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Forecasting Spot Freight Rates using Vector Error Correction Model in the Dry Bulk Market

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ABSTRACT

In this paper, we employ an applied econometric study concerning forecasting the spot freight rates based on Forward Freight Agreement (FFA) and Time Charter (TC) contracts. This study is important since the volatility of shipping freight rates is quite high and the future development of the rates is uncertain which may not easily predicted. Empirical analysis contains investigation of the relationship between the spot freight rates with FFA and TC. We also check for stationarity of those three types of data. The calibration of vector error correction model (VECM) is carried out using ordinary least square (OLS) method. Later, the VECM is used in forecasting the spot rates. Results show that the FFA forecasts better the spot compared to TC.

Keywords: Vector Error Correction Model, Dry Bulk Market, Spot Freight Rates, Forward Freight Agreement, Time Charter.

1. Introduction

Volatility of freight rates contributes risk to the participants in freight market including the shipowner, charterer, shipping banks and shipping hedge funds. As recorded in the years 2008 to 2011, the annualized volatility of shipping freight rates varies between 59% to 79%[1]. The freight rates, which represent the cost of hiring shipping transportation tend to move randomly over time with its change of direction is determined by the shipping market cycle. Such rates increase when there is less supply of ship in the market and the freight rates diminish when there is an exorbitant supply of ship. In this study, we aim at forecasting the spot freight rates based on the time charter and forward rates in international shipping market.

Shipping plays a major role in the world trade where 75% of the volume of the world trade in manufactured products and commodities are carried out using this seaborne transportation (see Alizadeh and Nomikos (2009)). One of the popular markets in shipping industry is dry bulk where the market is generally categorized either as major bulk (delivery of for instance iron ore, coal and grain) or minor bulk (delivery of for instance agricultural products, steel and mineral cargoes). Based on the vessel size and route, several markets in dry bulk are Capesize, Panamax, Supramax and Handysize. Reader may refer to Alizadeh et al. (2015) for a detailed explanation of the dry bulk markets.

The risk management techniques applied on commodities and financial markets could also be developed for risk management in the shipping industry. Traditionally, the risk of freight rate is managed by the time charter (TC) contract. A TC contract is an agreement between the shipowner and charterer where the charterer hire the vessel from the shipowner for a specific period of time (see Tezuka et al. (2012) and Zhang and Zeng (2015)). Such agreement in terms of duration and freight rates between those participants are recorded by charter party. However, the vessel is still under supervision of the shipowner while all the expenses and the direction of the vessel are under responsibilities of the charterer.

The Baltic International Freight Futures Exchange (BIFFEX) is the first exchange-traded freight futures contract and later the Forward Freight Agreements (FFA) provide dynamic hedges for participants. By definition, FFA is a contract between two parties to hire or settle the freight rates for a certain type of cargo at a future date. The development of shipping derivative results in an immense growth of the futures markets over the years. However, FFA

[1] The paper was presented by N. Nomikos at Cass Business School, City University London. See http://www.bbk.ac.uk/cfc/papers/nomikos.pdf for a detailed report.

market is still under research and considered interesting compared to other freight derivatives because the underlying asset in the market is not a storable commodity but is a service.

The FFA becomes a popular derivative tool in the shipping industry and it allows price discovery and hedging just like other financial derivative (see Kavussanos and Visvikis (2004)). The contract owner has the right to buy or sell the freight rate at a certain date in the future by using the FFA. Furthermore, FFA market also high in liquidity as it allows the shipping market participant to enter and exit the market without causing extreme changes in price (see Alizadeh et al. (2015)). According to Alizadeh (2013), FFA market grew rapidly between the years 2003 until 2009 and reached the peak at 2007 with 2.3 million trading. In arbitrage dominated markets, the spot rates are closely tied to the forward rates. The spot rates move in the direction towards forward to ensure convergence at the expiration date. Thus, the forward rates are unbiased forecasts of future spot rates (see Kavussanos et al. (2004) and Alnes and Marheim (2013)).

Modelling and forecasting of spot freight rates has been studied by many researchers neither it is done theoretically nor empirically. Among them are Kavussanos and Alizadeh (2001, 2002), Jonnala et al. (2002), Rygaard (2009) and recently in a paper by Benth et al. (2015). To mention a few, a study done by Rygaard (2009) used a dynamic programming approach to determine the value of a TC contract using vector error correction model (VECM). The study indicates that the price of ship is correlated for a long time charter contract but not for a short time contract. Further, six different continuous stochastic models of spot freight rates have been introduced in Benth et al. (2015). They find that their proposed dynamical models are fitted to market data and the models also can be used in risk management studies. However, in this paper, we only focus on forecasting the spot freight rates using VECM.

The general model of vector autoregression (VAR) is a flexible model and commonly used for multivariate time series analysis. The model is very helpful in forecasting and interpreting the dynamic performance of financial and economic time series. In order to use the model, all variables must be stationary with a similar order of integration.

However, in the case of non-stationary and exists co-integration between the variables, then error correction term will be added into VAR model. Such model is referred as VECM and also known as a restricted VAR. VECM is an econometric model that has been frequently used for modelling and forecasting spot freight rates, and also proven to be efficient in estimating the short and long term relations between variables. Examples of papers discovering this issue are Veenstra and Franses (1997), Batchelor et al. (2007), Spreckelsen et al. (2012) and Zhang et al. (2014).

The literature also has demonstrated the use of various econometric models in predicting the spot prices. For instance, Cullinane (1992) and Cullinane et al. (1999) reported the success of forecasting the spot freight rates using simpler univariate autoregressive integrated moving average (ARIMA) models. Zeng and Swanson (1998) estimate five models including VECM for spot and futures prices of the US 30-year Treasury bond, oil, gold and the S&P500 index. They find that the VECM produces more accurate forecasts than all simpler models in a shorter horizon. Furthermore, Kavussanos and Nomikos (2003) compared the forecasting performance of VAR, VECM, random walk and ARIMA models. They also find that VECM predicts better of spot prices compared to the other models but not of futures prices as reported in the paper by Batchelor et al. (2007). As the forecast horizons increases, the predicting ability of VECM is getting better. However, VECM can only be used if a co-integration relationship exist between the variables. Thus, the relationship between variables shall be initially determined in order to use the VECM model for forecasting.

The rest of the paper is organised as follows: Section 2 briefly discusses forecasting model and the relevant tests. In Section 3 we analyse the empirical spot freight rates and calibrating the model. Next, we derive the forecasting performance in Section 4 and finally conclusion ends the paper.

2. Forecasting model of the spot freight rates

In this section, we explain the VECM model together with appropriate tests used for the purpose of forecasting the spot freight rates. The parameters of VECM based on FFA and TC are calibrated and finally we forecast the spot freight rates using such model.

2.1 Correlation analysis

Correlation analysis measures the strength between two variables whether they move in same direction or opposite direction. Correlation coefficient is valued between -1 to 1 as shown in Table 1. The coefficient -1 indicates that the markets are moving in opposite direction, 0 indicates no direction between the markets and 1 indicates the markets are moving together in same direction.

Table 1: Correlation analysis.

Correlation coefficient	Strength of correlation
-1	Strongly negative
0	No correlation
1	Strongly positive

2.2 Augmented Dickey-Fuller test

Raw data are often in non-stationary form and can have specific cycle, trend, seasonality or random walk. This means that variance, covariance and mean of the data are changing over the time which will affect the reliability and consistency of the time series result (see Franses and McAleer (1998)). In order to have a consistent result, Augmented Dickey-Fuller (ADF) test is used to check the stationarity of the data. The series of data will be tested if it needs to be differenced in order to make it stationary. The following test equation is used:

$$\Delta z_t = \alpha_0 + \theta z_{t-1} + \gamma t + \alpha_1 \Delta z_{t-1} + \alpha_2 \Delta z_{t-2} + \cdots + \alpha_p \Delta z_{t-p} + e_t, \qquad (1)$$

where z_t is time series, Δ is difference operator, α_i is parameter, γ is coefficient on a time trend, t is time index, p is lag order of the first-differences autoregressive process and e_t is independent identically distributes residual term. The equation has an intercept term and a time trend. Hence, it is only suitable for a data series with a trend.

The null hypothesis of the ADF t-test is

$$H_0 : \theta = 0, \qquad \text{(unit root test is present)}$$

against the following alternative hypothesis

$$H_1 : \theta < 0; \qquad \text{(unit root test is absent).}$$

If the null hypothesis is accepted, the data need to be differenced to make it stationary and the Johansen Co-Integration test can be later carried out. On the contrary, the rejection of null hypothesis means that the data is stationary and can be analysed by using a time trend in the regression model instead of differencing.

2.3 Johansen co-integration test

Johansen test allows more than one co-integrating relationship. This test is better than Eagle-Granger test which allows only one co-integration relation. When there are more than two variables, all co-integrating vectors can be estimated since the Johansen test is a likelihood-ratio test (see Mallory and Lence (2012)). Generally, there are at most $n-1$ co-integrating vectors if there are n variables which all have unit roots. The long term relationship among the data set can be determined by using Johansen test.

There are two types of Johansen test: the trace and maximum eigenvalue tests. For the trace test, it is used to test if the rank of the matrix, Π is r_0. Rank $(\Pi) = r_0$ is the null hypothesis. The alternative hypothesis is $r_0 < \text{rank}(\Pi) \leq n$, where n is the maximum number of possible co-integrating vectors. The test equation is as below:

$$LR(r_0, n) = -T \sum_{i=r_0+1}^{n} \ln(1-\lambda_i), \tag{2}$$

where $LR(r_0, n)$ is the likelihood-ratio test statistic for testing whether rank $(\Pi) = r_0$ versus the alternative hypothesis that rank $(\Pi) \leq n$. For the succeeding test if this null hypothesis is rejected, the next null hypothesis is that rank $(\Pi) = r_0 + 1$ and the alternative hypothesis is that $r_0 + 1 < \text{rank}(\Pi) \leq n$.

Next, the maximum eigenvalue test is used to determine whether the largest eigenvalue is zero relative to the alternative that the next largest eigenvalue is zero. The first test is a test whether the rank of the matrix Π is zero. The null hypothesis is that rank $(\Pi) = 0$ and the alternative hypothesis is that rank $(\Pi) = 1$. For further tests, the null hypothesis is that rank $(\Pi) = 1, 2, \ldots$ and the alternative hypothesis is that rank $(\Pi) = 2, 3, \ldots,$

The test equation is as below:

$$LR(r_0, r_0+1) = -T \ln(1-\lambda_{r_0+1}), \tag{3}$$

where $LR(r_0, r_0+1)$ is the likelihood-ratio test statistic for testing whether rank $(\Pi) = r_0$ versus the alternative hypothesis that rank $(\Pi) = r_0 + 1$.

2.4 Vector error correction model

If the data series are co-integrated and long run relationship exists between the variables, then this model can be used for forecasting. Let S_t, W_t and F_t represent the spot rates, TC rates and FFA prices respectively. The VECM (p) for spot rates and TC rates is written as follows:

$$\Delta S_t = \sum_{i=1}^{p-1} a_{S,i} \Delta S_{t-i} + \sum_{i=1}^{p-1} b_{S,i} \Delta W_{t-i} + \alpha_S z_{t-1} + \varepsilon_{S,t}; \tag{4}$$

$$\Delta W_t = \sum_{i=1}^{p-1} a_{W,i} \Delta S_{t-i} + \sum_{i=1}^{p-1} b_{W,i} \Delta W_{t-i} + \alpha_W z_{t-1} + \varepsilon_{W,t}, \tag{5}$$

where Δ denotes the first difference operator, $a_{S,i}$, $a_{W,i}$, $b_{S,i}$, $b_{W,i}$ are coefficients, $\varepsilon_{S,t}$ and $\varepsilon_{W,t}$ are error terms, α_S and α_W are error correction coefficients and z_{t-1} is the error correction term.

The VECM (q) for spot rates and FFA prices is written as follows:

$$\Delta S_t = \sum_{i=1}^{q-1} a_{S,i} \Delta S_{t-i} + \sum_{i=1}^{q-1} c_{S,i} \Delta F_{t-i} + \alpha_S z_{t-1} + \varepsilon_{S,t}; \tag{6}$$

$$\Delta F_t = \sum_{i=1}^{q-1} a_{F,i} \Delta S_{t-i} + \sum_{i=1}^{q-1} c_{F,i} \Delta F_{t-i} + \alpha_F z_{t-1} + \varepsilon_{F,t}, \tag{7}$$

where Δ denotes the first difference operator, $a_{S,i}$, $a_{F,i}$, $c_{S,i}$, $c_{F,i}$ are coefficients, $\varepsilon_{S,t}$ and $\varepsilon_{F,t}$ are error terms, α_S and α_F are error correction coefficients and z_{t-1} is the error correction term.

2.5 Calibration of parameters

The calibration of parameters is carried out by using the Ordinary Least Square (OLS) method. In statistical analysis, this method is the simplest type of estimation technique and is used to fit a function closely with the data by minimizing the sum of squared errors from the data. The R-squared value, R^2 is also determined with the value ranging from 0 to 1 where 0 indicates no improvement in the forecasting and 1 indicates the forecasting model predicts perfectly. The equation is as shown below:

$$y_i = \sum_{j=0}^{k} B_j X_{ij} + \varepsilon_i, \tag{8}$$

where y is dependent variable, B is coefficient, X is independent variable and ε is error term.

2.6 Forecasting accuracy

The measures of mean absolute deviation (MAD) and root mean squared error (RMSE) are selected to compare the forecasting accuracy since both approaches are really good accuracy measures (see Batchelor et al. (2007)). According to Meese and Rogoff (1983), the MAD is more appropriate and reliable because it less sensitive to the presence of outliers while a study done by Ericsson (1992) shows that "forecast encompassing" proposed by Chong and Hendry (1986) is the sufficient condition of the RMSE dominance (see Ashiya (2007) and Kuo (2016)). The smaller the values of MAD and RMSE, the better the predicting ability of the model. The MAD and RMSE are respectively given by

$$MAD = \frac{\sum_{i=1}^{N} |\hat{y}_i - y_i|}{N} \tag{9}$$

and

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (\hat{y}_i - y_i)^2}{N}}, \tag{10}$$

where N is the number of forecast, $\hat{y}_i$ are predicted values and y_i are real values.

3. Empirical analysis of the freight rates

The data of spot freight rates and time charter for the segment of Baltic Capesize Index (BCI) are obtained from Baltic Exchange[2] while the FFA prices are obtained from Baltic Forward Assessments (BFA). The chosen series of spot rate is the BCI 4T/C which is the four time charter routes average and the TC rates consist of the prices of TC contracts for 6-month. The TC contract is for dry bulk vessels of 170,000 metric tons (Mt) dead weight tonnage (Dwt). The data set of spot rates, 6-month TC prices and FFA prices for Capesize market are observed from January 6, 2006 until June 5, 2009. The TC and FFA data are arranged to synchronize with the spot data.

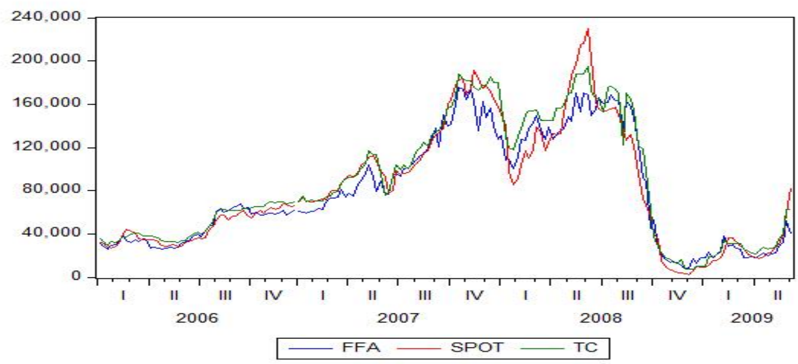

Figure 1: Time series of Spot, FFA and TC prices

Figure 1 shows that the spot prices closely follow with FFA and TC prices and there is a high consistency between the three prices. Result of correlation coefficient in Table 2 indicates the high correlation between spot, FFA and TC.

Table 2: Correlation Coefficient between Spot, FFA and TC prices.

	FFA	Spot	TC
FFA	1.000000	0.959908	0.982610
Spot	0.959908	1.000000	0.974596
TC	0.982610	0.974596	1.000000

[2]See http://www.balticexchange.com for detailed information of daily quotes for different routes and indices in various shipping segments.

Stationary of the time series are tested using ADF test and Table 3 shows the result. Note that all series with total observations of 178 are determined in natural logarithm. The critical value (CV) in the confidence level of 1% and 5% are -3.47 and -2.88 respectively. The study found that the t-statistics of all time series for unit root are greater than CV. Thus, null hypothesis cannot be rejected since the data is non-stationary. With the first differencing, all prices become stationary as the $t-$statistics is less than CV and null hypothesis is rejected. Figure 2, 3 and 4 show three types of graphical structure for first difference stationary of spot freight rates, TC rates and FFA prices. Since the unit root test gives sign of stationary at first difference, Johansen co-integration test can be conducted.

Table 3: Unit root test result.

Variables	Levels	First Differences
Spot	-2.52	-4.44
TC	-1.94	-6.46
FFA	-2.26	-7.29

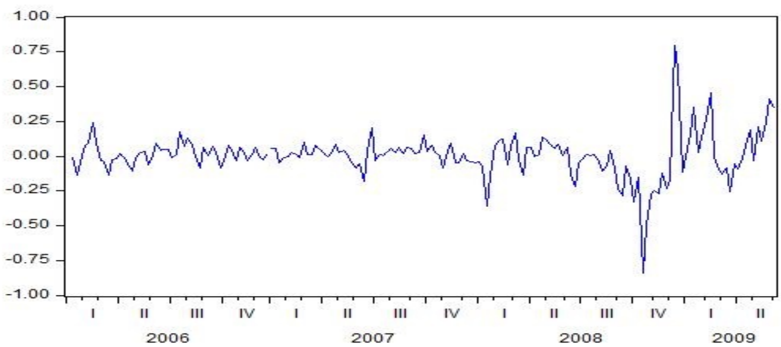

Figure 2: First difference stationary of spot freight

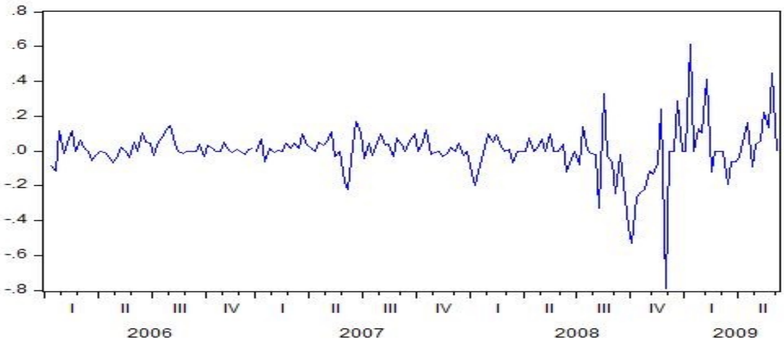

Figure 3: First difference stationary of TC rates

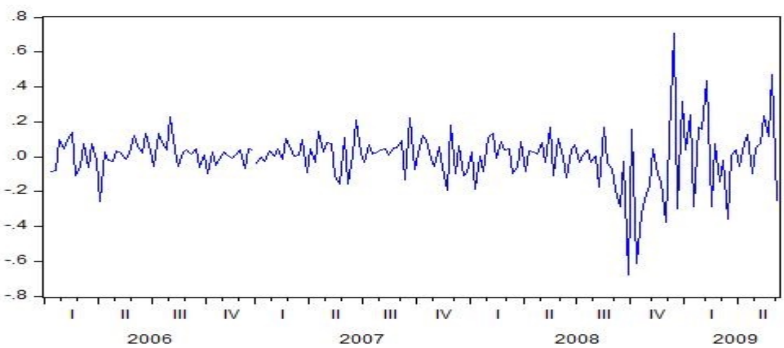

Figure 4: First difference stationary of FFA prices

Johansen test is used to measure the co-integration between variables. For this test, a suitable number of lag is selected using the lag selection criteria of Akaike Information Criterion (AIC). Results of selection number of lag are reported in Table 4 where we select lag 7 as an appropriate lag number based on the lower AIC value.

Table 4: Lag order selection criteria.

Lag length	Spot-TC	Spot-FFA
0	2.127907	2.521640
1	−2.375592	−1.943784
2	−2.896241	−3.114068
3	−2.910459	−3.204349
4	−3.018723	−3.242539
5	−3.051439	−3.322774
6	−3.041055	−3.337942
7	−3.102295*	−3.377629*

Note: '*' indicates lag order selected by the criterion

In Table 5, we present the analysis of Johansen test with r denotes the number of co-integrating vectors and λ_{trace} and $\lambda_{\max}$ are the statistics for trace and maximum eigenvalue tests respectively. The symbol '*' represents rejection of null hypothesis at 5% level.

Table 5: Analysis of Johansen co-integration test.

Variables	Hypothesis		λ_{trace}	Prob.	$\lambda_{\max}$	Prob.	CV (5%)	
	H_0	H_1					λ_{trace}	$\lambda_{\max}$
Spot-TC	$r = 0$	$r = 1$	38.78191	0.0000*	35.17310	0.0000*	15.49471	14.26460
	$r \leqslant 1$	$r = 2$	3.608811	0.0575	3.608811	0.0575	3.841466	3.841466
Spot-FFA	$r = 0$	$r = 1$	30.00616	0.0002*	25.94655	0.0005*	15.49471	14.26460
	$r \leqslant 1$	$r = 2$	4.059608	0.0439*	4.059608	0.0439*	3.841466	3.841466

For the Johansen test of spot and TC prices, both the probability values of trace and maximum eigenvalue statistics are lower than 5% level, and thus the rejection of null hypothesis is conducted. The test indicates that there is at least one co-integrating equation on the 5% level. For the spot and FFA prices, both the trace and maximum eigenvalue statistics shows two co-integrating relationships on the 5% level. Since there is a co-integration and long run relationship between spot, TC and FFA prices, the VECM is appropriate to be used in modelling the freight rates.

Table 6: Analysis of spot and TC prices on the sample (weekly).

Parameters	Coefficients	ΔS_t	Coefficients	ΔW_t
ΔS_{t-1}	$a_{S,1}$	0.521907 (5.79301*)	$a_{W,1}$	0.253707 (2.61340*)
ΔS_{t-2}	$a_{S,2}$	−0.082637 (−0.84048)	$a_{W,2}$	−0.100033 (−0.94419)
ΔS_{t-3}	$a_{S,3}$	0.157979 (1.64525)	$a_{W,3}$	0.280342 (2.70947*)
ΔS_{t-4}	$a_{S,4}$	0.025309 (0.26497)	$a_{W,4}$	−0.015594 (−0.15151)
ΔS_{t-5}	$a_{S,5}$	−0.000536 (−0.00564)	$a_{W,5}$	−0.021080 (−0.20584)
ΔS_{t-6}	$a_{S,6}$	0.116164 (1.31963)	$a_{W,6}$	0.232553 (2.45170*)
ΔS_{t-7}	$a_{S,7}$	−0.229518 (−2.83247*)	$a_{W,7}$	−0.018945 (−0.21698)
ΔW_{t-1}	$b_{S,1}$	0.329893 (3.27953*)	$b_{W,1}$	0.034257 (0.31604)
ΔW_{t-2}	$b_{S,2}$	−0.236415 (−2.55247*)	$b_{W,2}$	0.061115 (0.61234)
ΔW_{t-3}	$b_{S,3}$	0.097586 (1.02070)	$b_{W,3}$	−0.025085 (−0.24349)
ΔW_{t-4}	$b_{S,4}$	0.288770 (3.06530*)	$b_{W,4}$	0.055313 (0.54489)
ΔW_{t-5}	$b_{S,5}$	−0.004084 (−0.04637)	$b_{W,5}$	−0.090711 (−0.95574)
ΔW_{t-6}	$b_{S,6}$	0.066968 (0.76507)	$b_{W,6}$	−0.338671 (−3.59070*)
ΔW_{t-7}	$b_{S,7}$	0.160584 (1.77063)	$b_{W,7}$	−0.121907 (−1.24743)
z_{t-1}	α_S	−0.269007 (−3.48995*)	α_W	0.122073 (1.46974)
R^2		0.570850		0.314104

The calibration of VECM model is carried out using the OLS method for estimation period from January 6, 2006 to June 5, 2009. The results are presented in Table 6 and 7. Note that the values in bracket are $t-$statistics and the symbol '$*$' is the significance indicator at 5% level.

Based on Table 6, the estimated coefficients of $a_{S,1}$, $a_{W,1}$, $a_{W,3}$, $a_{W,6}$, $a_{S,7}$, $b_{S,1}$, $b_{S,2}$, $b_{S,4}$, $b_{W,6}$, α_S are statistically significant. Furthermore, it has been proven that a bidirectional lead-lag relationship exists between spot and TC prices if the coefficients are significant (see Kavussanos and Visvikis (2004)). In Table 7, we report the estimated coefficients for spot and FFA prices. Similar to spot rates and TC prices, the estimated coefficients of $a_{S,1}$, $a_{S,2}$, $a_{F,3}$, $a_{S,4}$, $a_{F,4}$, $a_{S,7}$, $c_{S,1}$, $c_{F,2}$, $c_{S,4}$, $c_{S,5}$, $c_{F,5}$, α_S are statistically significant. Thus, a bidirectional causal relationship exists between spot and FFA prices. Besides, a moderate R^2 indicates that our model fits the data well.

Table 7: Analysis of spot and FFA prices on the sample (weekly).

Parameters	Coefficients	ΔS_t	Coefficients	ΔF_t
ΔS_{t-1}	$a_{S,1}$	0.284039 (2.84128*)	$a_{F,1}$	−0.158310 (−1.06642)
ΔS_{t-2}	$a_{S,2}$	−0.235972 (−2.21062*)	$a_{F,2}$	0.037889 (0.23903)
ΔS_{t-3}	$a_{S,3}$	0.117766 (1.07701)	$a_{F,3}$	0.397666 (2.44908*)
ΔS_{t-4}	$a_{S,4}$	−0.298388 (−2.69989*)	$a_{F,4}$	−0.624203 (−3.80344*)
ΔS_{t-5}	$a_{S,5}$	0.113721 (1.00295)	$a_{F,5}$	0.192906 (1.14570)
ΔS_{t-6}	$a_{S,6}$	−0.065084 (−0.59459)	$a_{F,6}$	−0.003015 (−0.01855)
ΔS_{t-7}	$a_{S,7}$	−0.138983 (−2.17281*)	$a_{F,7}$	−0.072325 (−0.76143)
ΔF_{t-1}	$c_{S,1}$	0.577922 (7.94004*)	$c_{F,1}$	−0.054652 (−0.50565)
ΔF_{t-2}	$c_{S,2}$	0.072870 (0.77860)	$c_{F,2}$	0.410398 (2.95293*)
ΔF_{t-3}	$c_{S,3}$	0.129292 (1.33942)	$c_{F,3}$	−0.072048 (−0.50264)
ΔF_{t-4}	$c_{S,4}$	0.209184 (2.17396*)	$c_{F,4}$	0.138963 (0.97254)
ΔF_{t-5}	$c_{S,5}$	0.389728 (4.09783*)	$c_{F,5}$	0.403082 (2.85412*)
ΔF_{t-6}	$c_{S,6}$	0.076877 (0.79335)	$c_{F,6}$	−0.047204 (−0.32804)
ΔF_{t-7}	$c_{S,7}$	0.166821 (1.77407)	$c_{F,7}$	0.137312 (0.98337)
Z_{t-1}	α_S	−0.087890 (−3.68285*)	α_F	−0.060518 (−1.70772)
R^2		0.684413		0.239646

4. Forecasting performance

We use parameters of VECM model obtained in previous section to forecast the spot freight rates. The forecasting sample is from January 2, 2009 until June, 5 2009 with 23 numbers of observation. One step ahead forecast is used and Table 8 shows the result. The forecast error is the difference between forecasted and actual values. The forecasted value of spot rates is compared with the actual value of spot rates to determine the percentage of error. The first column in Table 8 is the real spot rates for BCI 4T/C and the second column is the results for the spot rates forecasting model based on spot and FFA rates (VECM (FFA)). The last column is the results for spot rates forecasting model based on spot and TC rates (VECM (TC)). Note that the data series for real and forecasting are measured in natural logarithm.

To analyse forecasting performance, two forecast errors, MAD and RMSE are being used. The calculated MAD for VECM (FFA) is less than MAD for VECM (TC) which reveal that VECM (FFA) predict better. Furthermore, the RMSE for VECM (TC) is higher than RMSE for VECM (FFA) which proves that FFA prices forecast the more accurate spot rates. The forecasted results of both FFA and TC are represented in Figures 5 and 6. It is clear that the forecasted spot rates based on TC contract deviate far from the actual spot rates compared to forecasted spot rate using FFA which appear closer to the actual one. In a nutshell, VECM (FFA) model performs better in forecasting the spot freight rates.

Table 8: Forecasting results of spot using VECM.

Date (2009)	Real data	VECM (FFA)		VECM (TC)	
		Value	Error	Value	Error
2 January	9.105	9.275	1.87%	9.069	0.40%
9 January	9.265	9.211	0.58%	9.213	0.56%
16 January	9.613	9.679	0.69%	9.638	0.26%
23 January	9.643	9.673	0.31%	9.767	1.29%
30 January	9.779	9.810	0.32%	9.699	0.82%
6 February	10.040	9.877	1.62%	10.002	0.38%
13 February	10.497	10.448	0.47%	10.398	0.94%
20 February	10.491	10.434	0.54%	10.621	1.24%
27 February	10.398	10.529	1.26%	10.611	2.05%
6 March	10.266	10.317	0.50%	10.408	1.38%
13 March	10.182	10.278	0.94%	10.191	0.09%
20 March	9.930	9.927	0.03%	10.057	1.28%
27 March	9.874	9.865	0.09%	9.853	0.21%
3 April	9.783	9.771	0.12%	9.689	0.96%
10 April	9.767	9.676	0.93%	9.636	1.34%
17 April	9.846	9.779	0.68%	9.805	0.42%
24 April	10.033	9.963	0.70%	9.954	0.79%
1 May	10.001	10.033	0.32%	9.986	0.15%
8 May	10.211	10.048	1.60%	10.099	1.10%
15 May	10.321	10.386	0.63%	10.354	0.32%
22 May	10.568	10.453	1.09%	10.413	1.47%
29 May	10.982	10.753	2.09%	10.735	2.25%
5 June	11.328	11.320	0.07%	11.361	0.29%
MAD		0.07661		0.08852	
RMSE		0.09661		0.10847	

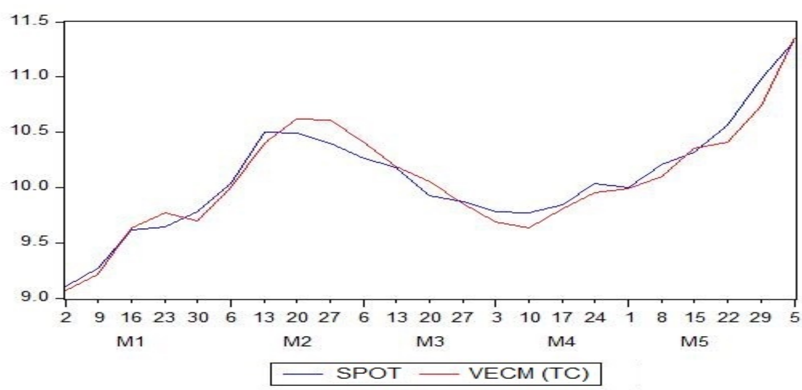

Figure 5: Actual and forecasted value of VECM (TC)

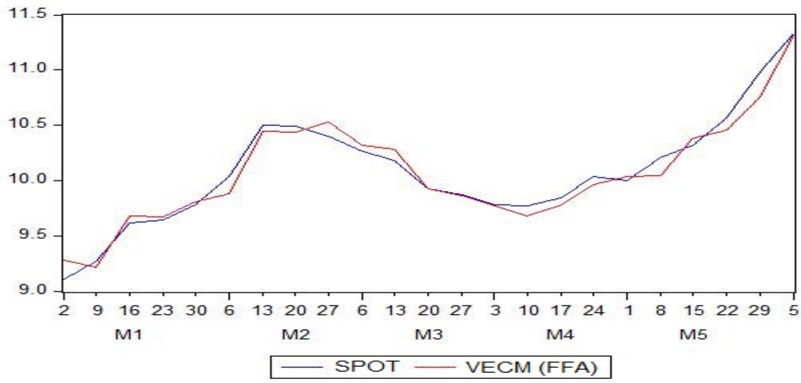

Figure 6: Actual and forecasted value of VECM (FFA)

5. Conclusion

There are a lot of business and financial risks involve in international shipping industry and this lead the researcher to develop various risk management tools that can lower the risk of spot rates. FFA and TC are the two examples of contract developed for hedge the risk of freight rate. However, the investors are having difficulty in selecting the best contract to manage the freight rate fluctuation effectively. Hence, this study was done to determine the best contract between FFA and TC in forecasting spot freight rates.

In this study, the data of spot freight rates and time charter for the segment of BCI are obtained from Baltic Exchange while the FFA prices are obtained from BFA which is a reliable source for FFA prices. We used a correlation analysis on the data series to measure the relationship between spot, FFA and TC. The result shows that the correlation coefficient indicates the high correlation between the three prices and it also indicates the markets are moving together in the same direction.

In order to use VECM as the forecasting model, the data must be initially stationary and co-integrated. Therefore, the stationarity of the data series are tested using ADF test and the results report that all the prices become stationary with only the first differencing. Since the unit root test gives sign of stationary at first difference, Johansen co-integration test can be conducted.

Johansen test is used to measure the co-integration between variables. The trace and maximum eigenvalue test for the Johansen test of spot and TC prices indicate the existence of one co-integrating equation on the 5% level. Meanwhile, for the spot and FFA prices, both the trace and maximum eigenvalue test shows two co-integrating relationships on the 5% level. The VECM is appropriate to be used in modelling the freight rates since there is a co-integration and long run relationship between spot, TC and FFA prices.

The calibration of VECM model is carried out using the OLS method. The results show that some estimated coefficients of spot and TC prices are significant. Similarly, some estimated coefficients of spot and FFA prices are reported statistically significant. These indicates that a bidirectional lead-lag relationship exists between the variables. Besides, for the spot rate forecasting model based on spot and FFA prices, the R^2 shows a higher value compared to the R^2 of spot and TC prices.

Finally, to forecast the spot freight rates we use parameters of VECM model obtained previously. One step ahead forecast is used as a measurement method, namely static forecast. To determine the percentage of error, the forecasted value of spot rates is compared with the actual value of spot rates. Further, two forecast error, MAD and RMSE are being used to analyse the forecasting performance. The calculated MAD and RMSE for VECM (FFA) are less than VECM (TC) which reveal that VECM (FFA) predict better. Hence, the FFA contract is the best and the most suitable method to manage the volatility of the freight market.

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