26**	0,073	0,38	0,065	1,57
Finland	0,294	**2,45**	-0,010	-0,14	0,056	0,47	0,117	1,12	0,176	1,48	0,166	**2,33**	0,089	0,52	0,021	0,43
Greece	0,126	1,07	-0,129	-0,86	0,053	0,43	-0,125	-1,40	0,011	0,08	0,031	0,79	0,212	1,53	0,001	0,01
Ireland	0,103	1,02	-0,097	-0,89	0,132	1,23	-0,037	-0,59	0,083	0,66	0,041	1,10	0,120	0,67	0,077	**1,75**
Portugal	0,153	1,00	-0,121	-1,43	0,045	0,22	0,014	0,19	0,146	1,09	0,088	**2,36**	0,203	1,35	0,012	0,39
Undeveloped Countries																
Argentina	0,046	0,21	-0,300	-0,75	-0,069	-0,59	0,044	0,37	0,021	0,12	0,002	0,02	0,361	**2,36**	0,076	1,21
Brazil	-0,460	-2,93	-0,241	-0,54	0,374	**2,94**	-0,004	-0,03	-0,032	-0,32	0,086	**1,81**	0,075	0,47	0,052	0,97
Chile	0,243	**2,21**	0,111	1,30	0,124	1,14	0,045	0,53	-0,052	-0,54	0,043	1,30	-0,085	-0,52	0,051	**1,77**
China	0,256	1,02	-0,704	-1,41	0,122	0,90	0,121	0,87	0,083	0,65	0,134	**1,99**	0,067	0,34	0,024	0,42
Colombia	0,571	**2,17**	-0,211	-0,86	0,054	0,62	0,046	0,41	0,169	1,60	0,031	0,63	0,060	0,44	0,034	0,74
India	0,092	0,34	-0,849	-2,03	0,007	0,06	-0,081	-0,70	0,051	0,58	0,093	**2,03**	0,002	0,01	0,097	**2,00**
Indonesia	0,080	0,65	-0,067	-0,34	0,045	0,35	0,190	1,55	0,109	1,09	0,096	**1,72**	0,172	0,99	0,079	1,62
Israel	-0,281	-0,72	0,233	0,79	-0,019	-0,13	0,014	0,14	0,073	0,41	0,062	1,46	0,015	0,10	0,043	**2,19**
Jordan	0,045	0,30	0,124	**1,83**	0,150	1,25	0,011	0,20	0,186	1,58	0,026	0,51	0,249	**1,80**	0,071	**2,44**
Korea	-0,191	-1,83	0,095	0,84	0,198	**2,55**	0,071	0,57	0,043	0,33	0,069	1,43	0,030	0,22	0,082	**2,06**
Malaysia	0,088	0,59	-0,053	-0,60	0,069	0,41	-0,038	-0,31	0,189	**1,81**	0,064	**1,74**	0,370	**2,47**	0,012	0,62
Mexico	0,032	0,21	-0,283	-1,66	-0,093	-0,72	-0,004	-0,05	0,051	0,43	0,071	**2,09**	-0,008	-0,04	0,056	1,32
Philippines	0,247	**1,97**	-0,088	-0,78	0,035	0,33	0,117	1,09	0,106	0,95	0,010	0,24	-0,117	-0,90	0,072	**1,99**
Taiwan	0,156	1,17	-0,173	-0,78	0,022	0,21	0,048	0,49	-0,037	-0,27	0,101	**2,23**	0,188	1,30	0,048	1,28
Thailand	0,289	**1,97**	-0,067	-0,63	-0,057	-0,50	0,339	**2,53**	-0,211	-1,64	-0,024	-0,52	0,062	0,34	0,072	1,49
Turkey	0,046	0,41	0,132	0,56	0,112	1,01	0,120	0,85	-0,144	-1,34	0,038	0,50	-0,084	-0,56	0,083	**1,90**
Pakistan	0,994	**2,65**	0,668	1,32	-0,042	-0,38	0,027	0,22	-0,176	-1,41	0,035	0,57	0,175	**2,42**	0,053	1,20
Peru	-0,258	-0,73	0,224	0,41	0,113	0,96	-0,117	-1,59	-0,219	-1,97	0,096	1,59	-0,174	-1,33	0,087	1,13
Poland	-0,185	-0,69	0,630	0,80	-0,101	-0,89	-0,209	-1,53	-0,113	-0,89	0,064	1,30	0,102	0,74	0,040	0,80
South Africa	0,373	0,72	0,102	0,56	0,029	0,29	-0,001	-0,01	-0,033	-0,26	0,036	0,89	-0,220	-1,39	0,032	1,14
Czech Republic	n/a	n/a	n/a	n/a	0,020	0,19	0,153	1,45	-0,125	-1,02	0,041	0,81	0,118	0,72	0,044	0,98
Egypt	n/a	n/a	n/a	n/a	0,175	1,29	-0,043	-0,29	0,084	0,62	0,068	0,87	0,092	0,47	0,055	0,94
Hungary	n/a	n/a	n/a	n/a	0,026	0,25	0,105	0,84	-0,065	-0,54	-0,019	-0,43	0,235	1,66	0,050	0,79
Morocco	n/a	n/a	n/a	n/a	0,257	**1,75**	-0,057	-0,98	0,041	0,42	-0,004	-0,12	-0,077	-0,39	0,005	0,18
Russia	n/a	n/a	n/a	n/a	0,133	0,73	0,197	0,70	-0,049	-0,50	-0,010	-0,15	0,283	1,59	0,070	1,08

4.4.2. *Sub samples for sectors*

To examine if the findings of Section 4.3 hold in different periods, this sector dataset is also divided into (the same) four sub samples. Table 10 presents the results in the same manner as Table 7 in Section 4.3.

Table 10
Summary results of equation (5): $\boldsymbol{r}_{s,c,t} = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1 r}_{s,c,t-1} + \boldsymbol{\alpha_2 r^{BDI}_{t-1}} + \boldsymbol{\varepsilon}_{s,c,t}$ for the four different sub samples.

	No. of observations				No. of countries significant				Percentage significant			
Start date	*1985*	*1994*	*2001*	*2008*	*1985*	*1994*	*2001*	*2008*	*1985*	*1994*	*2001*	*2008*
End date	*1993*	*2000*	*2007*	*2011*	*1993*	*2000*	*2007*	*2011*	*1993*	*2000*	*2007*	*2011*
Sector												
Oil & Gas	14	18	22	22	0	2	0	2	0%	11%	0%	9%
Basic Materials	21	22	22	22	0	3	3	2	0%	14%	14%	9%
Industrial	20	22	22	22	0	2	3	1	0%	9%	14%	5%
Consumer Goods	18	22	22	22	0	1	4	5	0%	5%	18%	23%
Health Services	18	19	21	22	0	1	4	3	0%	5%	19%	14%
Consumer Services	20	22	22	22	0	0	8	1	0%	0%	36%	5%
Telecommunication	9	20	22	22	0	0	13	2	0%	0%	59%	9%
Utility	14	19	22	19	1	0	7	1	7%	0%	32%	5%
Financials	21	22	22	22	0	1	9	2	0%	5%	41%	9%
Technology	13	19	21	21	2	1	10	6	15%	5%	48%	29%

The results are in line with both Section 4.3 and Section 4.4.1. For every sector, but the Oil & Gas, there are some countries which show significant results for the one-month lagged BDI return. Again, the evidence is the strongest for the Telecommunication and the Technology sector. But as in the previous section the results are mainly significant for the period 2001-2007, indicating again that the one-month lagged BDI return only is a good predictor of future stock market return during this economic boom.

4.4.3. *Sub indices*

Table 11 presents the correlations between the logarithmic returns of the BDI, its sub indices and the Arab Light Oil prices. To test if the findings of Section 4.2 are robust, we replace the logarithmic BDI returns as independent variable by the returns of its sub indices, the Baltic Capesize Index (BCI) and the Baltic Panamax Index (BPI). These indices transport the main bulks which are expected to have the biggest influence on industrial production and thus on stock market returns. Moreover, the Supramax and Handysize index only have observations for a couple of years (initiated in resp. 2005 and 2006) and are therefore excluded in this analysis. The descriptive statistics are presented in Table 2 and the historical development is graphically shown in Figure 4 and 5 in appendix B.

The results of the predictive regressions (7) and (8) are presented in Table 12.

$$r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BPI} + \varepsilon_{m,t} \quad (7)$$

$$r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BCI} + \varepsilon_{m,t} \quad (8)$$

With 19 of the 23 developed countries (plus the World, G-7 and EAFE Index) and 16 of the 25 undeveloped countries being significant at the 10% level, the results are quite convincing for the Panamax Index. Only 4 developed countries and 5 undeveloped countries show coefficients different from zero concerning the Capesize Index.

In appendix C we describe that the routes used for the determination of the BDI are time charter averages. Hence, it is not possible to make a distinction between different types of cargoes. Two main things do strike, looking at the Panamax and Capesize routes. First, two of the four Panamax routes are based on the delivery in the Skaw-Gibraltar area[24]. Within the Capesize routes, the focus lies on deliveries in China-Japan, as two of the four routes refer to that area. This could be an explanation for the different results of the indices. Second, the Panamax Index is predominantly significant in the period 2008-2012, whereas the Capesize Index shows only coefficients significant different from zero in the period 2001-2007. A possible explanation is that the fleet size heavily increased after 2008. The new bulk carriers mainly were of the Capesize category, while the Panamax fleet remained stable. Looking at the whole period (1985-2011), the Panamax Index seems to be the driver of the BDI as being a good predictor for stock market returns, but the Capesize Index definitely is the main driver during the years 2001-2007.

Compared to the BDI, the economic effect of an increase of one standard deviation is bigger for the Panamax Index. An increase of one standard deviation (21,5%)[25] in the BPI return will one month later result in an increase in the MSCI World Index return of 1.39%. For the return of developed countries the effect of a 21,5% increase will lie between 0,54 and 2,08%, with an average of 1,22%.

Table 11
Correlations of the changes in the Baltic Dry Index, Capesize Index, Panamax Index and Arab Light Oil prices.

	BDI	Capesize	Panamax	Arab Light Oil
BDI	1	-	-	-
Capesize	0,932	1		-
Panamax	0,932	0,780	1	-
Arab Light Oil	0,302	0,256	0,308	1

[24] Skaw-Gibraltar refers to an area from the north of Denmark to the south of Spain.
[25] See Table 2.

Table 12

Results of the regressions (7): $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BPI} + \varepsilon_{m,t}$ and (8): $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BCI} + \varepsilon_{m,t}$. The bolded t-values are significant different from zero at a 10% level.

Country / Area	Panamax				Capesize			
	MSCI_{t-1}		BPI_{t-1}		MSCI_{t-1}		BCI_{t-1}	
	α_1	t-value	α_2	t-value	α_1	t-value	α_2	t-value
World	0,086	0,78	0,064	**2,19**	0,105	0,83	0,032	1,24
G-7	0,083	0,75	0,062	**2,15**	0,097	0,76	0,032	1,28
EAFE	0,099	0,97	0,062	**2,09**	0,146	1,28	0,023	0,90
Developed Countries								
Australia	0,102	1,13	0,042	**1,96**	0,130	1,30	0,020	1,05
Austria	0,136	1,24	0,097	**2,22**	0,225	**1,74**	0,037	1,06
Belgium	0,177	**1,88**	0,080	**2,24**	0,222	**1,89**	0,041	1,49
Canada	0,125	1,29	0,058	**2,04**	0,151	1,30	0,033	1,46
Denmark	0,086	1,08	0,047	**1,87**	0,122	1,42	0,036	**1,76**
France	0,086	0,90	0,050	**1,99**	0,108	1,17	0,023	0,97
Germany	0,079	0,89	0,058	**2,12**	0,086	0,92	0,041	1,63
Hong Kong	0,141	1,27	0,054	**1,89**	0,153	1,37	0,036	1,34
Italy	0,102	1,09	0,043	1,48	0,101	1,00	0,014	0,53
Japan	0,170	**2,45**	0,056	**1,88**	0,206	**2,78**	0,030	1,38
Netherlands	0,031	0,36	0,057	**2,11**	0,042	0,46	0,035	1,53
New Zealand	-0,110	-1,32	0,025	1,08	-0,091	-1,11	0,018	1,05
Norway	0,033	0,38	0,073	**1,87**	0,086	0,87	0,041	1,23
Singapore	0,105	1,14	0,077	**2,47**	0,104	1,04	0,050	**2,03**
Spain	0,045	0,46	0,066	**2,3**	0,057	0,59	0,027	1,02
Sweden	0,106	1,06	0,061	**2,89**	0,114	1,11	0,030	1,35
Switzerland	0,132	1,07	0,050	**2,48**	0,158	1,51	0,029	**1,74**
United Kingdom	0,004	0,04	0,036	**1,69**	0,008	0,07	0,011	0,55
USA	0,055	0,48	0,067	**2,28**	0,047	0,36	0,039	1,53
Finland	0,179	**2,03**	0,061	**1,73**	0,182	**1,93**	0,041	1,29
Greece	0,134	1,53	0,032	0,62	0,160	**1,74**	-0,001	-0,03
Ireland	0,134	1,23	0,058	1,63	0,136	1,17	0,058	**2,03**
Portugal	0,054	0,42	0,054	**2,28**	0,186	**1,88**	0,019	0,96
Undeveloped Countries								
Argentina	0,122	1,09	0,086	1,56	0,155	1,30	0,054	1,23
Brazil	-0,031	-0,32	0,079	**1,99**	0,041	0,52	0,049	1,55
Chile	-0,057	-0,75	0,051	**2,61**	-0,035	-0,41	0,031	1,58
China	0,105	0,95	0,071	1,67	0,125	1,30	0,027	0,84
Colombia	0,069	0,99	0,061	1,64	0,094	1,17	0,024	0,88
India	0,034	0,38	0,099	**2,85**	0,048	0,50	0,053	**1,68**
Indonesia	0,168	1,67	0,095	**2,53**	0,170	**2,03**	0,052	**1,77**
Israel	0,019	0,15	0,047	**2,82**	0,021	0,16	0,034	**2,20**
Jordan	0,287	**3,34**	0,056	**1,97**	0,275	**3,03**	0,040	1,60
Korea	0,062	0,86	0,087	**2,70**	0,095	1,18	0,053	**2,18**
Malaysia	0,184	0,91	0,039	**2,19**	0,188	**2,25**	0,023	1,60
Mexico	-0,041	-0,43	0,073	**2,36**	-0,017	-0,18	0,037	1,46
Philippines	0,087	1,07	0,059	**2,12**	0,026	0,34	0,033	1,41
Taiwan	-0,012	-0,13	0,076	**2,77**	0,015	0,16	0,050	**1,98**
Thailand	-0,063	-0,65	0,066	1,60	-0,067	-0,80	0,042	1,23
Turkey	-0,008	-0,08	0,093	**2,61**	-0,062	-0,58	0,053	1,51
Pakistan	-0,058	-0,68	0,040	1,28	0,031	0,40	0,047	1,35
Peru	-0,158	-2,01	0,102	**1,74**	-0,115	-1,39	0,042	0,94
Poland	-0,040	-0,54	0,067	**1,69**	0,026	0,33	0,022	0,66
South Africa	-0,077	-1,01	0,036	1,58	-0,050	-0,54	0,014	0,78
Czech Republic	-0,020	-0,24	0,078	**2,04**	0,039	0,44	0,025	0,86
Egypt	0,114	1,19	0,071	1,43	0,182	**1,79**	0,013	0,29
Hungary	0,081	0,94	0,071	1,39	0,154	1,65	0,014	0,36
Morocco	0,004	0,05	0,001	0,06	0,007	0,08	-0,004	-0,21
Russia	0,137	0,70	0,125	**1,83**	0,170	**1,68**	0,037	0,77

4.4.4. *Other common stock return predictors*

To test for predictability in stock market returns, most studies in predictive literature look into several economic variables. Hjarlmarsson (2010), for example, investigates if the dividend-price (DP) and earnings-price (EP) ratio, the short interest rate and the term spread have significant effect on stock market returns. In developed countries, he finds consistent evidence that the short interest rate and the term spread have a predictability effect on stock returns. On the contrary, the dividend-price and earnings-price ratio show no significant effect and are no good predictors of stock returns. Lewellen (2004) shows that dividend yields, book-to-market and the earnings-price ratio do predict stock market returns in the last decades in the USA. Goyal (2010) shows that for the last 30 years common predictors (suggested by the academic literature) such as the dividend yield, the earnings-price ratio, stock variance, cross-sectional premium, book-to-market ratio, treasury bills, the term spread and the default yield spread are not good predictors of the equity premium.

In our research, some common predictors are incorporated into our model next to the BDI as independent variables, to examine whether the lagged BDI changes remain significant. For this robustness check, we will only look at USA data until December 2010. The predictive regression is formulated as follows,

$$r_t^{US} = \alpha_0 + \alpha_1 r_{t-1}^{US} + \alpha_2 r_{t-1}^{BDI} + \alpha X_{t-1} + \varepsilon_t \qquad (9)$$

The dependent variable is the MSCI Index for the USA. We included the own lag of the dependent variable, the one-month lagged BDI return and X. Where X is a vector of the logarithmic changes in the following independent variables.

Dividend yield: Difference between the log of dividends and the log of lagged prices, both with the S&P500 as underlying. Data is originally purchased from Global Financial Data. Goyal (2010) and Ang and Bekeart (2007) both use this data in their investigation.

Earnings Price Ratio: Difference between the log of earnings and the log of prices, both with the S&P500 as underlying. Data is originally purchased from Global Financial Data. Goyal (2010) and Ang and Bekeart (2007) both use this data in their investigation.

Term Spread: Difference between the long term yield on government bonds and the T-bill. Both variables are in Goyal's database and the term spread could be calculated.

Default Yield Spread: Difference between AAA- and BAA- rated corporate bond yields.

Table 13
Results of eight regressions with changing independent variables. The first row of a regression presents the coefficient and the lower number is the t-value. The bolded t-values are significant different from zero at a 10% level.

	$\mathbf{MSCI\ USA}_{t-1}$	$\mathbf{BDI}_{t-1}$	$\mathbf{Oil}_{t-1}$	$\mathbf{Div.Yield}_{t-1}$	$\mathbf{EP-ratio}_{t-1}$	$\mathbf{Term\ Spread}_{t-1}$	$\mathbf{Def.Spread}_{t-1}$
1	0,046	0,072	-0,078				
	0,55	**2,39**	**-2,99**				
2	0,040	0,058		-0,008			
	0,47	**2,02**		-0,02			
3	0,012	0,054			0,064		
	0,15	**1,89**			0,97		
4	0,014	0,053				-0,057	
	0,16	**1,93**				-1,34	
5	0,043	0,059					-0,006
	0,50	**2,04**					-1,00
6	0,015	0,067	-0,082			-0,067	
	0,18	**2,30**	**-3,14**			-1,58	
7	-0,008	0,050			0,057	-0,050	
	-0,09	**1,81**			0,86	-1,17	
8	-0,005	0,051			0,055	-0,050	-0,006
	-0,06	**1,83**			0,84	-1,17	-0,91

As Table 13 shows clearly, the BDI return outperforms all the other predictive variables. Its coefficient remains significant different from zero at a 10% level when including one or more other independent variables and the significance of the oil variable is in line with previous findings. As well as in the previous findings, the BDI returns show only significant effects for the period 2001-2007. The oil variable is statistically significant in the periods 1985-1993 and 2001-2007. In line with Goyal (2010), the other suggested predictors perform poorly as predictor of stock market returns as none of them shows a significant result in the whole sample or in one of the four sub periods.

5. Concluding Remarks

This study examines the predictive power of the Baltic Dry Index returns on stock market returns, by looking at MSCI Indices of countries which are part of the MSCI World Index plus several undeveloped countries. For the developed countries, this study also examines the effect of BDI returns on stock market returns in different sectors. This delayed reaction suggests that the information which the BDI contains diffuses only gradually across markets (Hong et al., 2007). The BDI displays ship freight rates to transport raw materials which are inputs for industrial production. Hence, the operations related to the dry bulk shipping market are performed in the beginning of the production cycle, and markets react at different points in time to this information. A higher BDI implies higher levels of demand for raw materials. This results in increased industrial production levels and economic growth (Mohtadi and Agarwal, 2001) and thus potentially increases stock market prices. We found empirical evidence that supports the conjecture that a higher BDI return will one month later result in a higher stock market return. However, these results only apply for the period 2001-2007.

The main findings presented in this paper show that the BDI returns have a positive effect on future stock market returns. For 11 of the 23 developed countries (plus the World Index) we found statistical and economic significance that the BDI returns and stock market returns have a positive predictive relationship. An increase of one standard deviation (16,2%) in the BDI return will one month later result in an increase in the MSCI World Index return of 0,78%. For the return of developed countries the effect of a 16,2% increase will lie between 0,05 and 1,13%, with an average of 0,70%. Regarding the whole sample period, the results are robust in the presence of some common stock market predictors. We also find evidence for the predictability of the BDI return on sector returns; where the Technology and Telecommunication sector show the most significant results. The Oil & Gas sector reacts almost immediately on changes in freight rates, while they only show significant effects on the non-lagged BDI returns.

We show evidence that the BDI effect cannot be explained by the predictability of oil. The statistical and economic effects on both countries' and sectors' market returns are even stronger when Arab Light Oil price changes are included as explanatory variable, whereas oil price changes have a negative effect on stock market returns and a huge impact on the BDI.

By dividing the dataset in four sub periods, we show that the BDI effect is only present after 2001. For developed countries (plus the World Index), all significant results lie in the period 2001-2007. These findings are in line with the sector results, where this period mainly shows significant results. One possible explanation for these findings is the economic boom effect in this period. However, the results are robust when including the oil variable, which also increased heavily during those seven years. Since the oil price changes have a negative influence on stock market returns, we can state that the BDI contains a positive effect on stock market returns which makes up for the influence of the oil prices on the BDI level. Another important possible explanation is the index modification in 1999, when the index became a weighted average of some sub indices, and only from that moment reflected the bulk trading volumes accurately. Moreover, we conclude that the Panamax Index is the main driver of the predictability of the BDI. The Capesize Index only shows a predictive effect in the period 2001-2007, possibly weakened by the growth in fleet size after 2008. Future research should point out what exactly drives the different results for the Panamax and Capesize Index and whether we must consider following these sub indices instead of the broad Baltic Dry Index.

In this study, we argued the effect of the unstable supply side. Due to vessel orders in the booming years, the available deadweight tonnage increased heavily the last years. This study has not empirically examined its impact. We recommend future research to the impact of the fleet supply, because the hypothesis that BDI returns have a positive and statistically significant impact on returns assumes that the supply side is constant. In this light, f.e. CARE Research states that vessel oversupply has a big impact on freight rates and a study of Credit Suisse argues that the Baltic Dry Index could be a better reflection of dry bulk demand after 2013 since then the fleet size is in balance.

Appendix A: Additional tables

Table 14

Estimates of regression: $r_t^{US\ Sector} = \alpha_0 + \alpha_1 r_{t-1}^{US\ Sector} + \alpha_2 r_t^{BDI} + \alpha_3 r_{t-1}^{BDI} + \alpha_4 r_{t-2}^{BDI} + \alpha_5 r_{t-3}^{BDI} + \varepsilon_t$. Where available, the sample period is May 1985 to December 2011. The bolded t-values are significant different from zero at a 10% level.

	US Sector_{t-1}		BDI_t		BDI_{t-1}		BDI_{t-2}		BDI_{t-3}	
USA Sector	α_1	**t-value**	α_2	**t-value**	α_3	**t-value**	α_4	**t-value**	α_5	**t-value**
Oil & Gas	-0,091	-1,19	0,072	**2,10**	0,001	0,02	0,029	1,16	0,003	0,16
Basic Materials	-0,055	-0,66	0,062	1,46	0,052	1,24	0,063	1,54	0,013	0,49
Industrial	0,038	0,46	0,015	0,41	0,038	1,35	0,029	0,89	0,028	1,08
Consumer Goods	0,085	1,33	0,014	0,53	0,027	1,33	0,026	1,13	0,011	0,51
Health Services	0,031	0,48	-0,012	-0,49	0,050	**2,36**	0,001	0,06	-0,004	-0,27
Consumer Services	0,090	1,20	0,004	0,16	0,046	**1,89**	0,018	0,61	0,005	0,21
Telecommunication	-0,017	-0,24	0,006	0,29	0,044	**2,03**	0,003	0,15	0,010	0,45
Utility	0,011	0,18	0,023	0,95	0,023	1,45	0,008	0,45	0,014	1,10
Financials	0,049	0,46	-0,012	-0,30	0,083	**1,99**	0,022	0,53	0,041	1,02
Technology	-0,042	-0,48	0,021	0,71	0,075	**2,77**	0,059	**1,83**	-0,021	-0,93

Table 15

Descriptive statistics of returns of the MSCI World Index and Arab Light Oil prices in the four different sample periods. The mean is measured in percentages.

	MSCI World Index				**Arab Light Oil**			
Sample period	*1985-1993*	*1994-2000*	*2001-2007*	*2008-2011*	*1985-1993*	*1994-2000*	*2001-2007*	*2008-2011*
No. of observations	103	84	84	49	103	84	84	49
Minimum	-0,169	-0,112	-0,107	-0,208	-0,485	-0,208	-0,342	-0,450
Maximum	0,120	0,136	0,093	0,136	0,487	0,402	0,191	0,261
Mean	1,035	0,872	0,335	-0,616	-0,780	0,987	1,327	0,471
Std. dev.	0,045	0,039	0,038	0,074	0,131	0,097	0,084	0,110
Skewness	-0,680	-0,152	-0,721	-0,483	0,281	0,467	-0,978	-1,489
Kurtosis	4,818	3,781	3,706	3,137	8,426	4,981	5,692	7,649

Table 16

Estimation of regression: $r_{m,t} = \alpha_0 + \alpha_1 r_{m,t-1} + \alpha_2 r_{t-1}^{BDI} + \alpha_3 r_{t-1}^{OIL} + \varepsilon_{m,t}$ for the period 2001-2007. The bolded t-values are significant different from zero at a 10% level.

Country / Area	$MSCI_{t-1}$		BDI_{t-1}		Arab Light Oil_{t-1}	
	α_1	t-value	α_2	t-value	α_3	t-value
World	0,106	0,77	0,057	**2,35**	-0,131	**-3,22**
G-7	0,111	0,81	0,054	**2,26**	-0,130	**-3,36**
EAFE	0,128	1,07	0,061	**2,28**	-0,114	**-2,29**
Developed Countries						
Australia	0,055	0,47	0,018	0,72	-0,108	**-3,44**
Austria	0,139	1,32	0,021	0,62	-0,088	-1,56
Belgium	0,123	0,93	0,063	**2,13**	-0,112	**-1,75**
Canada	0,220	**2,04**	0,034	1,25	-0,168	**-3,26**
Denmark	0,013	0,12	0,058	1,45	-0,191	**-3,52**
France	0,101	0,83	0,077	**2,14**	-0,152	**-2,41**
Germany	0,081	0,71	0,097	**2,08**	-0,214	**-2,93**
Hong Kong	0,199	**1,85**	0,097	**2,59**	-0,075	-1,29
Italy	-0,019	-0,17	0,067	**2,08**	-0,158	**-2,93**
Japan	0,255	**2,33**	0,048	1,28	-0,062	-1,38
Netherlands	0,045	0,35	0,076	**1,98**	-0,130	**-2,13**
New Zealand	-0,154	-1,47	0,017	0,58	-0,148	**-3,29**
Norway	0,142	1,39	0,037	0,80	-0,179	**-2,60**
Singapore	0,178	1,59	0,048	1,36	-0,128	**-2,13**
Spain	-0,064	-0,42	0,086	**2,36**	-0,159	**-2,66**
Sweden	0,055	0,39	0,083	**1,82**	-0,275	**-3,51**
Switzerland	0,198	1,65	0,072	**2,62**	-0,076	-1,44
United Kingdom	0,034	0,23	0,045	**1,92**	-0,116	**-2,73**
USA	0,077	0,54	0,055	**2,21**	-0,147	**-3,77**
Finland	0,157	1,40	0,168	**2,31**	-0,226	-1,04
Greece	0,020	0,18	0,031	0,81	-0,184	**-1,87**
Ireland	0,074	0,59	0,040	1,09	-0,072	-1,29
Portugal	0,129	0,99	0,088	**2,30**	-0,151	**-3,14**
Undeveloped Countries						
Argentina	0,079	0,43	-0,003	-0,05	-0,286	-1,64
Brazil	0,085	**1,72**	-0,140	-2,01	0,000	0,00
Chile	-0,023	-0,24	0,043	1,25	-0,123	**-2,09**
China	0,113	0,91	0,131	**1,94**	-0,113	-1,03
Colombia	0,184	**1,73**	0,031	0,63	-0,100	-0,86
India	0,094	1,11	0,090	**1,99**	-0,206	**-2,73**
Indonesia	0,132	1,28	0,095	**1,70**	-0,087	-0,98
Israel	0,033	0,19	0,063	1,43	-0,219	**-2,65**
Jordan	0,183	1,54	0,026	0,51	-0,078	-1,08
Korea	0,126	1,06	0,071	1,42	-0,364	**-3,63**
Malaysia	0,239	**2,29**	0,065	**1,77**	-0,126	**-2,06**
Mexico	0,088	0,79	0,071	**2,02**	-0,185	**-2,73**
Philippines	0,102	0,98	0,011	0,25	-0,187	**-2,40**
Taiwan	0,030	0,26	0,105	**2,34**	-0,287	**-2,34**
Thailand	-0,149	-1,09	-0,026	-0,56	-0,195	**-1,69**
Turkey	-0,144	-1,45	0,038	0,49	-0,386	**-3,76**
Pakistan	-0,178	-1,43	0,035	0,56	-0,093	-0,81
Peru	-0,188	-1,62	0,094	1,54	-0,098	-1,07
Poland	-0,122	-0,96	0,064	1,25	-0,138	-1,38
South Africa	0,010	0,08	0,036	0,88	-0,171	**-2,26**
Czech Republic	-0,127	-1,05	0,041	0,80	-0,078	-0,92
Egypt	0,102	0,73	0,068	0,87	-0,069	-0,62
Hungary	-0,067	-0,57	-0,019	-0,42	-0,117	-1,18
Morocco	0,040	0,40	-0,004	-0,12	0,007	0,11
Russia	-0,032	-0,34	-0,011	-0,16	-0,072	-0,59

Appendix B: Additional figures

Figure 3. Historical development of the Arab Light Oil prices, 1985-2011

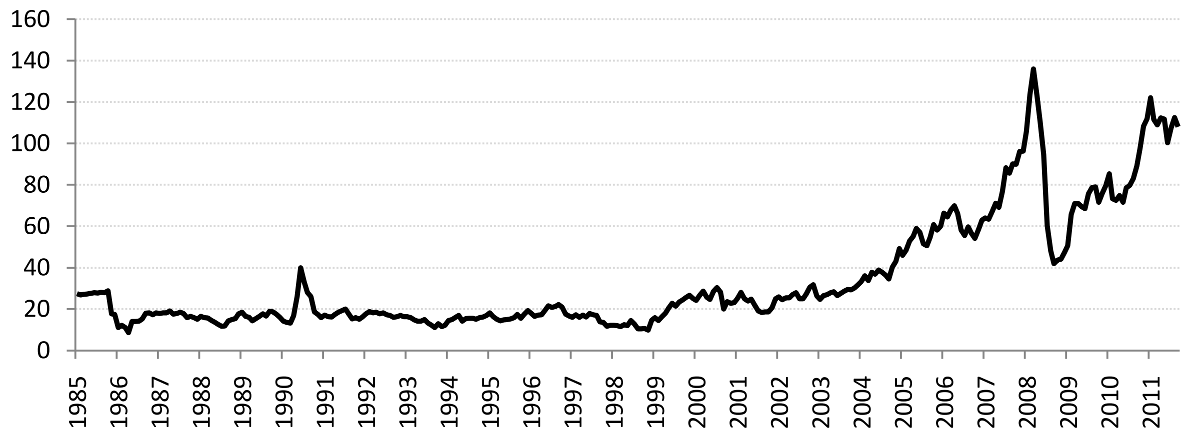


Figure 4. Historical development of the Baltic Panamax Index, 1998-2011

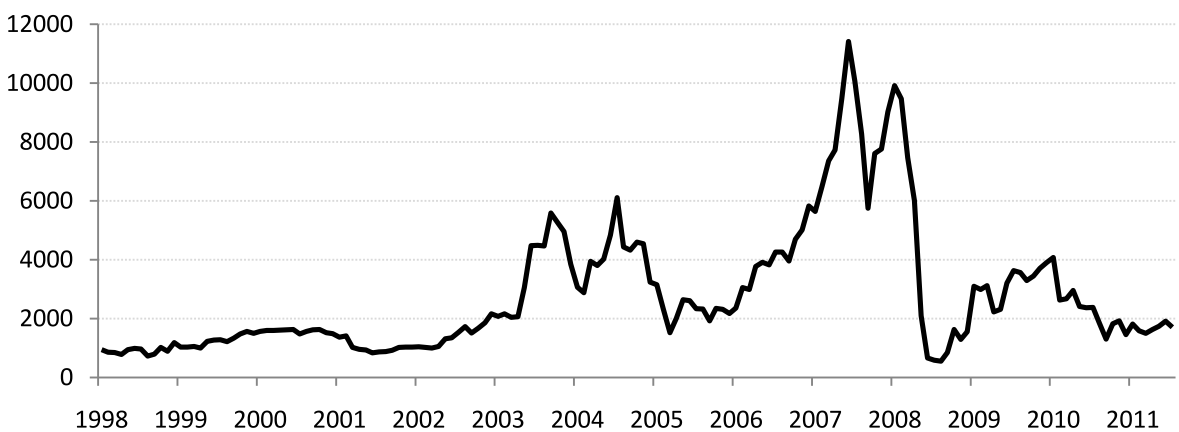
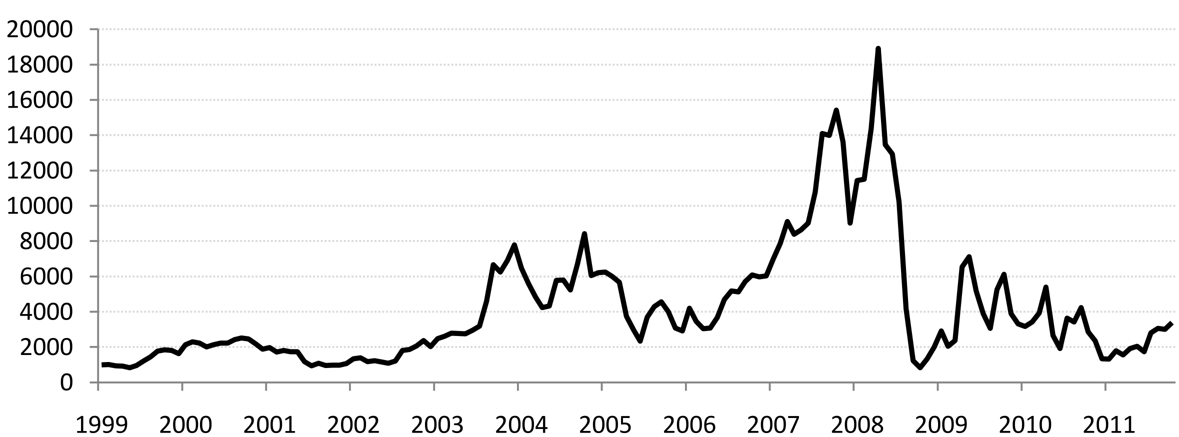


Figure 5. Historical development of the Baltic Capesize Index, 1999-2011



Appendix C: History of the composition of the Baltic Indices

After its establishment in 1985, the Baltic Dry Index consisted of thirteen voyage routes, covering several different cargoes. The first year after its inception, the composition of the BDI was made up as follows,

Route	Vessel size	Cargo	Route description	Weightings
1	55,000	Light Grain	US Gulf to ARA	20%
2	52,000	HSS	US Gulf to S. Japan	20%
3	52,000	HSS	US Pacific coast to S. Japan	15%
4	21,000	HSS	US Gulf to Venezuela	5%
5	20,000	Barley	Antwerp to Red Sea	5%
6	120,000	Coal	Hampton Roads to S. Japan	5%
7	65,000	Coal	Hampton Roads to ARA	5%
8	110,000	Coal	Queensland to Rotterdam	5%
9	55,000	Coke	Vancouver to Rotterdam	5%
10	90,000	Iron Ore	Monrovia to Rotterdam	5%
11	20,000	Sugar	Recife (Brazil)-US East Coast	5%
12	20,000	Potash	Hamburg to west coast India	2,5 %
13	14,000	Phosphates	Aqaba to west coast India	2,5 %

As stated in Section 2.4, the development originally had only one purpose. The BDI was originated as a settlement mechanism for the BIFFEX contracts. Over the last decades the composition of the BDI heavily changed. Routes and/or cargoes were included or excluded in the calculation. These changes were often the result of investors' demands. These practitioners used the contract to hedge their exposure and would benefit if the index effectively and precisely reflected their trade/business.

To provide more specific information and to give the opportunity to hedge more effectively, it was necessary to develop indices which each would cover a specific range of vessel sizes[26]. In the late 90's, such indices were established. For example, the Baltic Panamax Index (BPI) was first published in December 1998 and both the Baltic Capesize Index and the Baltic Handy Index (BHI) were originated in March 1999. To provide also a general dry bulk market indicator, a weighted average of these three indices was introduced. The name of this weighted average index was the Baltic Dry Index, which replaced the original Baltic Freight Index in November 1999.

Since July 2009 the BDI is a weighted average of four separate indices: the BCI, BPI, BSI and the BHSI[27]. As of that moment the index is calculated as follows,

[26] The vessel sizes of the indices, currently included in the calculation of the BDI, are shown in Section 2.1
[27] The Baltic Supramax Index (BSI) was introduced in June 2005 and the Baltic Handysize Index (BHSI) replaced the BHI in January 2001.

*((CapesizeTCavg + PanamaxTCavg + SupramaxTCavg + HandysizeTCavg) / 4) * 0,113473601*

Where TCavg = Time charter average

Time charter average is a method to determine the price of vessel charters. The shipowners are paid on a per-day basis plus additional costs such as fuel costs and port fees. The charterer is responsible for the commercial risks and gives instructions to the shipowner. With voyage charters, on the contrary, the shipowner receives a fixed amount to transport a certain cargo. In this case, the shipowner bears all the risks and costs concerning the transport (Prokopczuk, 2010).

Note that for the calculation of the BCI, ten different dry bulk routes are used, but only four Capesize routes for the calculation of the BDI. Six of the Capesize routes are excluded in the formula above. This also applies for the other indices. Overall, twenty key dry bulk routes are used in the determination of the BDI (resp. 4, 4, 6, 6) while the individual indices cover more dry bulk routes (resp. 10, 4, 9, 6).

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