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Predicting Spot Freight Rates by Spreads of Time Charter Contracts of Different Duration

by

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CERTIFICATION OF THESIS PREPARATION

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Abstract

This dissertation examines the predictive ability of spreads between time charter contracts of different durations to spot freight rates. As the spot freight rates are characterized by extreme volatility, the need to predict them is undeniable. In this research monthly data were collected from Clarksons Shipping Intelligence Network for a period starting from January 2009 until September 2020. The analysis refers to three different ship types, which are Capesize, Panamax and Handysize vessels. For each vessel type, a linear model was defined from a pool of variables that, based on theory, affect freight rates. Then, the first model was compared with the same model with a time charter spread added.

1. Introduction

In shipping, the dry bulk market accounts for almost 50% of the world trade volume. It is consisted of small size bulk carriers, Handy size, Handymax, Panamax, Post-Panamax, Capesize and Very Large Bulk Carriers and it is a highly volatile market. This volatility is translated to high risks for the industry. One of the most important sources of risk, due to volatility, is the freight rate risk because it has a great impact on the main source of income. As a result, there is an increasing interest for ship owners, shipping and financial companies, banks, charterers, and shipping hedge funds to predict the future freight rates so as to prevent this risk, in other words, to hedge the risk.

The term structure of interest rates or the slope of the yield curve is said to have a high predictive ability of the economic activity. The study of the slope of the yield curve for freight rates, accordingly, may add a significant component to the forecasting ability of spot freight rates. As the economic theory suggests, every price in the economy depends on supply and demand factors. Accordingly, shipping freight rates are affected by several endogenous and exogenous factors that influence supply and demand. To name a few, global macroeconomic factors such as GDP, exchange rates, interest rates, global trade but also from endogenous factors like orderbook, scrapping, fuel prices, lay-up rate and more.

The slope of the yield curve may be upward or downward based on the future expectations. In this case, the slope will be upward if the long-term time charter rates are higher than the short-term meaning that the market expectations are positive. On the other hand, it will be downward if the market expectations are negative.

The Baltic Dry Index is published every day by the Baltic Exchange, a membership organization based in London UK. The Baltic Exchange provides information about the shipping industry and operates as an independent source. The BDI refers to the dry bulk market and is made up of three other indices, the Baltic Capesize Index (BCI), the Baltic

Panamax Index (BPI) and the Baltic Handymax Index (BHMI). However, until 2018 part of the BDI was also the Baltic Handysize Index. Every index that participates in the calculation of BDI has a specific weight, that is 40% for Capesize vessels, 30% for Panamax vessels and another 30% for Supramax vessels. This index provides information for the maritime industry and is used as point of reference for the calculation of freight. In this dissertation, we are going to examine some of its current main components, which are the BCI and BPI, but also its recent withdrawal, BHI.

2. Literature Review

In the previous literature, empirical research has been done about the term structure of nominal interest rates in relation to inflation and the real interest rates (Mishkin, 1990), which points out that there is significant predictive ability for inflation. Moreover, the relationship of spreads between different duration charter rates was investigated (Veenstra, 1999) and the conclusion was that the spreads between spot and time charter rates are important variables of information in shipping as they have a long-term relationship. The unbiasedness hypothesis in the Freight Forward market was investigated (Kavussanos, Visvikis and Menachof, 2001) indicating that there are specific routes and maturities for which unbiasedness is valid. Previous research also examined the lead-lag relationship in returns and volatilities of the spot and forward prices in Forward Freight Agreement market for specific voyage and time charter routes (Kavussanos and Visvikis, 2004). Results showed that FFA prices provide up to date information in the spot market although they are non-storable commodities and they do so faster than spot markets, possibly because of the lower transaction costs. Another study examines if freight rates of spot, FFA and time charter markets are cross correlated (Zhang, Zeng and Zhao, 2014) and suggests the use of both FFA and time charter rates as their integration improves the forecast of spot freight rates. Furthermore, the price discovery function of time charter contracts was studied and proved (Zhang and Zeng, 2015), as time charter hire also demonstrates the expectations of trade parties like forward freight agreements and thus can be used to forecast the spot freight rates. In this research it was suggested that as the ship type gets smaller and the charter period gets longer, the price discovery function becomes stronger. A comparative study between FFA and TC contracts was also held in order to define the best predictor for spot freight rates (Taib C.M.I.C. and Mohtar Z.I., 2017), the study results show that the FFA contract is better than TC contract to control the fluctuations of the freight market. The precision in which the FFAs predict the future freight rates was investigated (Kasimati and Veraros, 2018) and showed that the shorter the period of prediction the better the forecast, as it is also stated in previous academic research. Finally, a recent study examined the slope of the yield curve between spot and time charter rates of 6 months, 1 year and 3-year contracts (Tsz Leung Yip, 2018). It is stated that as in the financial markets this slope can form the expectations and the corresponding policy, this can be done also in the shipping market. The findings suggest that recent data influence more the market change and that the market has a long memory. Hence for predicting freight rates it is recommended to use as a benchmark the 3-year rate as it is less volatile than the others, and for a weekly prediction to pair it with the 6 months rate, while for a six month long or three months long forecast it is better to use the 3 year rate with the 1 year rate spread.

3. Previous studies in freight rate forecasting

Albert W. Veenstra in 1999 made a research about the term structure of ocean bulk freight rates. In his paper he used monthly data for a period starting at October 1980 until October 1993 regarding the spot and time charter rates for dry bulk carriers of 30k, 55k and120k DWT. He constructed a present value model, to describe the relationship between spot and time charter rates, in terms of the spread and the change in the spot freight rate. With the use of VAR models, he demonstrated that the two rates are co-integrated with a long-term relationship. The conclusion was that the spreads provide important information in shipping[1].

In 2012, Chang, Hsieh and Chih wanted to create a predictive model for the freight rates of Capesize dry bulk vessels. They collected monthly data from Clarksons SIN for a period starting at November 1995 to September 2008. The independent variables of their model were the new building prices of 170k DWT vessels, secondhand prices for 5-year-old vessels of 150k DWT (both in million dollars), Indian demolition prices in $/ltd and Capesize fleet development in million DWT. A nonlinear regression predictive model was created, taking into consideration the MAPE criterion. It was concluded that the prices of secondhand ships may be good predictors of freight rates as they had the greatest explanatory power.

Kyong H. Kim studied the Capesize freight market and tried to make predictions about Capesize freight rates for a 24-year period starting from January 1989 and ending in July 2013, based on quarterly and yearly data. In order to predict freight rates, he took into account factors that affect demand and supply. The chosen variable for the demand side was seaborne commodity trade volume for iron ore and coal and for the supply, the secondhand vessel prices, and fleet development. However, he found out that there was not strong correlation between freight rates and fleet or trade.

Another study conducted in 2014 by Zhang, Zeng and Zhao used time charter contracts and forward freight agreements to forecast spot freight rates for the Capesize market. They analyzed the relationship of these variables with the use of a VECM model and weekly data for the period 7 January 2005 - 5 June 2009. To demonstrate time charter rates, they used 6-month time charter prices for Capesize vessels of 170k DWT; for spot

[1] (Veenstra, 1999) (Yip, 2018)

and forward freight agreement prices, they used their prices in 4TC BCI routes. They concluded that FFA prices and TC contracts are co-integrated and can be used to improve the predictions of spot freight rates.

Tsz Leung Yip in 2018 published a paper that examined the forecasting ability of spreads between long term and short-term period rates on spot freight rates. Focusing on the Panamax dry bulk market, and with the use of the dynamic probit model, he tried to discover the direction of the spot market for weekly, quarterly, and biyearly forecasts. The collected data were referring to a weekly period from 5 January 1990 to 21 September 2012. The spreads that he examined were 3 year minus 1 year, 3 year minus 6 months, 1 year minus 6 months, 3 year minus spot, 1 year minus spot and 6 months minus spot. The results pointed out that the weekly model has longer memory and needs more recent information so the 3 year minus 6 months spread is a better indicator; while the quarterly and biyearly models have shorter memory so the 3 year minus 1 year spread is a good indicator for them[2]. He concluded that spreads provide significant information for the prediction of the freight market, although they cannot be used alone to define the future of the market as the second is affected by a lot of other variables and situations.

Our paper investigates the forecasting ability of spreads between time charter contracts of different duration for the freight rates of Capesize, Panamax and Handysize dry bulk markets. Following Tsz Leung Yip research, three different spreads will be used: 3 year minus 1 year, 3 year minus 6 months and 1 year minus 6 months. The monthly data refer to the period from January 2009 to September 2020 and were collected from the Clarksons Shipping Intelligence Network. The analysis was conducted with Stata software. The examined period starts from 2009 so that not to include the years 2007-

[2] (Yip, 2018)

2008 characterized by extreme values due to the global economic crisis, as the incorporation of extreme values in the analysis may lead to unreliable results.

4. Methodology

4.1. General Models

To examine if the spreads between different duration time charter rates can add information for the future prices of freight rates, we created a general prediction model and then added each spread in it to measure the impact it had in the model's explanatory power. To express spot freight rates, we will use the corresponding Baltic indices for each market; BCI for Capesize, BPI for Panamax and BHI for Handysize. So, three general models were created, one for each index.

Baltic Capesize Index:

$$BCI_t = \alpha + \beta_1 Coal\_Imports + \beta_4 \, Iron\_Ore\_Exports + \beta_5 Bunker\_Price + u_t$$

Baltic Panamax Index:

$$BPI_t = \alpha + \beta_1 Coal\_Imports + \beta_4 \, Iron\_Ore\_Exports + \beta_5 Bunker\_Price + u_t$$

Baltic Handysize Index:

$$BHI_t = \alpha + \beta_1 Steel\_Imports + \beta_2 Steel\_Exports + \beta_5 \, Bunker\_Price + u_t$$

It is expected that all the variables will have a positive relationship with the indices as they refer to commodity trade. An increase in the amount of trade causes an increase in the demand for dry bulk vessels, hence an increase in freight rates. The price of fuel also has a positive relationship with freight as it is a significant factor that affects the operation costs of a vessel and a rise in its prices usually oblige the shipowners to raise the freight to cover the voyage costs.

4.2. Information Criteria

To fit augmented Dickey Fuller tests of the correct order, we used some of the selection-order statistics (pre estimation). In the set of maximum allowed lag order in Stata software, we chose four lags, as we deal with monthly data and 141 observations. From the results given, we chose the number of lags that was proposed from most of the information criteria (i.e. the lag with the smallest value). The estimation reports the information criteria AIC, SBIC, HQIC and the Akaike's final prediction error (FPE). The AIC, SBIC, and HQIC are computed according to their standard definitions, which include the constant term from the log likelihood[3].

$$AIC = -2\left(\frac{LL}{T}\right) + \frac{2t_p}{T}$$

$$SBIC = -2\left(\frac{LL}{T}\right) + \frac{\ln(T)}{T}t_p$$

$$HQIC = -2\left(\frac{LL}{T}\right) + \frac{2\ln\{\ln(T)\}}{T}t_p$$

$$FPE = |\Sigma_u|\left(\frac{T+\overline{m}}{T-\overline{m}}\right)^K$$

where t_p, is the total number of parameters in the model and LL is the log likelihood.

[3] (Stata, n.d.)

where m, is the average number of parameters over the K equations.

4.3. Stationarity

For the model to be dependable (i.e., to avoid spurious regressions), the stationarity of the variables must be examined. When a variable is stationary, its mean and variance are constant over time, when it is not, these measures have a tendency, and they depend on time. The stationarity test that we will use is the augmented Dickey Fuller test. The augmented Dickey Fuller test examines the null hypothesis that the variable has a unit root, so it is non-stationary, and the alternative hypothesis that the variable is stationary.

In detail, for an autoregressive model of order q (AR(p)):

$$X_t = \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + \dots + \varphi_p X_{t-p} + \varepsilon_t$$

Which equals to:

$$\Delta X_t = \delta X_{t-1} + \delta_1 \Delta X_{t-1} + \delta_2 \Delta X_{t-2} + \dots + \delta_{p-1} \Delta X_{t-p+1} + \varepsilon_t$$
$$\delta = \varphi_1 + \varphi_2 + \dots + \varphi_{p-1}$$

In addition to there are two more equation cases. So, the three cases are:

Without constant, without trend term:

$$\Delta X_t = \delta X_{t-1} + \sum_{j=1}^{p-1} \delta_j \Delta X_{t-j} + \varepsilon_t$$

With constant, without trend term:

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{j=1}^{p-1} \delta_j \Delta X_{t-j} + \varepsilon_t$$

With constant, with trend term:

$$\Delta X_t = \alpha + \beta_t + \delta X_{t-1} + \sum_{j=1}^{p-1} \delta_j \Delta X_{t-j} + \varepsilon_t$$

The hypotheses tested are:

Ho: δ=0, if t-statistic is greater than critical value

H1: δ<0, if t-statistic is less (more negative) than critical value

We will use the 10% critical values.

In the case that the null hypothesis cannot be rejected, meaning that the variable is nonstationary, the first differences of the variable will be tested for stationarity and if they prove to be stationary, they will be used in the model instead of the respective initial variables.

4.4. Stepwise Regression Method with Backward Elimination

To find the best variables for each model (from the ones mentioned above) the stepwise regression method with backward elimination was employed. This method starts with the full model (includes all the possible variables) and makes iterations deleting each time the variable that is insignificant for the model, until all the variables left are significant[4]. The significance or the insignificance of each variable that will be taken out in each iteration is decided based on its P > |t|; i.e. if P > |t| >=0.1 the variable will be dropped out.[5]

4.5. Ordinary Least Squares Method (OLS)

After deciding which variables to use, we will run regressions including the variables we want to examine.

[4] (Wikipedia, n.d.)

[5] (Μωϋσιάδης & Μπόρα-Σέντα, 1997)

5. Data

5.1. Dependent variables

5.1.1. BCI -- Baltic Capesize Index

The Baltic Capesize Index was first published in 1999 and it is used as a benchmark for Capesize freight rates. More specifically it addresses the movement of the Capesize freight market. It is consisted of both voyage and time charter routes, measured in dollars per ton and dollars per day, respectively. Capesize vessels are the second largest dry bulk vessels. The size of the Capesize vessels is usually between 145,000-220,000 DWT. For the calculation of BCI a vessel from this range is selected according to the route. They are gearless due to their size, usually have 9 holds and the commodities they transfer are iron ore and coal. Their name comes from the fact that their big size restricts the ports and canals they have access to, so they are usually obliged to pass through the Cape of Good Hope. The routes that are considered for the estimation of BCI are presented in the table below.

Route	**Route Description**
C2	Tubarao to Rotterdam
C3	Tubarao to Qingdao
C5	West Australia to Qingdao
C7	Bolivar to Rotterdam
C8_14	Gibraltar/Hamburg transatlantic round voyage
C9_14	Continent/Mediterranean trip China – Japan
C10_14	China – Japan transpacific round voyage
C14	China – Brazil round voyage
C16	Revised backhaul
C17	Saldanha Bay to Qingdao

Table 1:Capesize routes (Baltic Exchange, n.d.)

The BCI data are monthly data from Clarksons Shipping Intelligence Network from January 2009 until September 2020. The descriptive statistics of the variable are in the table below.

Variable	Obs	Mean	Std. Dev.	Min	Max
BCI	141	2123.942	1270.608	-243.05	7225.909

Figure 1:BCI summary statistics, (Clarksons SIN, n.d.)

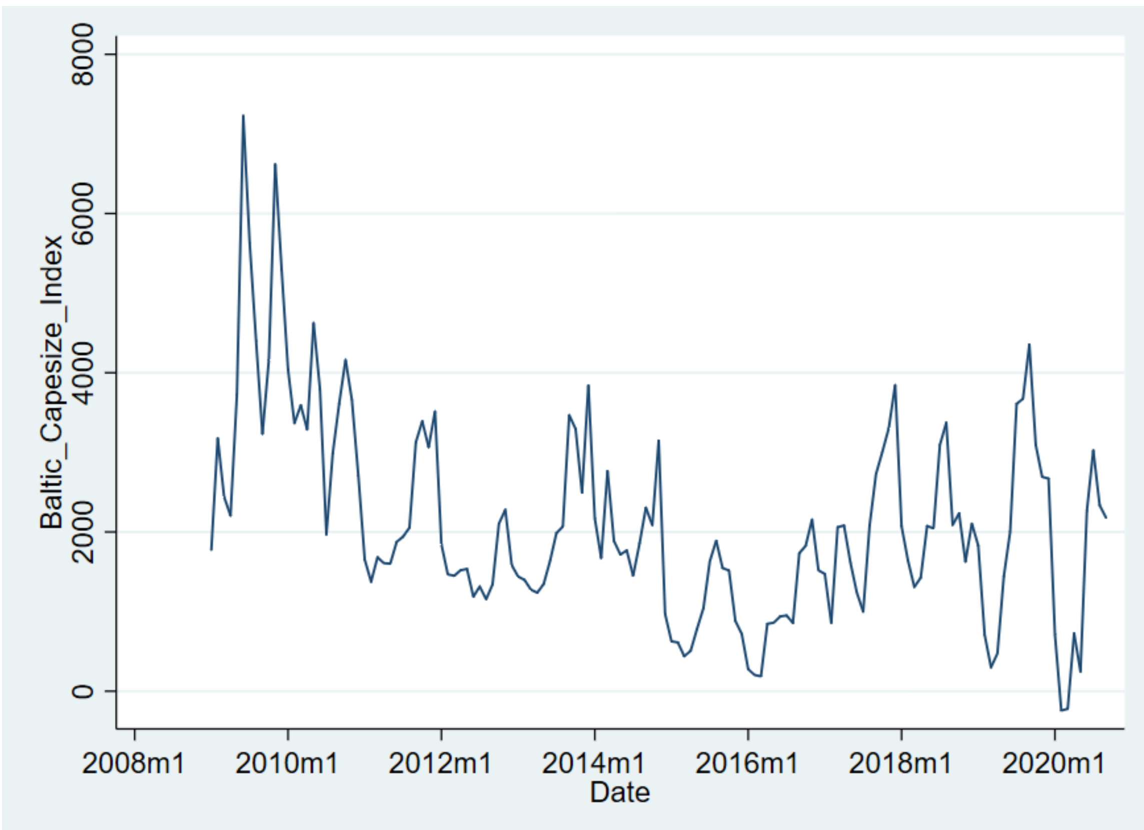

Figure 2:Baltic Capesize Index, (Clarksons SIN, n.d.)

For Capesize markets, usually the first quarter of every year is characterized by a downturn. This decline is expected to some extend due to the Chinese New Year. However, in the first months of 2020 the index became negative for the first time; This year's drop was not only influenced by seasonality factors, such as the Chinese holidays, but also from the IMO 2020 and the coronavirus pandemic.

5.1.2. BPI – Baltic Panamax Index

The Baltic Panamax Index was first published in 1998 and it is used as a guide for the Panamax freight rates. It is a mixture of voyage and time charter routes, measured in dollars per ton and dollars per day, respectively. A Panamax vessel usually has a DWT of 68,000-82,000 tons. They use to have 7 holds and they normally transfer coal, grain, iron ore and bauxite. Panamax vessels are designed with such characteristics (draft, length, depth) so as to pass through the Panama Canal. The routes that constitute the Baltic Panamax Index are shown below.

Route	*Route Description*
P1A_82	Skaw-Gib transatlantic round voyage
P2A_82	Skaw-Gib trip HK-S Korea incl Taiwan
P3A_82	HK-S Korea incl Taiwan, one Pacific RV
P4_82	HK-S Korea incl Taiwan trip to Skaw-Gib
P5_82	South China, one Indonesian round voyage
P6_82	Dely Singapore for one round voyage via Atlantic

Table 2:Panamax routes, (Baltic Exchange, n.d.)

For BPI we used monthly data starting from January 2009 until September 2020, from Clarksons SIN. The summary statistics of this variable are shown below.

Variable	Obs	Mean	Std. Dev.	Min	Max
BPI	141	1412.313	819.025	324.1905	4304.895

Figure 3:BPI summary statistics, (Clarksons SIN, n.d.)

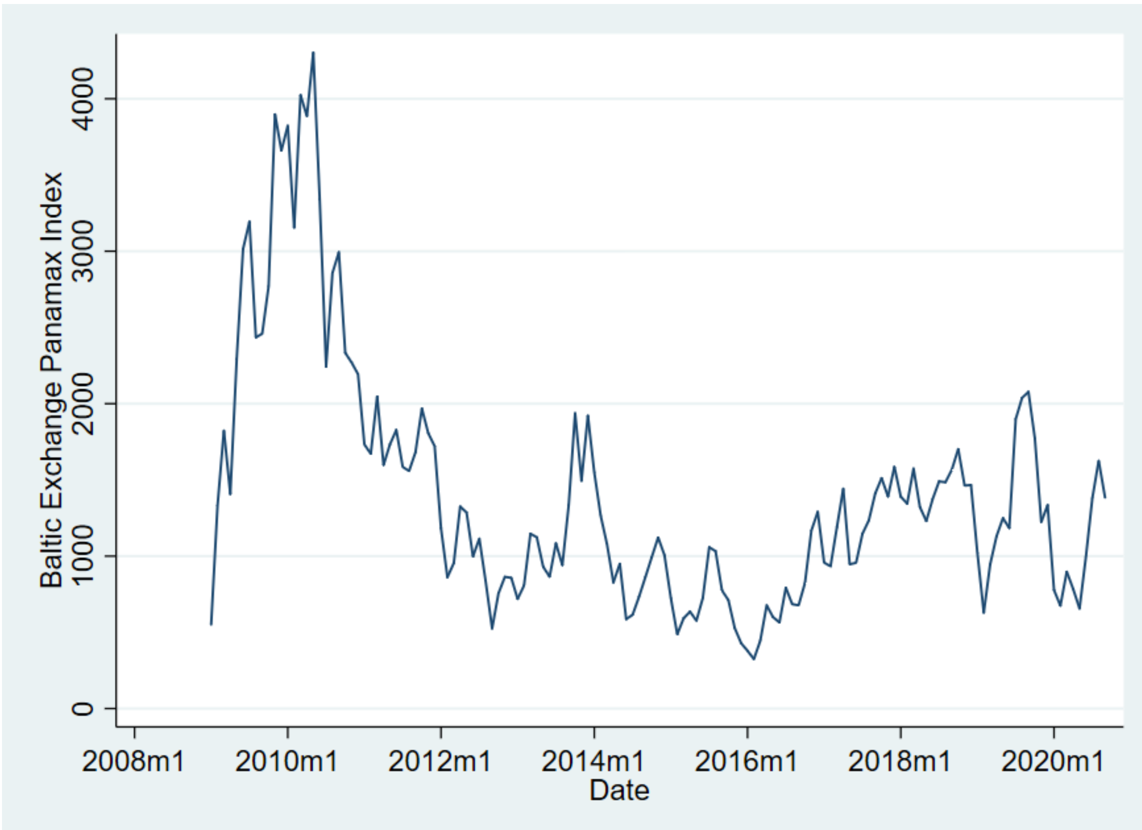

Figure 4:Baltic Panamax Index, (Clarksons SIN, n.d.)

We can see from the graph that the Panamax market in the beginning of 2009, after the outbreak of the economic crisis in 2008, was in historical low levels. However, an impressive increase started in 2009. While Europe was halving its iron ore imports, the demand of China for iron ore was doubled from January 2009 to September 2009 driving the freight rates of Panamax vessels four times higher and of Capesize vessels almost six times higher. The market hit the lowest level in last months of 2015-first months of 2016, as it was characterized by oversupply that pushed the freight rates down.[6]

[6] (Bakhsh, n.d.)

5.1.3. BHI – Baltic Handysize Index

The Baltic Handysize Index was first issued in 1997 and is used for monitoring the freight rates of small bulk carriers, the Handysize vessels. A vessel can be classified as Handysize if its size is from 20,000 up to 50,000 DWT. Due to their small size, they can enter smaller ports that other types of vessels cannot. Another reason that makes these vessels more flexible is that they are usually geared, having on average 5 holds and 4 cranes. The main commodities they transfer are grains, products of steel and minor bulks.

The main routes of Handysize vessels are presented in the table below:

Route	*Route Description*
HS1	Skaw-Passero trip to Rio de Janeiro-Recalada
HS2	Skaw-Passero trip to Boston-Galveston
HS3	Rio de Janeiro-Recalada trip to Skaw-Passero
HS4	US Gulf trip via US Gulf or north coast South America to Skaw-Passero
HS5	South East Asia trip to Singarore-Japan
HS6	North China-South Korea-Japan trip to North China-South Korea-Hapan
HS7	North China-South Korea-Japan trip to south east Asia

Table 3:Handysize routes, (Baltic Exchange, n.d.)

The data used for BHI are monthly data from Clarksons database for the period January 2009-September 2020.

Variable	Obs	Mean	Std. Dev.	Min	Max
BHI	141	583.9545	238.8759	197.1905	1467.211

Figure 5:BHI summary statistics, (Clarksons SIN, n.d.)

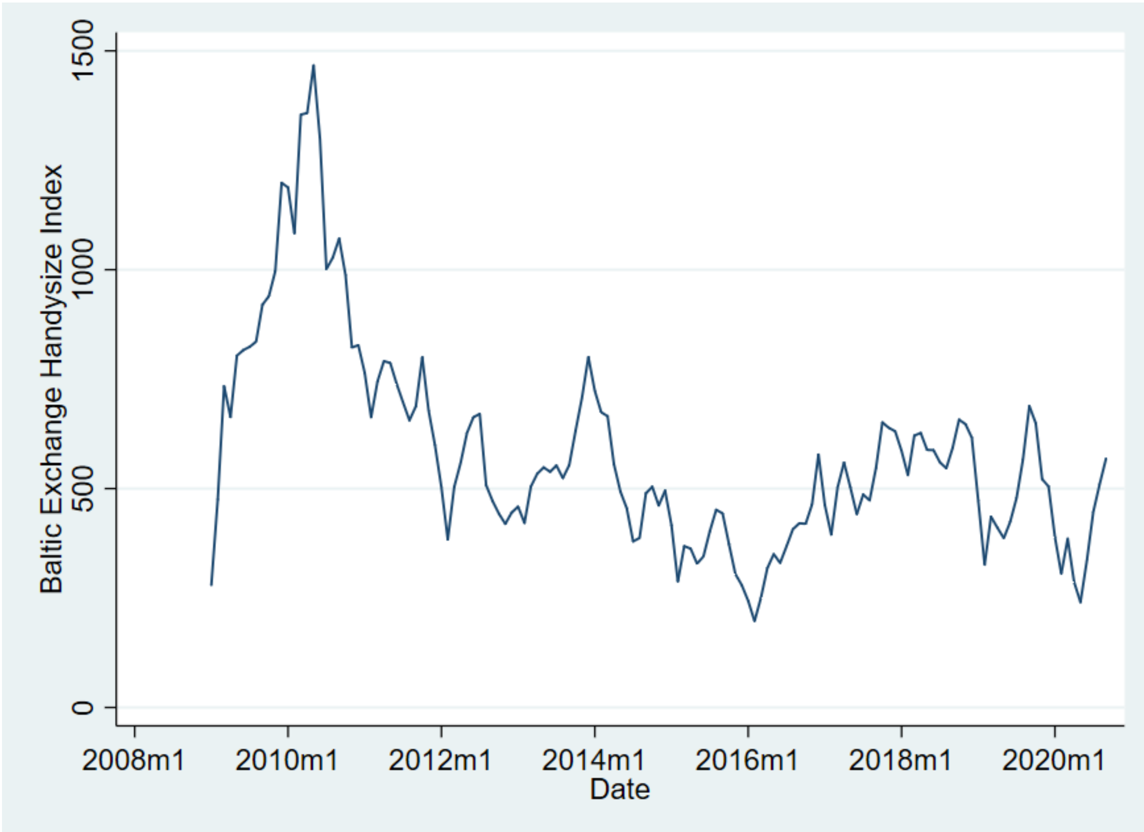

Figure 6:Baltic Handysize Index, (Clarksons SIN, n.d.)

For Handysize market, the pattern is almost identical with the Panamax. The economic crisis of 2008 that push the freight rates in very low levels, was followed by an upward trend in 2009, reaching the greatest level of the decade. China's economic activity was again driving this trend. In 2015-2016 period, which is regarded the second wave of the crisis, environmental measures for pollution in China were followed by decreased demand for imports of minor bulk commodities.

5.1.4. Stationarity Tests for BCI, BPI & BHI

The numbers in the parentheses show the number of lags used for the test, based on the pre-estimation test for selection order criteria.

	With constant, without trend			With constant, with trend		
	1%= -3.498	5%= -2.888	10%= -2.578	1%= -4.028	5%= -3.445	10%= -3.145
BCI (2)	-3.825			-4.333		
BPI (1)	-2.427			-2.882		
ΔBPI (0)	-12.103			-12.057		
BHI (4)	-1.954			-2.333		
ΔBHI (4)	-5.487			-5.435		

Table 4:ADF tests for BCI, BPI, BHI (Clarksons SIN, n.d.)

Based on the ADF hypotheses presented in the previous section, the t-stat for BCI for the equation with constant but without a trend is -3.825 which is more negative from the critical values at all significance levels. The same applies also for the case that the equation includes a trend term. Hence, we reject the null and the BCI time series is stationary.

The t-stat for BPI, in both cases, is higher than the critical values in all significance levels. Therefore, we cannot reject the null hypothesis that the series contain a unit root. As a sequence, the first differences of the variable tested for stationarity, and the series proved to be I(1).

Regarding BHI, the t-stat is -1.954 for the equation that includes only a constant and -2.333 for the equation that includes a constant and a trend term. Therefore, the BHI variable is nonstationary in all cases for all critical values, so the test was repeated for its first differences, and the series was stationary, I(1).

5.2. Independent Variables

5.2.1. Spreads

The slope of the yield curve or the spread between interest rates of bonds of different durations is usually used as a point of reference to forecast the economic activity. Relocating this concept to the shipping industry, we want to examine if the spreads between time charter rates of different durations can reflect the market expectations for the freight rates. Spread terms, are expected to have a negative relationship with spot freight rates. Spot prices refer to present values, while time charter contracts refer to future values. If it is expected that in the future the market will be higher than it is now, then the time charter rates will have higher prices in the future. Hence, when we subtract the sort-term rate from the long-term rate, the value will be positive. Whereas, when the market is expected to go down, the future rates will be lower than present rates, so the spread will be negative. When the freight market is high in the presence, the shipowner will choose to operate his ship in voyage charter; when the market is low he will choose to secure his earnings with a time charter contract.

We will examine three spreads for each vessel type, 3 year – 1 year time charter rate, 3 year – 6 month time charter rate and 1 year – 6 month time charter rate.

5.2.1.1. Spreads for Capesize vessels

The summary statistics of the three spreads are pictured below.

```
. summarize _3y_1y_SPR _3y_6m_SPR _1y_6m_SPR
```

Variable	Obs	Mean	Std. Dev.	Min	Max
_3y_1y_SPR	141	-869.734	2886.363	-15750	3300
_3y_6m_SPR	141	-2658.169	6116.187	-36875	5050
_1y_6m_SPR	141	-1788.435	3606.521	-21125	4500

Figure 7:Capesize Spreads summary statistics, (Clarksons SIN, n.d.)

The sample consists of 141 observations. We observe that the 3Y-6M spread has the greatest range of prices with the lower mean value and it is more volatile. The higher sensitivity of this spread related to the other two can be perceived from the graph below.

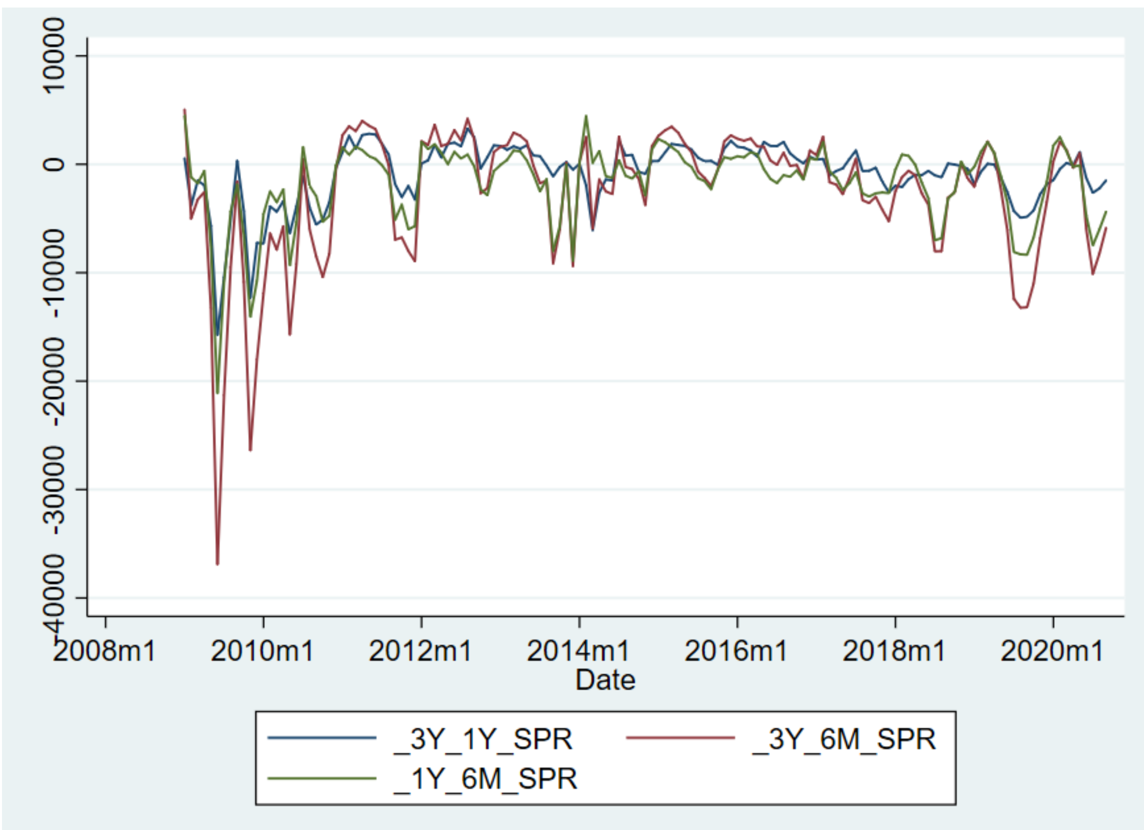

Figure 8:Capesize Spreads, (Clarksons SIN, n.d.)

The spreads of Capesize time charter contracts were negative for almost the entire examined period, meaning that the longer period rates were smaller than the short period. This was more intense in years 2009 – 2011, the first years of economic crisis when the market sentiment was negative, the impact was stronger for 3Y-6M spread. In 2014, whereas there was an increase in China's iron ore imports that was faster than the fleet growth of these vessels, it did not overcome the bad impact and freight rates were pushed down.[7]

5.2.1.2. Spreads for Panamax vessels

The summary statistics for the three spreads related to the Panamax vessels are pictured below.

Variable	Obs	Mean	Std. Dev.	Min	Max
_3y_1y_spr	141	-510.6073	2090.448	-8500	2290
_3y_6m_spr	141	-1723.174	3769.006	-14375	5100
_1y_6m_spr	141	-1212.566	1872.274	-6937.5	3325

Figure 9:Panamax Spreads, (Clarksons SIN, n.d.)

We can see that also in this case the 3Y-6M spread has the more negative mean and the bigger price range, which is reasonable as it is the spread with the highest time difference among the three.

[7] (UNCTAD, 2010)

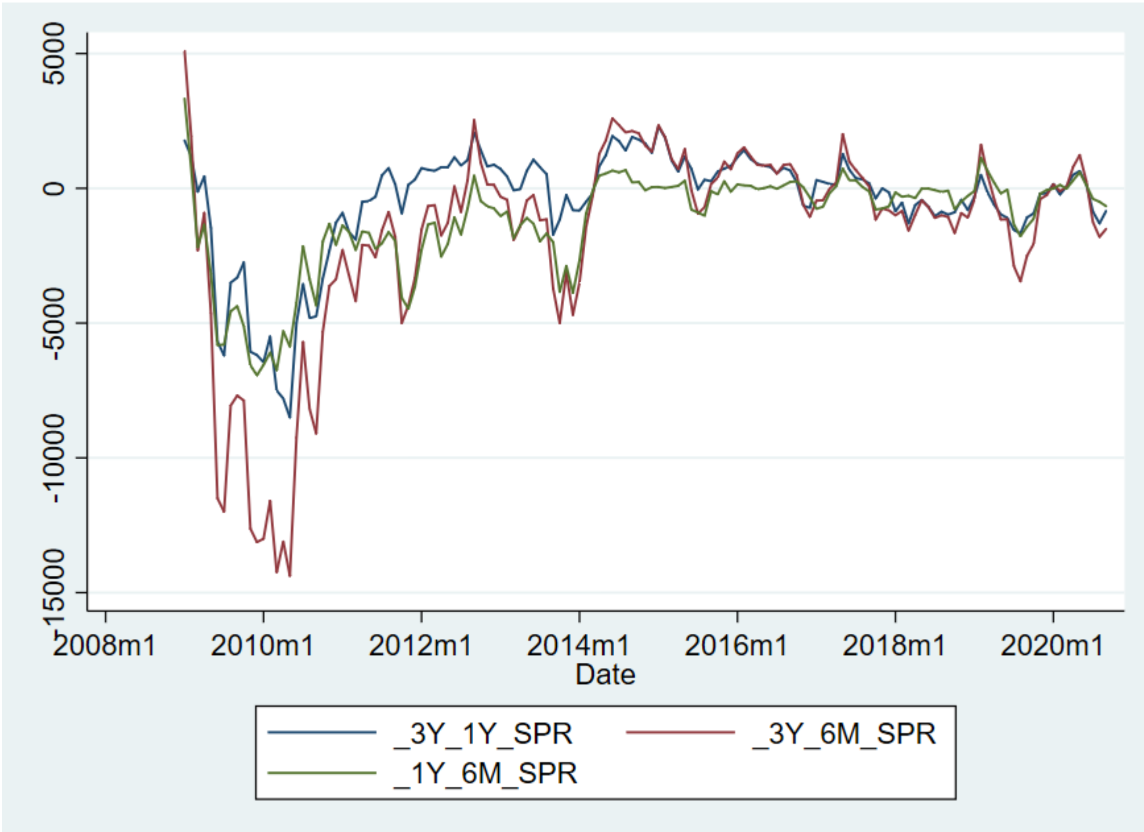

Figure 10:Panamax Spreads, (Clarksons SIN, n.d.)

From the graph, we see that all the three spreads had more fluctuations in the case of Panamax vessels. Again, the 3Y-6M spread seems to be more sensitive than the others but all of them have greater deviations from zero. However, in this case there are periods that the spreads are positive. The Panamax rates in 2014 were negatively affected by the oversupply along with low demand for coal.

5.2.1.3. Spreads for Handysize vessels

The summary statistics for the spreads of this type of vessels are pictured below.

Variable	Obs	Mean	Std. Dev.	Min	Max
_3Y_1Y_SPR	141	2.60195	924.2277	-3687.5	2562.5
_3Y_6M_SPR	141	-136.2589	1384.388	-6250	3550
_1Y_6M_SPR	141	-138.8608	572.5695	-2562.5	1300

Figure 11:Handysize Spreads summary statistics, (Clarksons SIN, n.d.)

The range of minimum and maximum values in this case is even narrower and the mean values are lower.

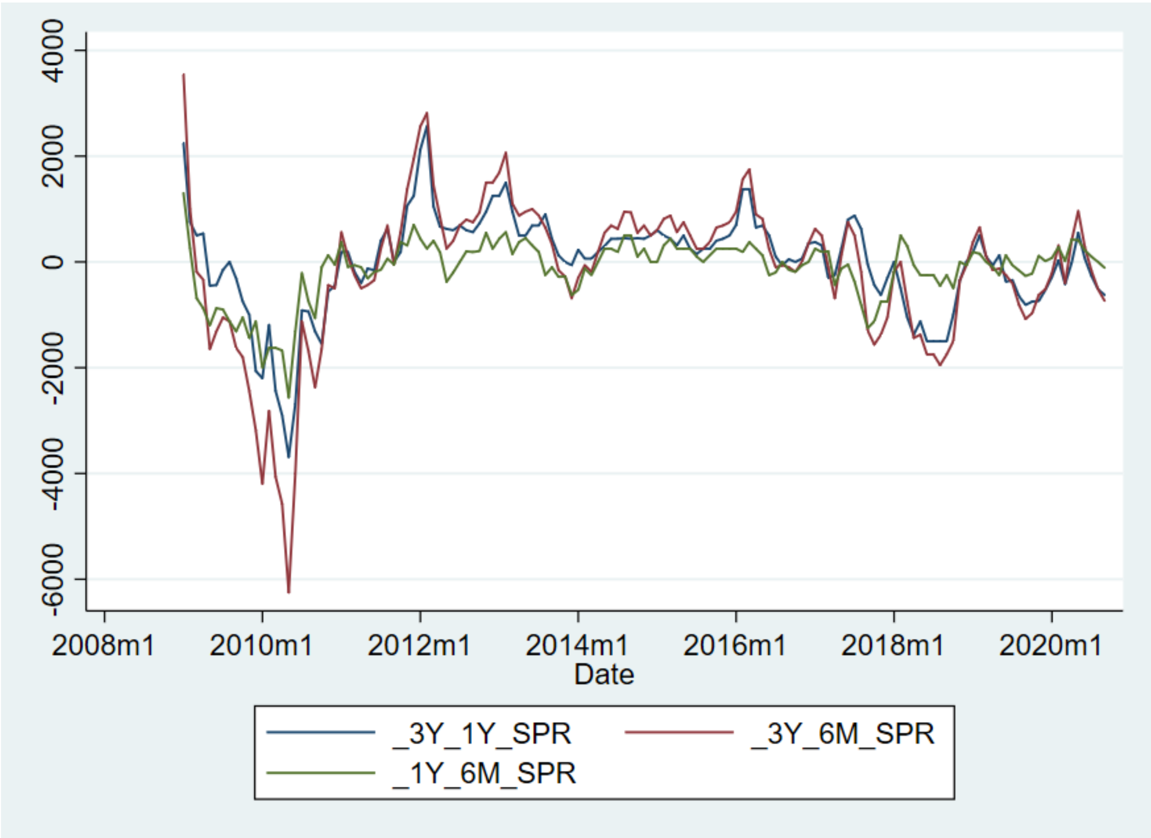

Figure 12:Handysize Spreads, (Clarksons SIN, n.d.)

Looking to the graph, the Handysize vessels' spreads have also big fluctuations and affected more by changes in the economy.

5.2.1.4. Stationarity Tests for Spreads

The output of the ADF tests is presented below. The numbers in the parenthesis indicate the number of lags that were used for each one, based on the selection order criteria, for p-value = 0.10.

	with constant, without trend	**With constant, with trend**
	10%= -2.578	10%= -3.145
Capesize		
3Y-1Y SPR (4)	-2.666	-2.585
3Y-6M SPR (3)	-3.588	-3.662
1Y-6M SPR (2)	-4.759	-4.823
Panamax		
3Y-1Y SPR (3)	-1.933	-2.261
3Y-6M SPR (3)	-2.337	-3.057
1Y-6M SPR (4)	-2.518	-3.447
Δ3Y-1Y SPR (4)	-6.672	
Δ3Y-6M SPR (2)	-6.921	
Δ1Y-6M SPR (3)	-6.507	
Handysize		
3Y-1Y SPR (3)	-2.808	-2.799
3Y-6M SPR (2)	-2.763	-2.783
1Y-6M SPR (1)	-3.481	-3.815

Figure 13:ADF tests for Spreads, (Clarksons SIN, n.d.)

For Capesize, the 3Y-1Y spread is stationary when there is no trend term (t-stat = -2.666 < -2.578); while is nonstationary when a trend term is included (t-stat = -2.585 > -3.145). However, in the second case the t-stat and p-value of the trend term are 0.13 and 0.893 respectively, so it is not statistically significant. Hence, the 3M-1Y spread is stationary. The 3Y-6M & 1Y-6M spreads are stationary for 10% critical values in both cases as their t-statistics are more negative than critical values.

Concerning Panamax spreads, the 3Y-1Y spread is nonstationary in each case as the t-stats are higher than the critical values for 10% significance level, so we cannot reject the null hypothesis of unit root. The 3Y-6M spread has also t-stats greater than the critical values meaning that this variable is also nonstationary. Finally, the 1Y-6M spread is nonstationary if we use a constant in the equation but becomes stationary if we include a constant along with a trend term. In this case, the t-stat of the trend term was 2.34 with P > |t| = 0.021, so the trend term is statistically significant and should be included in the equation, this means that the deviations from the trend are stationary. Running the ADF test for the first differences for every spread, they are all stationary as their t-stats are more negative than the critical values. Therefore, we reject the null hypothesis of non-stationarity and the spreads are integrated of order one I(1). For the 1Y-6M spread we can use either the de-trended version or the first differenced, so we will choose the second.

For Handysize, the 3Y-1Y spread is stationary when we include only the constant term in the equation but nonstationary when we include both a constant and a trend term, as t-stat = -2.808<-2.578. The same applies for the 3Y-6M spread. However, the t-stat p-value for 3 year minus 1 year spread were 0.1 and 0.92 respectively, while for 3 year minus 6 moths spread they were 0.4 & 0.689; so they were not statistically significant and the null hypothesis of nonstationarity can be rejected for 10% significance level. The 1 year minus 6 months spread is stationary in both cases, I(0).

5.2.2. Demand

5.2.2.1. Seaborne Trade of Coal

Coal is one of the two most important commodities for the dry bulk market. There are two types of coal which are the coking coal and the steam coal. Coking coal is mainly used in steel production while steam coal is burnt to produce heat in thermal power plants. Coal is cheap and produces one quarter of the energy worldwide. On the other hand, as coal is heavy fuel with high emissions, there are many environmental concerns about its use. The environmental regulations are increasing every year, while 2020 was an important landmark for these regulations due to IMO 2020 that was first applied and send a loud message about environmental issues worldwide. If the demand for coal declines, that would have a big negative impact on the dry bulk market. However, it is also argued that the coal industry will not distinguish and will find new ways to adjust in the new era.

Therefore, the seaborne trade of coal has a direct and positive influence in the demand for dry bulk vessels (in this case Capesize and Panamax vessels). To measure seaborne coal trade, we will use coal imports. We will use monthly data from Clarksons SIN from January 2009 until September 2020.

The summary statistics for coal imports are pictured below.

Variable	Obs	Mean	Std. Dev.	Min	Max
Coal_imports	141	33162.79	8774.796	0	50342.01

Figure 14:Coal Imports summary statistics, (Clarksons SIN, n.d.)

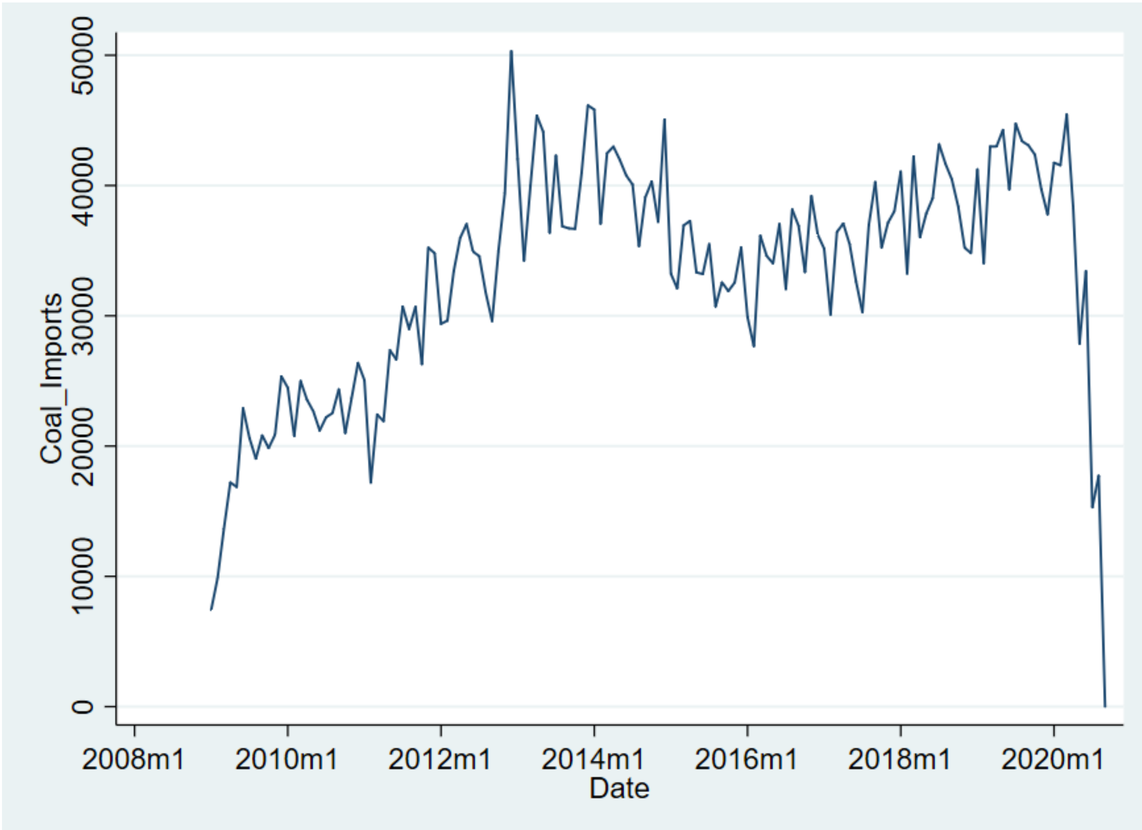

Figure 15:Coal Imports, (Clarksons SIN, n.d.)

From the graph, coal imports appear to follow a constant increase over time, with an absolute downturn in 2020 due to the Coronavirus pandemic. The coal imports time series was constructed with the sum of China's and India's coal imports, which are the two biggest importers of coal right now, overpassing Japan and Europe who were dominating coal imports until 2010. In this 10-year range, coal imports were increased but with low rate as China's and India's increased demand for coal was balanced from Japan's and Europe's decrease in demand.

5.2.2.2. Seaborne Trade of Iron Ore

In the dry bulk sector, iron ore is the most traded commodity. It accounts for 30% of the trade in the dry bulk market, so it highly affects it. In contrast with coal, iron ore does not have 'types' but quality categories. This commodity is fundamental to produce steel and that is its main use. The leading exporters of iron ore are Australia and Brazil who manage more that 80%. On the other side, China is the capital of iron ore imports due to the high industrial production.

To measure iron ore trade we will use the monthly sum of seaborne iron ore exports from Canada, Chile, and India. The data period range is January 2009-September 2020 and were retrieved from Clarksons SIN.

The descriptive statistics of iron ore exports are pictured below.

Variable	Obs	Mean	Std. Dev.	Min	Max
Iron_Ore_Exp	141	6315.263	2583.222	2208	14540

Figure 16:Iron Ore Exports summary statistics, (Clarksons SIN, n.d.)

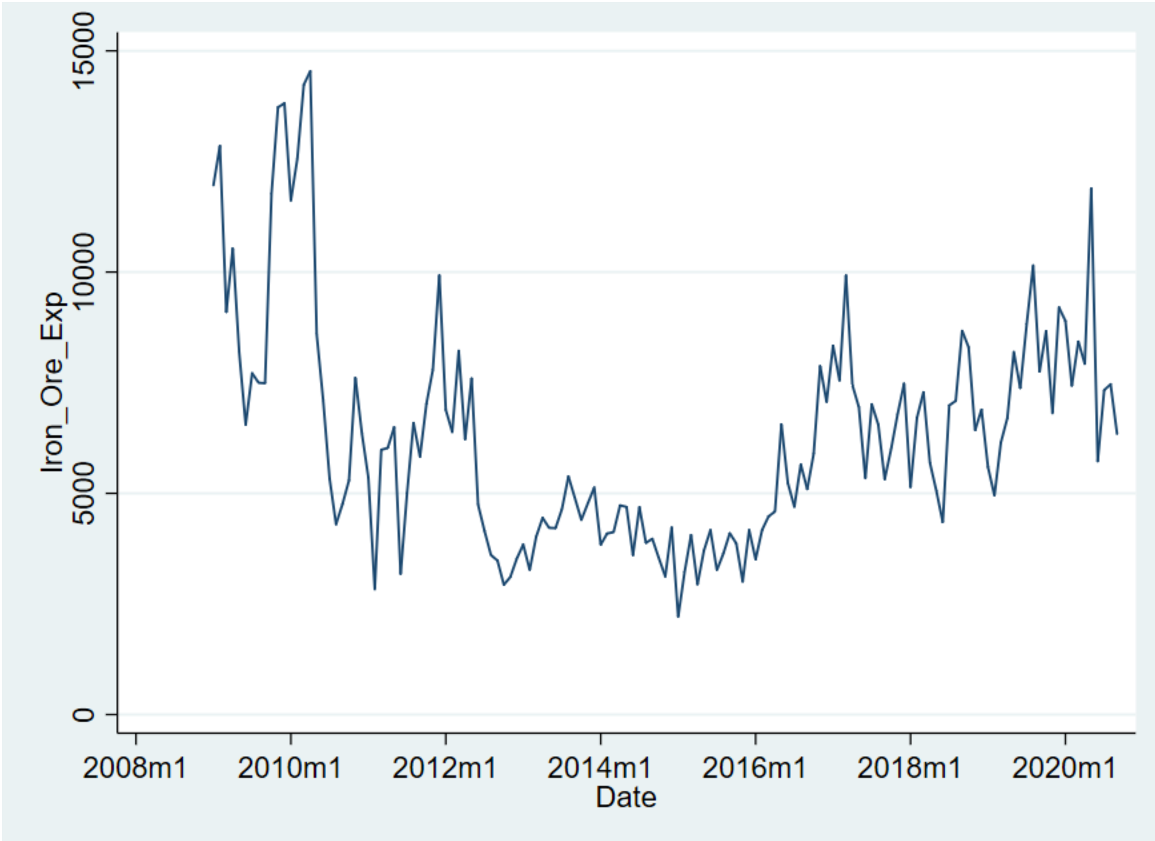

Figure 17:Iron Ore Exports, (Clarksons SIN, n.d.)

5.2.2.3. Trade of Steel Products

Steel production and trade are of great importance for the dry bulk market. As the steel production and trade were booming the last 55 years, facing its gold growth period especially in the first decade of the 21st century, so did the dry bulk market. Steel products are the principal players in the minor dry bulk market. These products are transferred with Handysize vessels. China is on the focal point of this indicator as it accounts for almost 50% of the world's steel production. The higher the production of steel, the higher the demand for iron ore imports which, as one of the two main commodities a Capesize transfers, has a huge impact on the demand and subsequently on the Capesize freight rates.

To capture steel trade we will use two variables, China's seaborne steel imports and exports.

The descriptive statistics reflecting the imports of steel imports are the following:

Variable	Obs	Mean	Std. Dev.	Min	Max
Steel_imp_Ch	141	1.675291	.8262165	1.03018	6.4769

Figure 18:China's Steel Imports summary statistics, (Clarksons SIN, n.d.)

The descriptive statistics for steel exports are:

Variable	Obs	Mean	Std. Dev.	Min	Max
Steel_exp_ch	141	5.567235	2.266002	1.31329	11.09212

Figure 19:China's Steel Exports summary statistics, (Clarksons SIN, n.d.)

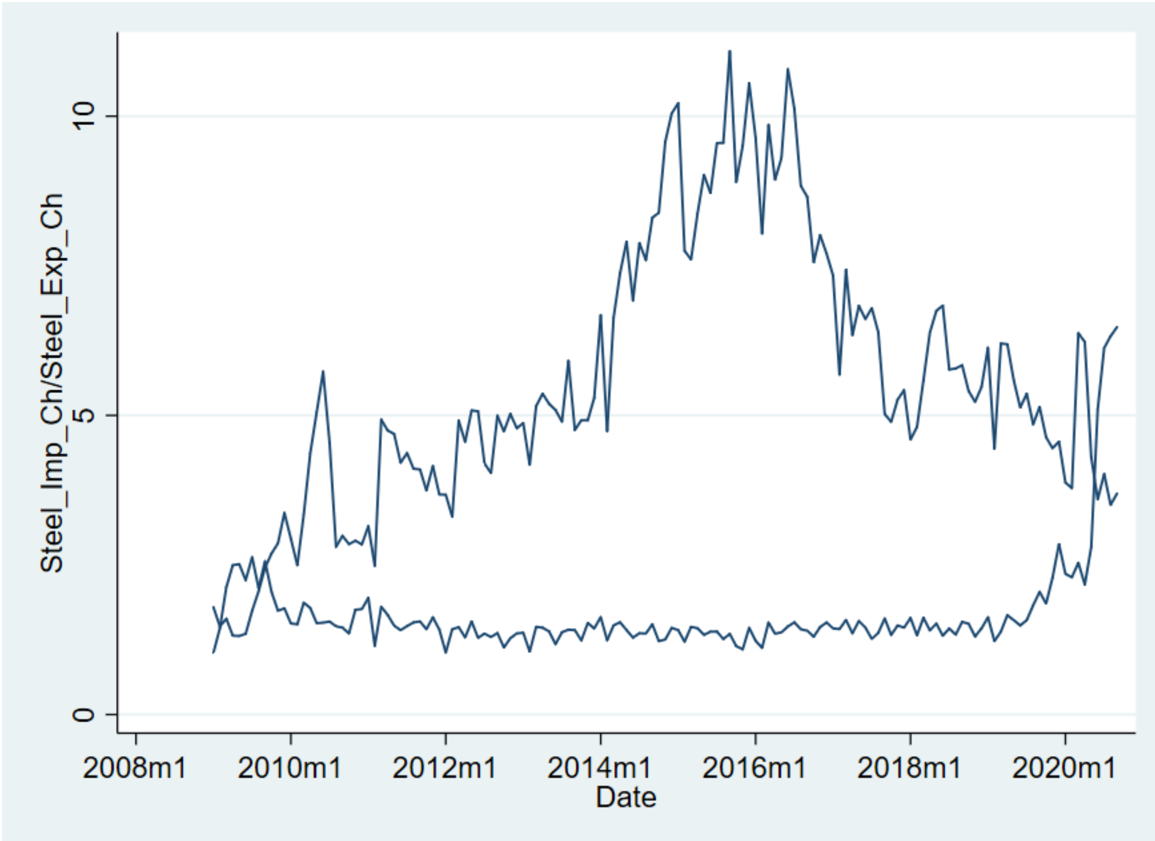

Figure 20:China's Steel Imports & Exports (Clarksons SIN, n.d.)

We can see that China's trade of steel, regarding imports and exports, follows an opposite direction. China is one of the largest producers of steel globally. After the global recession in 2009, Chinese exports were increasing every year until 2016 but despite the decrease in volume for the period 2016-2020, they remain in high levels. However, in 2020 we see that steel imports were rapidly increased, while steel exports decreased. That change was the result of the coronavirus pandemic that slowed down activities in construction the first three months of the year, but as the country recovered the following months of 2020 the demand was again rising. So, we can say that this increase highlights the country's economic recovery.

5.2.3. Supply

5.2.3.1. Bunker Price

Voyage costs is the second most important (after the capital costs) cost category for operating a bulk carrier vessel. The biggest percentage of voyage costs consists of the costs for fuel oil. So, in first sight, when bunkering costs are decreasing, it is considered good for maritime companies because their voyage or operating costs are also decreasing, and they have the opportunity to benefit from greater profit margins. Moreover, iron ore freight rates have found to be "quite responsive" to oil prices[8], as they tend to have the same direction and percentage movement.

To calculate the bunker price, we took the average sum of monthly prices of the HSFO 380cst (3.5% Sulphur) for twelve areas (Rotterdam, Genoa, Los Angeles, Panama, Houston, Singapore, Fujairah, Philadelphia, Japan, Korea, Hong Kong, Gibraltar).

The descriptive statistics of this variable are:

Variable	Obs	Mean	Std. Dev.	Min	Max
Bunker_pr	141	447.0691	154.3409	156.5333	743.2083

Figure 21:Bunker Prices summary statistics, (Clarksons SIN, n.d.)

[8] (UNCTAD, 2010)

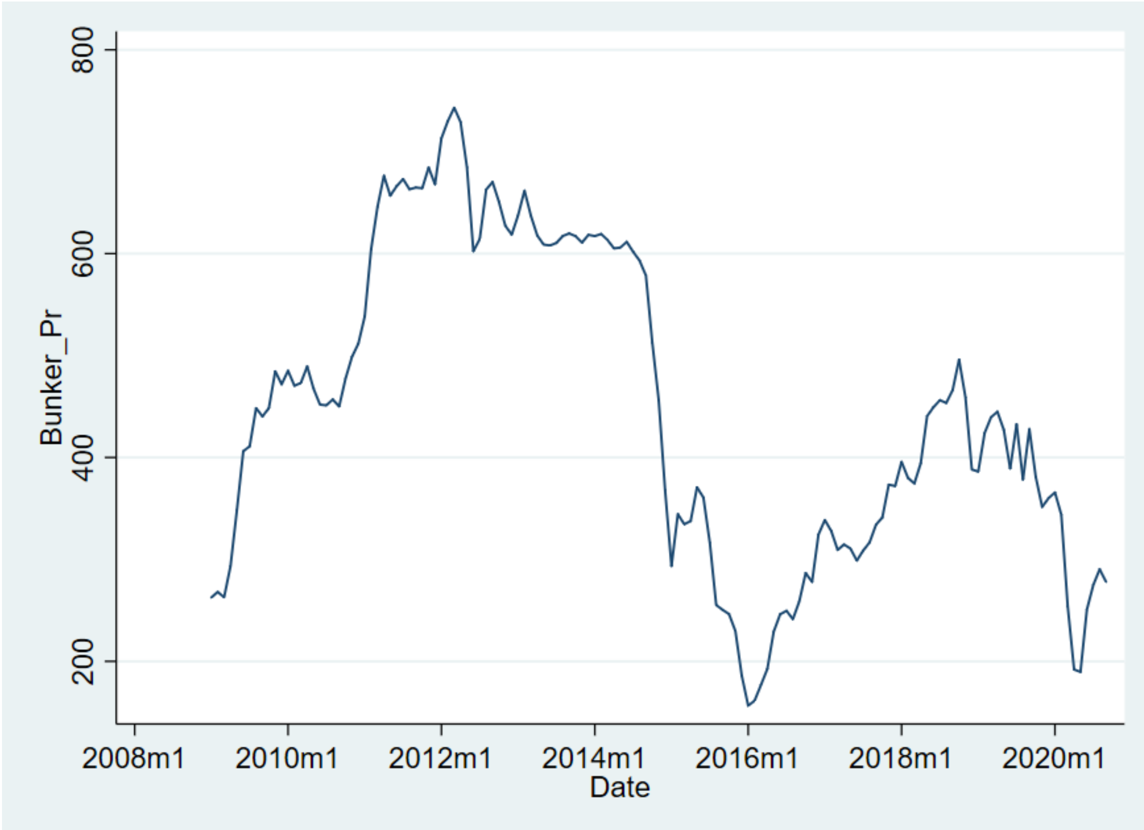

Figure 22:Bunker Prices, (Clarksons SIN, n.d.)

From the graph we can observe a cyclical pattern in fuel prices as the frequency of the fluctuations is not fixed and they last more than two years. They are probably related to the economic conditions.

5.2.4. Stationarity Tests for Independent Variables

The augmented Dickey Fuller test results for the independent variables are presented in the table below. The numbers in parentheses indicate the optimal number of lags for each variable based on the selection order criteria.

	With constant, without trend	**With constant, with trend**
	10%= -2.577	10%= -3.145
Coal Imports (2)	-1.871	-0.388
Δcoal Imports (1)	-9.654	-10.089
Iron Ore Exports (2)	-3.089	-3.040
Steel Imports (1)	1.442	1.160
ΔSteel Imports (0)	-11.034	-11.337
Steel Exports (2)	-1.986	-1.429
ΔSteel Exports (1)	-10.631	-10.792
Bunker Price (2)	-1.581	-2.727
ΔBunker Price (1)	-7.037	-7.192

Table 5:ADF tests for Independent Variables, (Clarksons SIN, n.d.)

Coal imports, steel imports and exports and bunker prices have t-statistics higher than critical values, so the null hypothesis of unit root cannot be rejected, and the series are nonstationary. Repeating the process for their first differences, the series become stationary. Therefore they are stochastic processes of order I(1). Iron ore exports has a t-statistic more negative than the critical value for the equation with constant and without trend, but this is not true when a trend term is included in the equation. However, the trend term was not statistically significant so the series is stationary, I(0).

6. Correlation Matrices

6.1. Capesize

	ΔBunker Price	**ΔCoal Imports**	**Iron Ore Exports**	**3Y-1Y SPR**	**3Y-6M SPR**	**1Y-6M SPR**
ΔBunker Price	1.000					
ΔCoal Imports	-0.0038	1.0662				
Iron Ore Exports	0.0806	0.0555	1.000			
3Y-1Y SPR	-0.1418	-0.0524	-0.5275	1.000		
3Y-6M SPR	-0.1701	-0.0637	-0.4810	0.9287	1.000	
1Y-6M SPR	-0.1753	-0.0662	-0.3935	0.7749	0.954	1.000

Table 6:Capesize Independent Variables Correlation Matrix

6.2. Panamax

	ΔBunker Price	ΔCoal Imports	Iron Ore Exports	Δ3Y-1Y SPR	Δ3Y-6M SPR	Δ1Y -6M SPR
ΔBunker Price	1.000					
ΔCoal Imports	-0.0038	1.0662				
Iron Ore Exports	0.0806	0.0555	1.000			
Δ3Y-1Y SPR	-0.1245	-0.1701	-0.1308	1.000		
Δ3Y-6M SPR	-0.1057	-0.1971	-0.1394	0.903	1.000	
Δ1Y-6M SPR	-0.0634	-0.1839	-0.1189	0.609	0.8907	1.000

Table 7:Panamax Independent Variables Correlation Matrix

6.3. Handysize

	ΔBunker Price	ΔSteel Imports	ΔSteel exports	3Y-1Y SPR	3Y-6M SPR	1Y-6M SPR
ΔBunker Price	1.000					
ΔSteel Imports	0.0657	1.000				
ΔSteel exports	-0.1629	0.2141	1.000			
3Y-1Y SPR	-0.0299	-0.1224	-0.2075	1.000		
3Y-6M SPR	-0.0473	-0.1362	-0.1824	0.8771	1.000	
1Y-6M SPR	-0.0517	-0.1003	-0.0761	0.3628	0.7658	1.000

Table 8:Handysize Independent Variables Correlation Matrix

7. Results

7.1. Capesize

To construct the model for Capesize index, we run a stepwise regression with a list of variables that, according to theory, are related with this market. So, the variables we used were iron ore exports, coal imports and fuel prices.

$$BCI_t = \alpha + \beta_1 \Delta Coal\_Imports + \beta_2 Iron\_Ore\_Exports + \beta_5 \Delta Bunker\_Price + u_t$$

where α is the constant term

where u_t is the term for the residuals

The stepwise method suggested the used of bunker price and iron ore exports. That model had an explanatory power of ~ 23% so, we included the first lag of the dependent variable to see if the model becomes better. The next model with bunker price, iron ore exports and the first lag of BCI had R^2 ~ 64% while the general model presented in the table below had explanatory power of ~ 62%. Therefore, instead of iron ore exports, the first lag of BCI was used as independent variable. So, the general model becomes:

$$BCI_t = \alpha + \beta_1 BCI_{t-1} + \beta_2 \Delta Bunker\_Price + u_t$$

The general model has an F-value of 115.3 with p-value 0.0000, meaning that is statistically significant. The first lag of BCI has a beta coefficient equal to 0.768 (se = .0524257). The beta coefficient of the first difference of bunker price is 5.559 (se= 2.244825). The explanatory power of this model is 62.7%.

The regression of the general model with the 3Y-1Y spread gave an R^2 = 80,1%. The beta coefficient of the spread was -0.246 with t-stat = -10.9 (se = 0.0225). For the 3Y-6M spread the beta coefficient was -0.140 (se = 0.00789) with R^2 = 88.8%. The 1Y-6M spread has a beta coefficient equal to -0.217 (se = 0.0131) with R^2 = 87.7%.

In every case, including a spread variable in the regression, added explanatory power in the model. The highest R^2 and adjusted R^2 was achieved with the 3Y-6M spread. With the insert of the spread terms, the beta coefficients, and standard errors for both the first lag of BCI and the bunker price halved down, although they remain statistically significant. All of three spreads proved statistically significant with a negative impact on BCI.

BCI	Stepwise	General Model	OLS with 3Y-1Y SPR	OLS with 3Y-6M SPR	OLS with 1Y-6M SPR
BCI_{t-1}		0.768*** (14.64) (0.000)	0.404*** (7.93) (0.000)	0.344*** (9.19) (0.000)	0.434*** (11.95) (0.000)
ΔBunker Price	7.436556 (2.32) (0.022)	5.559* (2.48) (0.014)	3.788* (2.29) (0.024)	2.547* (2.04) (0.043)	2.468 (1.89) (0.061)
Iron Ore Exports	.2219002 (5.93) (0.000)				
3Y-1Y SPR			-0.246*** (-10.90) (0.000)		
3Y-6M SPR				-0.140*** (-17.80) (0.000)	
1Y-6M SPR					-0.217*** (-16.61) (0.000)
_cons	733.2054 (2.90) (0.004)	495.4*** (3.82) (0.000)	1052.3*** (9.76) (0.000)	1015.2*** (13.19) (0.000)	806.9*** (10.48) (0.000)
N	140	140	140	140	140
R-squared	23.92	0.627	0.801	0.888	0.877
Adjusted R-squared	22.81	0.622	0.797	0.886	0.874
F	21.54	115.3	182.54	359.79	323.09
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000
Root MSE	1120	783.92	574.85	431.13	452.09
SSM	54,042,779.2	141,709,550	180959395	200621703	198103582
SSR	171,857,377	84,190,606.1	44940761.4	25278453	27796574.4
SST	225900156	225,900,156	225900156	225900156	225900156

t-statistics & p-values in parentheses
***p<0.05, **p<0.01, ***p<0.001**

Table 9:Regression Results Capesize

7.2. Panamax

To decide which variables could better forecast the movement of the BPI variable, we run a stepwise regression. In this regression we included the bunker prices, coal imports, and iron ore exports.

$$\Delta BPI_t = \alpha + \beta_1 \Delta Coal\_Imports + \beta_4\, Iron\_Ore\_Exports + \beta_5 \Delta Bunker\_Price + u_t$$

where α is the constant term
where u_t is the term for the residuals

For 10% significance level, the outcome of the stepwise regression was that coal imports and iron ore exports were statistically significant. So, the general model becomes:

$$\Delta BPI_t = \alpha + \beta_1 \Delta Coal\_Imports + \beta_2\, Iron\_Ore\_Exports + u_t$$

However, the R-squared of this model was only 8.1%, indicating its low predictive ability for the BPI prices.

Thereafter, we run the regression with each spread at a time. The 3 year minus 1 year spread proved to be statistically significant with t-stat = -13.7 (se=0.0215). The degree to which the model forecasted the BPI was 61.4%. This spread's beta coefficient was -0.295 which means that if the spread experience an increase of one unit, this will have a negative impact on BPI of 0.295 units.
The second spread, 3 year minus 6 months, proved also statistically significant with t-stat= -19.63 (se=0.00978). The beta coefficient was -0.192. However, when the spread was included in the model, the two other variables became statistically insignificant. This model had the greatest R^2 among the three, which was equal to 0.76, which means that the model can predict 76% of the changes in BPI prices.

Finally, the 1 year minus 6 months spread was tested. This spread had a beta coefficient equal to -0.317 (se=0.0223), so we can conclude that a unit's change in the value of this spread, has the greatest impact on BPI. The explanatory power of this model was 63% with F-value=77.03 and prob>F=0.0000, therefore the model is statistically significant. The following table shows the analytical results of the regressions.

ΔBPI	Stepwise	OLS with 3Y-1Y SPR	OLS with 3Y-6M SPR	OLS with 1Y-6M SPR
ΔCoal Imports	0.0152** (2.62) (0.010)	0.00656 (1.72) (0.088)	0.00379 (1.25) (0.212)	0.00565 (1.51) (0.134)
Iron Ore Exports	0.0231* (2.12) (0.036)	0.0110 (1.54) (0.126)	0.00857 (1.52) (0.131)	0.0121 (1.73) (0.086)
Δ3Y-1Y SPR		-0.295*** (-13.70) (0.000)		
Δ3Y-6M SPR			-0.192*** (-19.63) (0.000)	
Δ1Y-6M SPR				-0.317*** (-14.20) (0.000)
cons	-138.2 (-1.87) (0.063)	-68.37 (-1.42) (0.159)	-56.72 (-1.49) (0.139)	-78.76 (-1.67) (0.098)
Number of observations	140	140	140	140
R^2	0.081	0.614	0.760	0.630
Adj R^2	0.067	0.605	0.755	0.621
F	6.00	71.97	143.70	77.03
Prob>F	0.0032	0.0000	0.0000	0.0000
Root MSE	327.09	212.84	167.66	208.39
SSM	1283808.71	9780456.56	12118231.2	10035365.9
SSR	14657428.1	6160780.26	3823005.57	5905870.88
SST	15941236.8	15941236.8	15941236.8	15941236.8
t-statistics & p-values in parentheses				
*** p<0.05, **p<0.01, ***p<0.001**				

Table 10:Regression Results Panamax

7.3. Handysize

To run the stepwise regression for Handysize Index, the variables included in the model were steel products imports & exports and bunker prices.

$$\Delta BHI_{\ t} = \alpha + \beta_1 \Delta Steel\_Imports + \beta_2 \Delta Steel\_Exports + \beta_5\ \Delta Bunker\_Price + u_t$$

where α is the constant term

where u_t is the term for the residuals

The variables that were statistically significant were steel imports and exports. So, the model becomes:

$$\Delta BHI_{\ t} = \alpha + \beta_1 \Delta Steel\_Imports + \beta_2 \Delta Steel\_Exports + ut$$

Both the dependent and the independent variables were nonstationary, so they were used in first differences. The general (stepwise) model has an F-value equal to 8.58. However, as we can see from the table SSR>SSM, which consequently gives an R^2 = 11.1%. For steel imports, the beta coefficient is 58.16 (se = 21.43) with a t-stat = 2.71. For steel exports, β=19.98 (se = 8.069).

Putting the 3Y-1Y spread in the regression, the beta coefficient is now 60.63 for steel imports, 18.43 for steel exports and -0.0144 (se = 0.00741), while R^2 is approximately two points higher than the previous model. Continuing with the 3Y-6M spread, its beta coefficient is -0.0131 (se = 0.00492) and the R^2 is four points higher than the initial model. For the 1Y-6M spread, its beta coefficient is 0.0384 (se = 0.0117) with R^2 six points higher than the initial model.

In the case of Handysize index, we observe a different pattern in contrast with the previous two. The primary variables were the same for the three vessels, although in this case coal and iron ore imports and exports were replaced by grain and steel imports and exports as these are the main cargos that this type of index refers to. The statistically significant variables were seaborne steel imports and exports and remain significant when each of the spreads was added in the model, with a positive relationship with BHI and no considerable changes in their beta coefficients. On the other hand, all the three spreads added, were also statistically significant and added little explanatory value in the model, with a negative impact on BHI.

The regression results are presented in detail in the table below.

ΔBHI	Stepwise	OLS with 3Y-1Y SPR	OLS with 3Y-6M SPR	OLS with 1Y-6M SPR
ΔSteel imp	58.16** (2.71) (0.008)	60.63** (2.85) (0.005)	62.69** (2.98) (0.003)	64.87** (3.12) (0.002)
ΔSteel exp	19.98* (2.48) (0.014)	18.43* (2.30) (0.023)	17.85* (2.25) (0.026)	17.88* (2.29) (0.024)
3Y-1Y SPR		-0.0144 (-1.94) (0.054)		
3Y-6M SPR			-0.0131** (-2.66) (0.009)	
1Y-6M SPR				-0.0384** (-3.28) (0.001)
Cons	-0.469 (-0.07) (0.945)	-0.737 (-0.11) (0.913)	-2.744 (-0.41) (0.682)	-6.422 (-0.95) (0.346)
Number of observations	140	140	140	140
R^2	0.111	0.135	0.155	0.176
Adj. R^2	0.098	0.116	0.137	0.158
F	8.58	7.09	8.34	9.71
Prob>F	0.0003	0.0002	0.0000	0.0000
Root MSE	79.608	78.815	77.896	76.919
SSM	108738.744	132164.908	151743.34	172329.488
SSR	868230.208	844804.043	825225.611	804639.463
SST	976968.951	976968.951	976968.951	976968.951
t-statistics & p-values in parentheses				
*** p<0.05, ** p<0.01, *** p<0.001**				

Table 11:Regression Results Handysize

8. Interpretation of the Results

Based on the results, the monthly prices of the indices are affected from spreads with a negative relationship; meaning that when the spreads are increased by one unit, the indices decrease (i.e., different decrease according to the index and the beta coefficient of the corresponding spread). Higher spreads imply that the long-term and the short-term time charter rates are far from each other, and as they have a long-term relationship, this means that they will start to move towards each other. Hence, a large spread is above the mean and will start to decrease. So, when the spread is large, the indices (which denote the spot freight rates) are decreased, and the shipowner should choose a time charter contract; when the spread is small, the freight rates are higher, and the shipowner should choose a spot contract.

9. Discussion of results

The results of this research indicate that there is statistically significant relationship between spreads and freight rates. This statement is in accordance with the findings of Veenstra, back to 1999, that spot and time charter rates have a long-term relationship. Moreover, in Tsz Leung Yip's study in 2018, same type of spreads was used, although only for the Panamax vessels and the methodology was based on the dynamic probit model. However, his study was based on weekly data, while our study is based on monthly data. He emphasized the use of 3-year minus 6-moths spread for weekly predictions, which agrees with our results that indicate that this spread had the best forecasting ability for Capesize and Panamax indices. Although, he stated that spreads cannot be used alone to predict freight rates as there are a lot of factors that affect them.

10. Conclusions

In this study, the explanatory power of spreads between time charter contracts with different duration on dry bulk spot freight rates was investigated. To compare the effects of spreads on freight rates, and have a wider picture of this effect, the indices of three different types of vessels were examined: BCI for Capesize vessels, BPI for Panamax vessels and BHI for Handysize vessels. For each index, three spreads were analyzed: 3-year minus 1-year, 3-year minus 6-months and 1-year minus 6-months. Every spread for every vessel type had explanatory power and proved statistically significant.

For Capesize index, the 3-year minus 6-months spread gave better results among the three. This model had the highest R^2 and F-value, and the lower sum of squares for the residuals. The Panamax index was also affected more by the 3-year minus 6-months spread, having the highest R^2 and lowest root mean square error. Regarding to Handysize index, spreads proved statistically significant with lower beta coefficients compared to the other two indices. However, in this case the explanatory power of the model did not change much. The biggest positive change in R^2 was given by the 1-year minus 6-months spread. The results of this study seem to agree with Tsz Leung Yip's findings which, as it is stated in his research, suggest that recent data influence more the market change.

The other independent variables that used for the construction of the models were bunker prices and commodity seaborne trade related variables, according to each vessel type.

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