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Predicting the shipping market by spreads of timecharter rates

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Key words: timecharter rates, shipping market, Panamax dry bulk ships, economic indicator, maritime transport

Abstract

This paper has explored the predictability of spreads between long-term and short-term timecharter rates on spot freight rates. The spread between long-term and short-term rates (or the slope of the yield curve) is often used as a leading economic indicator of economic activities. This concept has been extended to the shipping market in this paper and the probability that the spot freight rate will increase or decrease has been determined. Using the spread between the timecharter rates on long-term and short-term charter contracts, the direction of spot freight rates has been predicted with the dynamic probit model, which is used to estimate the probability of discrete events. Evidence has been drawn from Panamax dry bulk ships for future weekly, quarterly and biyearly changes of spot freight rates. While the dynamic probit model has shown moderate predictive power, the weekly model has shown that the market has a relatively longer memory than the quarterly and biyearly models.

Introduction

Tramp shipping is a speculative business, because it is very difficult to anticipate freight rates. Tramp ships are free to trade where they can and to carry whatever cargoes they technically can. The freight rates are the result of bargaining between the shipowner and the charterer. To understand the shipping industry, one needs to have a broad understanding of its influences from the micro- and macro-economic perspectives. As the bulk shipping market is global, the world economy has profound consequences on the shipping market as a whole.

This paper was motivated by the following facts: first, despite much research we do not yet fully know the predictability of the spread of long-term and short-term rates (also known as the slope of the yield curve) on the market direction in the international shipping market. Estrella and Mishkin (Estrella & Mishkin, 1996) proposed the use of the yield curve as a predicator of US recessions. Second, the spread between long-term and short-term timecharter rates on the shipping market has not been fully investigated so far in the literature. Third, the results of this study can furnish managerial implications. Estrella and Trubin (Estrella & Trubin, 2006) documented the practical issues of using the yield curve as a leading indicator of economic recession. The objective of this paper was to provide statistical evidence on the predictability of the spread of long-term and short term rates on the market direction and to extract managerial implications.

Shipping economists often use complex mathematical models to forecast the path of the freight rate. In shipping, the spot market price is known as the spot freight rate (or freight index) and the long-term contract market price is known as the timecharter rate. These two rates are associated with trip charter and timecharter where ships operate under these two major types of contracts. The spot freight rate is expressed in terms of dollars per tones ($/ton) for transportation service, which is trip charter. Trip charter is 'voyage charter on a time basis'. The fundamental difference between trip charter and voyage charter is that the ship is not chartered for the trip (or voyage) but hired for the time taken to complete the trip. The timecharter rate is expressed in dollars per day ($/day) for hiring ships. The ship is hired for $/day, while the charterer pays voyage costs (including fuel costs) while the shipowner pays the capital and running costs.

For analysis of the bulk shipping market directions (ups and downs), chartering activity is being used as an indicator to reflect what is happening in the market and it is directly related to the long cycles of the world economy. Despite it being known that the bulk shipping industry has a typical cyclic pattern, which includes expansion, prosperity, contraction, and recession, throughout the financial history, many shipping companies could still not avoid being drawn into the risk of bankruptcy, such as KLC (Korea Line Cooperation) and Transfield Shipping, or even declared bankrupt altogether, for example, Armada Singapore, in the last financial crisis in 2008.

In the financial markets, empirical research has demonstrated the predictive relationships between the slope of the yield curve and subsequent economic activities, such as inflation (e.g. Mishkin, 1990; Chauvet & Potter, 2002). The expectation hypothesis is the line of reasoning as to why term spreads might be useful to predict the subsequent economic activity. The higher the term spread, the more restrictive current market policy is, and the more likely there is to be a downturn over the subsequent period. Similarly in shipping, expectations of the future spot freight rate may be contained in the spread of long-term and short-term timecharter rates. Therefore, the spread of timecharter rates may be helpful in forecasting the direction of the shipping market.

Apart from timecharter rates, several other variables have been widely used to forecast the path of the spot freight rate and they are the tonnage of the ship fleet, the tonnage of ships being built, the tonnage of ships being scrapped, worldwide GDP, ship bunker price, the price of cargoes (Evans & Marlow, 1990). In this paper, the probit model of the spread of timecharter rates has been used to forecast the spot freight rate.

Veenstra (Veenstra, 1999) attempted to explain the spread between the period and the spot rate for the ocean dry bulk shipping market. He showed that the period and the spot rate are co-integrated and exhibit a long-term equilibrium relation. His findings agree with the efficient market hypothesis and the assumption that the dry bulk shipping market is close to being perfectly competitive. He concluded that the spread is an important information variable in shipping. In this paper it has been argued that the spread between long- and short-term timecharter rates is a good indicator of future shipping activity. In stock trading, the moving average trading rule is one of most popular technical trading rules. The rule states to buy (or sell) when the short-term moving average rate rises above (or falls below) the long-term moving average rate. This is because, when the short-term rate is above the long-term rate, the trend is considered "upward". This is known as the expectation hypothesis (reference).

Adland and Cullinane (Adland & Cullinane, 2005) discussed the two implications of the expectation hypothesis in bulk shipping freight rates. Firstly, the short-term freight rate will rise in the long-run, if the spread of freight rates is high. Secondly, the long-term freight rate will rise in the short-run, if the spread of freight rates is high. However, because the expectation hypothesis holds only under particular market conditions, they conceptually suggested that time varying risk – volatility should be considered. The validity of the expectation hypothesis has been tested in this study.

This paper has been organized as follows. In the first section I summarized the general understanding of the dry bulk shipping market. Next, the models for probit have been specified and estimation techniques for econometrics analysis have been explained.

Later data descriptions for the analysis and empirical results have been provided. In the last section, the findings have been discussed and the conclusions have been presented.

The dry bulk shipping market

Because the commodities, such as ore, coal and grains, in the world are not equally distributed, some economies need to import or export resources for consumption, production and revenue generation. Bulk carriers are the key means of transport for shipping huge amounts of cargoes since the first specialized bulk carrier was built in 1852. There are six major size categories of bulk carriers: small size (< 10,000 deadweight tonnage or DWT), Handysize (10,000–34,999 DWT), Handymax (35,000–59,999 DWT), Panamax (60,000–79,999 DWT), Capesize (80,000–199,000 DWT), and Very Large Ore Carriers (180,000 + DWT). Very large bulk and ore carriers fall into the Capesize category but are often considered separately.

A brief overview for the three major bulk carriers and the routes that have recently been active in the dry bulk market: Capesize normally carry iron ore, coal and grain; Panamax normally carry iron ore, coal, grain, bauxite and phosphate; and, the carriage of commodities is covered by Handysize bulkers that are wider and includes grain, coal steels, cement, potash, rice, sugar, gypsum, etc. Meantime, it seems that the Handysize market is attractive to investors for long term investment because of the prospect in Asia-Pacific trade and aging Handysize vessels in the market.

Why did the shipowners that previously only just focused on Capesize or Panamax markets lose a lot after the financial crisis? The main reason is that shipowners are just only concerned with the marginal profit and economies of scale. They just kept on producing large size vessels to maximize their return; however, they did not think whether the demand in the market could absorb all the supply from their own vessels. Also, the flexibility of such large vessels restricts the routes and trades that they can operate. Even the vessels that can trade within some routes may still have other conflicts in between. For instance, when a Capesize or Panamax is loading coal in Australia, they normally have to wait for a berth for at least two weeks or even longer. In this case, shipowners should shoulder the burden for the expenses and time lost. If the delay is unexpected, the vessels may miss their next employment. Pacific Basin is a good example for the investor to understand how they can gain benefit from the Handysize market. They have kept on expanding their company on the basis of the Handysize core segment. Thus, in the coming 5 years, it would be wise to concentrate on the Handysize market.

When fixing vessels, the cargo size and transit limitation should be considered. A Capesize bulk carrier with a capacity of usually 130,000 to 200,000 DWT which, due to its size, must transit

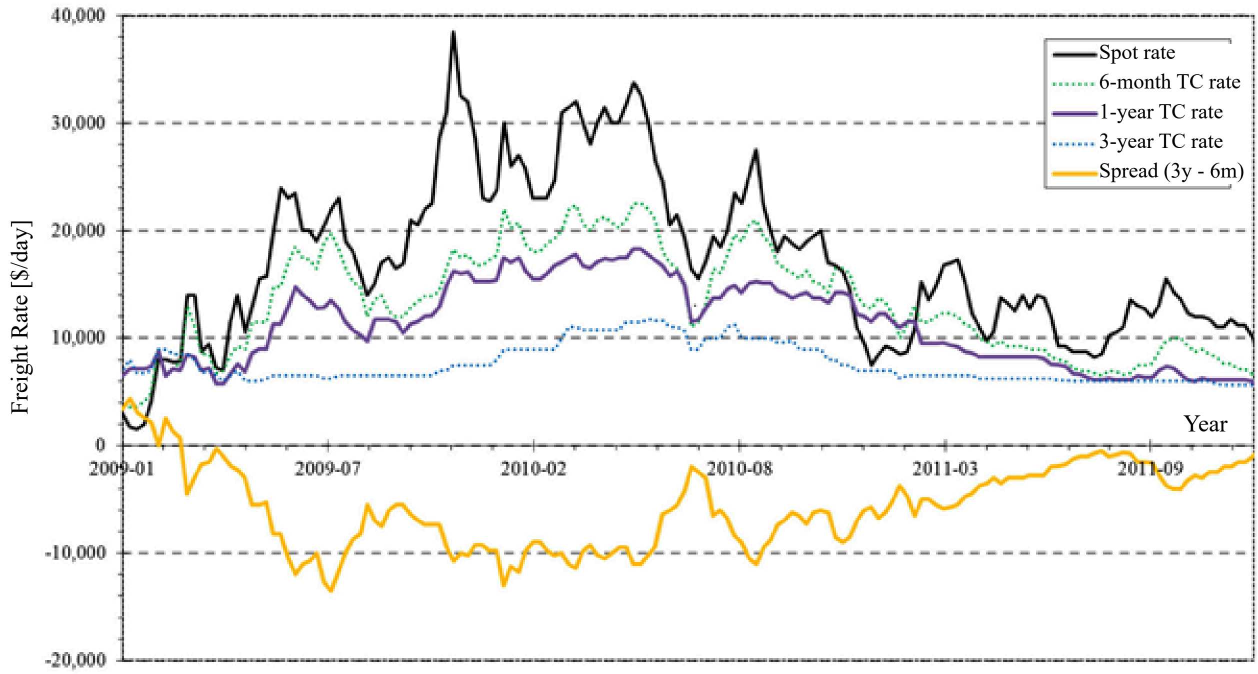

Figure 1. Freight rates and spreads (Shipping Intelligence Network, 2017)

the Atlantic to the Pacific via Cape Horn or the Cape of Good Hope when loaded and these vessels are normally employed for long voyages. A Panamax bulk carrier of 60,000 to 79,999 DWT and with a beam not exceeding 32.2 metres will be able to transit the Panama Canal even after being fully loaded. Panamax vessels initially provided seaborne iron ore trades in 1960s. Towards the end of the 1960s, Panamax carriers became increasingly involved in the coal trade. Now, Panamax vessels are primarily used to transport major bulks (iron ore, coal and grain) instead of certain minor bulks, such as fertilisers, ores and salt. A Handysize dry bulk carrier of 10,000 to 59,999 dwt is commonly equipped with cargo gear, such as cranes. This type of vessel principally carries minor bulk cargoes and limited quantities of major bulk cargoes. It is well suited for transporting cargoes to ports that may have draft restrictions or are not equipped with gear for loading or discharging cargoes. Without a loss of generality, Panamax vessels have been selected for further analysis in this paper.

Figure 1 shows the freight rates between January 2009 and December 2011. We can see that the timecharter rates of the Panamax follow the spot rate. The spot rate of a Panamax vessel has the greatest volatility, and the longer term rates are less volatile. The 3-year timecharter rate is very stable in the Panamax market. With reference to the spread between 3-year and 6-month timecharter rates, a small negative spread leads to an increase in the spot rate in the following months. A large negative spread is followed by an increase of long-term rates over several months. The fluctuation of freight rates on the spot market and timecharter market is adjusting to the changes in the supply and demand relationship.

Although a simple chart analysis is a powerful tool for evaluating investments, it rarely tells a complete story without the help of a more rigorous analysis.

The dynamic probit model

In order to predict the direction of the future freight rate, a dynamic probit model was used. Using a binary variable to focus on the direction of the spot market has some advantages. First, this allows the probability that the freight rate will increase or not over some specific interval in the future to be addressed. Second, a binary approach is more appropriate than the standard regression model, as the information of the spread alone is not sufficient to predict the magnitude.

The binary dependent variable *UP* at time *t* is defined as:

$$UP_t = 1 \quad \text{if} \quad Fr_{t+n} - Fr_t > 0 \tag{1}$$

$$UP_t = 0 \quad \text{if} \quad Fr_{t+n} - Fr_t \leq 0 \tag{2}$$

where Fr_t and Fr_{t+n} denote the spot freight rate at time t and $t + n$, respectively. The dependent variable *UP* is one in time t if the freight rate over n time steps is increasing. With difference values of the variable n, the changes have been modelled over different durations. To be specific, models of yearly, biyearly, quarterly, and weekly changes of spot freight rates have been empirically tested by setting n to be 52 weeks, 26 weeks, 13 weeks and 1 week in Eq. (1) and (2).

The estimated equation of the dynamic probit model is:

$$\begin{gathered} UP_t^* = \Sigma_j \beta_j(\text{Spread}_{t-j}) + u_t, \\ \text{for } t = 1,\ldots,T; \ \ j = 0,\ldots,J \\ UP_t = 1 \quad \text{if} \quad UP_t^* > 0 \\ UP_t = 0 \quad \text{if} \quad UP_t^* \leq 0 \end{gathered} \tag{3}$$

where β_j are parameters, u_t is the standard normal error, T is the number of observations, and J is the lag length. Spread_t, which is an independent variable, is measured as the difference of a long-term rate and a short-term rate at time t. The model with J lag-terms of Spread_t is estimated by maximum-likelihood using a sample of T observations. To ensure the robustness of the results, different spreads have been used in the empirical tests.

Data and analysis

Table 1 has shown the average spot, 6-month, 1-year and 3-year timecharter rates and their spreads over the observation period. The descriptive statistics indicate that the mean rate of the long-term time-charter rate is lower than the short-term rate on average, and the timecharter rates are lower than the spot rate. The standard derivation follows a similar manner such that the spot rate is more volatile than the timecharter rates across the observation period. The skewness of freight rates are slightly positive and have a long right tail. Such properties of freight rates have been mentioned in previous studies.

The spreads of a long-term rate less a short-term rate have also been reported in Table 1. As a long-term rate is lower than a short-term rate on average, the means of all the spreads are negative. The spreads show similar descriptive statistics of

Table 1. Descriptive statistics of freight rates and spreads

Variable	Mean [$/day]	Standard deviation	Minimum [$/day]	Maximum [$/day]	Skewness	Kurtosis	Auto-correlation
Freight Rates							
Spot rate	16,526.6	14,797.3	1,500	99,163	2.37	9.35	0.988
6-month TC	15,019.2	12,932.2	3,250	82,000	2.79	11.1	0.992
1-year TC	13,925.9	11,921.3	4,000	72,500	3.08	12.76	0.994
3-year TC	11,241.1	7,045.5	3,250	52,000	3.22	14.21	0.989
Spread							
3Y-S	–5,285.5	9,484.6	–51,163	6,250	–1.54	4.97	0.975
3Y-6M	–3,778.1	6,753.6	–35,250	4,375	–1.90	6.64	0.981
3Y-1Y	–2,684.8	5,543.2	–28,000	2,500	–2.47	9.24	0.983
1Y-S	–2,600.7	5,673.2	–30,000	15,500	–1.39	5.54	0.946
1Y-6M	–1,093.3	2,124.1	–16,000	5,000	–2.15	11.68	0.890
6M-S	–1,507.4	4,268.4	–25,250	16,500	–1.36	7.00	0.929

Spot rate [$/day] = Panamax 72,000 dwt trip charter rate trans-pacific RV
TC [$/day] = Timecharter rate 65,000 dwt bulk carrier
Observation period = 5 January 1990 to 21 September 2012 (Weekly)
Number of observations = 1,186

the freight rates, because a spread is a difference between two freight rates. However, the skewness of the spreads was moderately negative and has a long left (negative) tail.

The auto-correlation coefficients of the freight rates and spreads are close to one, indicating that a serial correlation is there. However, as the spread as a leading indicator of shipping market has been tested, the serial correlation of the freight rates and spreads in empirical tests have been ignored. In order to produce robust results, the spread of long-term less short-term timecharter rates have been further expressed in six different ways:

(1) 3-year less spot [3Y-S],
(2) 3-year less 6-month [3Y-6M],
(3) 3-year less 1-year [3Y-1Y],
(4) 1-year less spot [1Y-S],
(5) 1-year less 6-month [1Y-6M], and
(6) 6-month less spot [6M-S].

The results of the probit model, based on the data from 5 January 1990 to 21 September 2012 (1,186 weeks) have been presented in Table 2, Table 3 and Table 4. In order to consider yearly, biyearly, quarterly and weekly changes in the spot freight rate, the time period was set as n = 52 weeks, 26 weeks, 13 weeks and 1 week in Eq. (1) and Eq. (2), respectively. However, as for yearly changes, no "Spread_t" term was statistically significant in the probit models; the empirical results have not been reported here. Different lag lengths J were used in the models but only the estimated models of the preferred lag lengths have been reported. For the consistent estimation of the coefficients, Tables 2 to 4 have shown the same lag lengths across the same duration of changes.

The results show the spreads of the long-term less short-term timecharter rates that correspond to the estimated probabilities of the direction of the spot freight rate. To consider the overall fitness of the models, three quantities were employed, namely, the percentage of correct predictions, the Chi-squared statistic and the log-likelihood statistic. The percentage of correct predictions and the Chi-squared statistics agreed with each other. The log-likelihood statistic conflicted with the percentage of correct predictions and the Chi-squared statistics. These probit models correctly predicted approximately 50% of observations, which is only moderately good. The Chi-squared statistics were in the range of 10 to 38 for the probit models with statistically significant variables. Based on the highest Chi-squared statistics in Tables 2 to 4, the biyearly probit models (38.923 for 1 degree of freedom) were a better fit than the quarterly models (14.206 for 1 degree of freedom) or the weekly models (19.982 for 4 degrees of freedom). This is because the short-term noises tend to be averaged out with long-term observations.

As reported in Table 4, the probit models depended on three Spread_t terms in the weekly models. Tables 2 and 3 showed that the probit models depended on at most one Spread_t term in the biyearly and quarterly models. The yearly models do not depend on any Spread_t term and so the empirical tests have

Table 2. Predictability of probit models for biyearly changes

Spread	3Y-S	3Y-6M	3Y-1Y	1Y-S	1Y-6M	6M-S
UP_t			$Spot_{t+26} - Spot_t$			
Constant	0.115*** (0.042)	0.17*** (0.043)	0.158*** (0.041)	0.040 (0.04)	0.097** (0.042)	0.022 (0.039)
$Spread_t$ [,000$/day]	0.014*** (0.004)	0.034*** (0.006)	0.043*** (0.007)	–0.001 (0.006)	0.049*** (0.018)	–0.014* (0.009)
% correct predictions	50.52%	**51.55%**	**51.55%**	50.00%	50.35%	50.17%
Chi-squared	12.065	36.038	**38.923**	0.042	7.883	2.763
Log Likelihood	–797.328	–785.342	–783.899	**–803.34**	–799.419	–801.98

Number of observations = 1,160; Degree of freedom = 1; () = Standard Error
Note: ***, **, * statistically significance at the 1%, 5%, 10% level.

Table 3. Predictability of probit models for quarterly changes

Spread	3Y-S	3Y-6M	3Y-1Y	1Y-S	1Y-6M	6M-S
UP_t			$Spot_{t+13} - Spot_t$			
Constant	0.086** (0.042)	0.140*** (0.042)	0.144*** (0.041)	0.029 (0.04)	0.075* (0.041)	0.028 (0.039)
$Spread_t$ [,000$/day]	0.002 (0.004)	0.017*** (0.006)	0.025*** (0.007)	–0.018*** (0.007)	–0.001 (0.017)	–0.032*** (0.009)
% correct predictions	50.04%	50.55%	**50.73%**	50.38%	50.04%	50.73%
Chi-squared	0.258	9.461	**14.206**	7.974	0.002	13.945
Log Likelihood	–810.782	–806.181	–803.809	–806.925	**–810.911**	–803.939

Number of observations = 1,173; Degree of freedom = 1; () = Standard Error
Note: ***, **, * statistically significance at the 1%, 5%, 10% level.

Table 4. Predictability of probit models for weekly changes

Spread	3Y-S	3Y-6M	3Y-1Y	1Y-S	1Y-6M	6M-S
UP_t			$Spot_{t+1} - Spot_t$			
Constant	–0.026 (0.042)	0.000 (0.042)	0.018 (0.041)	–0.042 (0.04)	–0.037 (0.041)	–0.024 (0.039)
$Spread_t$ [,000$/day]	–0.009** (0.004)	–0.005 (0.006)	0.000 (0.007)	–0.024*** (0.007)	–0.054*** (0.018)	–0.029*** (0.01)
$Spread_{t-1}$ [,000$/day]	0.001 (0.002)	0.000 (0.003)	0.000 (0.003)	0.001 (0.004)	0.000 (0.004)	0.002 (0.013)
$Spread_{t-2}$ [,000$/day]	–0.045** (0.018)	–0.117*** (0.031)	–0.113*** (0.04)	–0.02 (0.02)	–0.07* (0.037)	–0.006 (0.013)
$Spread_{t-3}$ [,000$/day]	0.043** (0.018)	0.116*** (0.03)	0.111*** (0.04)	0.017 (0.02)	0.068* (0.037)	0.003 (0.005)
% correct predictions	50.59%	**50.76%**	50.42%	**50.76%**	50.59%	50.59%
Chi-squared	15.275	**19.982**	11.759	19.705	17.864	16.899
Log Likelihood	–814.231	–811.878	**–815.989**	–812.016	–812.936	–813.419

Number of observations = 1,185; Degree of freedom = 4; () = Standard Error
Note: ***, **, * statistically significance at the 1%, 5%, 10% level.

not been reported here. The number of $Spread_t$ terms implies that the market has a relatively longer memory and new data has a relatively stronger effect on the market change. Therefore, the empirical results demonstrated that the weekly probit model has a relatively longer memory in weekly periods of rapid market changes. In other words, the biyearly and quarterly models have a relatively short memory in longer periods, because the market changes are not as rapid as in a weekly period.

Table 2 and 3 further showed that the spread of the 3-year less 1-year rates was the best indicator of biyearly and quarterly prediction of the spot freight rate. However, Table 4 showed that the spread of the 3-year less 6-month rate (3Y-6M) was the best indicator of the weekly forecast. The 3-year timecharter rate was the least volatile and can be regarded as the fundamental freight rate in the long run or the benchmark. For biyearly and quarterly prediction of the spot freight rate, the 1-year timecharter rate (3Y-1Y) is appropriate to provide information to the spot market. The weekly forecast needs more recent information and so the 6-month timecharter rate (or 3Y-6M) is more suited.

The theoretical line of reasoning that can help explain the relationship of the spot freight rate and the spread of timecharter rates has been shown in Figure 2. Figure 2 has illustrated the demand and supply in the tramp shipping market. Without a loss of generality, it was assumed that the supply

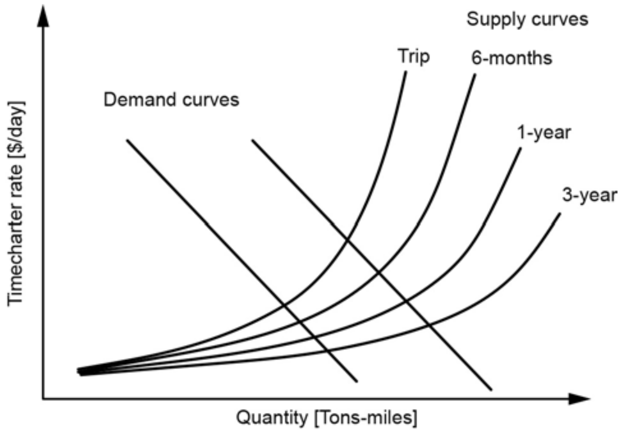

Figure 2. Shipping freight markets for timecharters of different durations

comprises ships in the spot and time charter market, and tramp shipowners are free to switch ships between the spot market and the timecharter market. One of the effects of ships fixed under time charter contacts is the removal of the supply of ships from the spot market. Timecharter rates on short durations are based on the rational expectation of the market. This reflects the expectation of the whole market to either strengthen or weaken and tramp shipowners make the best use of this, switching between the spot and timecharter markets to keep their ships employed in a better type of contract. This switching behaviour leads to the freight rate in the future being determined by hire rates in the past.

The timecharter rate is considered to be an expected average of the spot hire rate over the charter duration. The timecharter rate refers to a ship's functions as an operating unit for a period of time, while the freight rate denotes a ship's cargo carrying ability. Table 4 has shown that the second and third lag terms are statistically significant but the first lag term is not. It should reflect the industrial practice of lagged reporting of the timecharter rates to the market. As it takes one or two weeks to conclude timecharter contracts of dry bulk carriers, the market activities are revealed to other industrial participants within one or two weeks.

In Figure 2, four different supply curves represent the spot, 6-month, 1-year and 3-year time charter supply curves. It is assumed that the longer the charter duration, the flatter the supply curve in the shipping market. The flatter supply curve indicates that the supply of ship capacity for long-term timecharter contracts is less responsive to changes of quantity, because longer-term charter contracts are less flexible. Different elasticity of supply curves leads to different reactions of timecharter rates versus changes in demand. As illustrated in Figure 2, the same change in demand (from left to right or vice versa) brings about different reactions in the supply curves. A short-term timecharter rate will react more to the same magnitude of changes in demand. As a consequence, the spread between the long-term less short-term timecharter rates is expected to be higher in a stronger market.

Ship speed is one of the factors that influence the supply of shipping. Ship speed has various facets. When freight rates are low, ships are utilized by sailing at a low economical speed. When a ship is sailing at sea, it stays employed and is not competing for charter contracts. The greater the number of ships that are at sea, the lesser the number of ships that are available in the market. Low ship speed helps to improve the supply situation in a market that may be over-supplied. In this low-freight environment, long-term charters are favoured by shipowners. On the other hand, if the freight rates are high, indicating a strong demand for ships, ships will be operated at a maximum speed to offer more shipping capability. In this high-freight environment, short-term charters are favoured by shipowners.

Together with the previous discussion, one practical issue in the use of the spread as a leading indicator is that the frequency of spread data should be lower than that of the quantity (i.e. the spot freight rate in this study) to be predicted, in order to average out the noise or error. Meanwhile, the difference in the time durations of long-term and short-term should be comparable with the forecast time duration ahead, so as to reflect the market data in the forecasting.

Conclusions

The levels of freight rates are determined by the interaction of supply and demand. In the short run, supply is relatively fixed while demand can vary widely, depending on a lot of factors.

The probit model of spreads can usefully supplement large-scale macro-econometric models. Forecasting using the spreads has the distinct advantage of being quick and simple. With a glance at the 3-year and 3-month timecharter rates, the probability of rise and fall can be computed easily. This simple probit model can be further used to double-check both the large-scale model and expert judgments.

The experience of preparing this study has been really fruitful, meaningful and useful to the author. The analysis on the spread has provided more information about the "real" situation of the shipping industry. The spread of rates in the freight market does not fully represent the market directions. We cannot solely rely on the spread of freight rates to define how good or bad the market is. There are many other elements which can cause the shipping market to collapse at any given time. They can be weather related, as we saw with the weak market forces which caused many vessels in the Panamax and Capesize market to sit idle.

However, needless to say, there are still a lot of variables and changes every day. In contrast, risk is always associated with chances. The person who can do the right thing at the right time will be the winner. In fact no one can accurately predict what will happen, for example the nuclear power incident in Japan. Thus, when investors make decisions to invest in which segment of shipping, they should consider their long term company direction for future planning.

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