Identifying Shipowners' Risk Attitudes over Gains and Losses: Evidence from the Dry Bulk Freight Market

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Abstract

This study examines the risk-return trade-off in the dry bulk freight market under different scenarios such as risk measures, risk attitudes and controlling for variables associated with the freight rate cycle. For long-term contracts, there exists a negative association between risk and return, suggesting that shipowners are willing to offer a discount on time-charter rates over spot rates to compensate for the loss of flexibility. Additionally, shipowners are not uniformly risk averse, as finance theory suggests, since their utility functions are concave (risk-averse) for losses and convex (risk-seeking) for gains.

Keywords: Risk Preferences, Prospect Theory, Risk-Return Relationship, Dry-bulk Freight Market, Utility Functions;
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1. Introduction

An important problem that portfolio managers face on a daily basis is the ability to predict market returns in future periods and explain the nature of return variations. Sharpe (1964) and Lintner (1965) developed the Capital Asset Pricing Model (CAPM), an equilibrium model that determines asset returns in the financial world and implies that there is a positive relationship between risk and return. This positive relationship mainly arises from a risk-averse reasoning since investors require more volatile investments to pay higher returns and vice versa.

Although a negative risk and return trade-off is considered a paradoxical finding on the basis of financial theory, there is extensive evidence in the literature (Campbell, 1987; Nelson, 1991; Wu and Chiou, 2007; Huang and Hueng, 2008 and Bali et al, 2009 amongst other) supporting the existence of such a relationship. In many cases, a negative risk and return trade-off depends on the model specification used. Using time-varying volatility models for the conditional variance, Glosten et al (1993), Harvey (2001), Brandt and Kang (2004) and Bae et al (2007) find both a positive and negative relation, depending on the empirical model used.

Along the same lines, numerous studies in the shipping literature (Grammenos and Marcoulis, 1996; Kavussanos and Marcoulis, 2000a,b; Grammenos and Arkoulis, 2002; Kavussanos et al, 2003; Drobetz et al, 2010 amongst others) investigate how firm-specific, microeconomic and macroeconomic risk factors affect the risk and return relationship in the shipping industry. Motivated by the unique features of the shipping industry, we extend these studies and investigate the possibility of a negative risk-return profile through several dimensions and using multiple valuation models. The risk and return relationship is analyzed using multiple risk measures since various studies support the fact that the negative association between risk and return may be due to the choice of statistical model (Denrell, 2004; Ruefli, 1990; Ruefli and Wiggins, 1994) or the risk and return measures used (Baucus et al, 1993).

Additionally, this study attempts to examine whether the negative association between risk and returns may be explained by *Prospect Theory* (Tversky and Kahneman, 1992). The use of behavioral decision theory is driven by empirical evidence that participants in shipping markets are subject to behavioral biases. In particular, Greenwood and Hanson (2015) show that shipowners tend to over-invest in new capacity during booms due to being overconfident and incorrectly believing that investments will continue to reap high returns. They attribute this behavior partly to "competition neglect" by shipowners, which is caused by the construction lag in the shipbuilding process (Kalouptsidi, 2014).

Prospect theory supports the fact that decision makers become risk seekers or risk averse depending on whether their investment performance has been below or above a specific target level (Tversky and Kahneman, 1992). This means that the utility function is S-shaped and the expectation is that there is a negative risk-return association above target levels and a positive risk-return association below target-levels. This implies that during losses, investors appear to be risk-seekers but refrain from taking risks during gains.

However, shipping entrepreneurs have different risk preferences compared to a typical financial institution (Stopford, 2009); for instance, when markets anticipate a downturn (upturn), expectations are negative (positive) and owners prefer to operate their vessels under long-term (short-term) contracts, suggesting that they tend to be risk-averse (risk-seekers) during losses (gains). In other words, utility functions in the dry bulk freight market do not obey the risk attitudes conceptualized as per the prospect theory's utility function (i.e. concave for gains and convex for losses). The empirical utility functions (see Figure 1 and 2) and the risk and return relationship confirm that behavior. Multiple checks are performed to enhance the robustness of the empirical findings and establish that the risk-return relationship in this study remains intact and is not affected by the choice of risk measures, different sample periods, time lag effects, distribution of the freight series and controlling variables associated with the business cycle.

The contributions of this study can be divided into methodological and practical. In terms of methodological contributions, this study examines the nature of the risk and return relationship in dry-bulk physical shipping investments. The various volatility model specifications that we use, the inclusion of control variables and accounting for the period of the 2008 Financial Crisis, capture the time lag effects and the highly volatile nature of the freight markets and allow us to draw robust conclusions. Additionally, this study examines whether the observed relationship between risk and return can be explained by Prospect Theory (Tversky and Kahneman, 1979, 1992). The risk attitudes are assessed and reported on the basis of the loss-gain dichotomy meaning that any return greater than zero is considered a gain and any return below zero is considered a loss. We find that the utility function is not S-shaped and there is a negative risk-return association below target levels and a positive risk-return association above target-levels. The risk-return relationship is also dependent on the particular type of contract with longer period rates being less sensitive on the difference between gains and losses.

From a practical perspective, the findings also provide useful insights for making chartering decisions in the freight market under different market conditions. The ability to choose between freight contracts with different maturities offers flexibility to both ship-owners and charterers in terms of chartering strategies but at the same time introduces significant risks. Ideally, optimal chartering strategies should take these factors into consideration. The observed negative association between risk and return implies that shipowners that do not follow a diversified chartering strategy and operate exclusively using one type of contract (i.e. only spot or period contracts) are expected to have sub-optimal portfolios that might also lead to losses. Therefore, shipowners should assess the profitability of diversified chartering strategies that combine both short- and long-term contracts in order to transform the distribution of returns by minimizing the downside risk and enhancing the upside potential.

The rest of this study defines the conceptual model that assesses the nature of the shipping investments (Section 2). Following that, section 3 introduces and evaluates the data; Section 4 presents the empirical results whilst the final section concludes.

2. Methodology

The benchmark model investigates the relationship between risk and return by regressing the estimated measure of risk (VAR_{tij}) on the returns from the investment, R_{tij}, as follows:

$$R_{tij} = a + b_{ij}\mathrm{E}_{t-1ij}\left(VAR_{tij}\right) + \varepsilon_{tij} \qquad (1)$$

where R_{tij} represents the monthly returns of a type i vessel (where i = Capesize, Panamax) and freight rate *j* (where j = spot, 6-, 12- and 36-months period freight rates) at time *t*. The returns R_{tij}, are the continuously compounded logarithmic freight rate differences expressed as:

$$R_{tij} = lnFR_{tij} - lnFR_{(t-1)ij} \qquad (2)$$

Where $lnFR_{tij}$ denotes the natural logarithm of freight rate of a type i vessel at time t. Similar definitions of returns have also been used in numerous shipping studies (i.e. Cullinane, 1995; Berg-Andreassen, 1998; Adland and Strandenes, 2006; Alizadeh and Nomikos, 2007, 2009 and 2011 and Stopford, 2009). Similarly, VAR_{tij} captures the volatility of freight rate j for a type i vessel. Freight rates exhibit price characteristics similar to those of other commodity markets such as time-varying volatility, volatility clustering, seasonality, cyclicality and dependence on global commodity and financial markets. Considering the specifications of the volatility process, there is a need to examine whether the use of additional risk measures will affect the sign of the risk and return relationship. Therefore, in order to enhance the robustness of the empirical analysis, returns' volatility (VAR_{tij}) is assessed using the following risk measures (models):

1. Simple Variance Approach ($SVAR$) and Exponentially Weighted Moving Average Variance ($EWMAV$) models to investigate time-lag effects in volatility;
2. $GARCH$ model which addresses volatility clustering and serial dependence in volatility;
3. Exponential $GARCH$ ($EGARCH$) and Glosten et al (1993) $GARCH$ ($GJRGARCH$) model to account for the asymmetry in the impact of positive and negative shocks to volatility;
4. Integrated $GARCH$ ($IGARCH$) and asymmetric power $ARCH$ model ($APARCH$) models to handle the long memory processes of the freight rate series.

Each type of contract in the physical market requires a certain amount of time in order to be completed, which may affect the risk and return relationship. For instance, in the case of a 6-month period contract, if a charter decision is made at $t = 0$ then the next decision will be made at $t = 6$, $t = 12$, $t = 18$ months, …, etc. In other words, decisions can only be made at the maturity date of the contracts and the freight rate remains the same between $t = 0$ and $t + HP$ (where HP is the holding period of the contract). Estimating holding period returns would be appropriate if analyzing the freight market for a specific investor with a single vessel. However, since the purpose of this study is to assess the trade-off between risk and return at an aggregate level, returns (Eq. 2) are estimated for $h = 1m$. This means that a shipowner can only charter one vessel per month and then charters it out immediately resulting in the number of ships in the fleet being equal to the number of months required for the charter contract to be completed. Effectively, every month another vessel of the fleet is chartered under a spot, six-, twelve- or thirty-six-month contract. Therefore, we assess the distribution of the return series at an aggregate level for a large owner/operator.

Simple Variance Approach (SVAR) model

The Simple Variance Approach (SVAR), also known as a rolling window variance model, is one of the simplest ways to capture volatility clustering. The variance prediction function is an equally weighted sum of m past squared returns. A rolling window of 6, 12 and 36 months, ($m = 6, m = 12 \ and \ m = 36$) is used. It is clear that a high m will lead to a smooth σ_{t+1}^2 and a low m will generate a more volatile pattern of σ_{t+1}^2. The simple variance approach is the average of the squared returns and is defined as:

$$variance = \sigma_t^2 = \frac{1}{m-1} \sum_{i=t-m}^{t-1} (R_i - \mu)^2 \qquad (3)$$

The parameter m specifies the number of months included in the moving average, R_i is the return on day i, and μ is the mean of the return series. Following the recommendations of Hendricks (1996), μ is assumed to be zero.

Exponentially Weighted Moving Average Variance Model (EWMAV)

The Exponentially Weighted Moving Average Variance method (EWMAV), applies a non-uniform weighting to time series data and allows for more data to be used whilst weighting recent ones more heavily. As a result, EWMAV captures short-term movements in volatility. EWMAV is estimated using the following equation:

$$\sigma_t^2 = \lambda\sigma_t^2 + (1-\lambda)(R_t - \mu)^2 \qquad (4)$$

where λ is the volatility decay factor, set at 0.94, which is the most commonly used value in the literature. When small values of λ are used, recent observations have a larger impact on the variance estimation than when λ is closer to 1. As in the SVAR approach, μ is assumed to be zero.

GARCH(p, q) Model

The variance of returns over time is also estimated using a $GARCH\ (p,q)$ model, with p $GARCH$ coefficients associated with lagged variances and q $ARCH$ coefficients associated with past squared innovations. The $GARCH$ approach is suitable when a series exhibits volatility clustering and serial correlation suggesting that past variances might be predictive of the current variance (Bollerslev, 1986). Precisely, in the case of the $GARCH\ (p,q)$ model, the conditional variance is measured as follows:

$$\Delta lnFR_t = \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim N(0, h_t^2)$$

$$\text{where } h_t^2 = a_0 + \sum_{j=1}^{p} \beta_j h_{t-1}^2 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2 \qquad (5)$$

Where the specification of the conditional mean of $\Delta lnFR_t$, ε_t is a white noise error term with the usual classical properties and a conditional time varying variance process, h_t^2. AIC and BIC tests are used to determine the optimal values of p and q.

Exponential $GARCH(p,q)$ Model

The use of $EGARCH(p,q)$ model is appropriate when the impact of positive and negative shocks to volatility is asymmetric. The $EGARCH$ approach mathematically models the conditional variance process as follows:

$$\Delta lnFR_t = \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim N(0, logh_t^2)$$

$$\text{where } logh_t^2 = a_0 + \sum_{i=1}^{p} \gamma_i logh_{t-i}^2 + \sum_{j=1}^{q} a_j \left[\frac{|\varepsilon_{t-j}|}{h_{t-j}} - \mathrm{E}\left\{\frac{|\varepsilon_{t-j}|}{h_{t-j}}\right\}\right] + \sum_{j=1}^{q} \xi_j \left(\frac{\varepsilon_{t-j}}{h_{t-j}}\right) \qquad (6)$$

where γ_i is the GARCH component coefficient, a_j is the ARCH coefficient and ξ_j is the leverage coefficient.

$GJRGARCH(p,q)$ Model

The Glosten, Jagannathan and Runkle (1993) GARCH –$GJRGARCH$ model can be used when negative shocks have a stronger impact on volatility compared to positive shocks (Tsay, 2010). The model posits that the current conditional variance is the sum of past conditional variances, past squared innovations and past squared negative residuals. The mathematical formulation for the $GJRGARCH$ is defined as:

$$\Delta lnFR_t = \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim N(0, h_t^2) \qquad (7)$$

where $h_t^2 = a_0 + \sum_{i=1}^{p} \gamma_i h_{t-i}^2 + \sum_{j=1}^{q} a_j \, \varepsilon_{t-j}^2 + \sum_{j=1}^{q} \xi_j \, I\big[\varepsilon_{t-j} < 0\big]\varepsilon_{t-j}^2$

where a_0 is the conditional variance model constant, γ_i is the GARCH coefficient, a_j is the ARCH coefficient and ξ_j is the leverage coefficient.

IGARCH and APARCH Models

The integrated GARCH (IGARCH) and the asymmetric power ARCH (APARCH) models can handle the presence of a unit root in the autoregressive dynamics of squared residuals and long-term memory (Ding et al, 1993). Given the conditional time varying variance process $\boldsymbol{h_t^2}$ from the GARCH model, where $\boldsymbol{h_t^2 = a_0 + \sum_{j=1}^{p} \beta_j h_{t-1}^2 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2}$, it is assumed that α + β = 1 and the IGARCH(1,1) model takes the following form:

$$h_t^2 = \omega \; + (1-a)h_{t-1}^2 + a\varepsilon_{t-1}^2 \tag{8}$$

An example of the IGARCH model is the EWMAV model. In this case the values of the ARCH and GARCH parameters are fixed as follows: $\beta = \lambda, a = 1 - \lambda$ and $\omega = 0$.

$$h_t^2 = \; \lambda h_{t-1}^2 + (1-\lambda)\varepsilon_{t-1}^2 \tag{9}$$

The $APARCH$ model can express fat tails, excess kurtosis and leverage effects (Ding et al (1993)). The model implies that the current conditional variance is the sum of past conditional variances and past innovation differences. The mathematical formulation for the $APARCH$ is the following:

$$\Delta lnFR_t = \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim N(0, h_t^2) \tag{10}$$

where $h_t^2 = a_0 + \sum_{i=1}^{p} \gamma_i h_{t-i}^2 + \sum_{j=1}^{q} a_j \left(\left|\varepsilon_{t-j}\right| - \xi_j \varepsilon_{t-j}\right)^{\delta}$

where a_0 is the conditional variance model constant, γ_i is the GARCH coefficient, a_j is the ARCH coefficient, ξ_j is the leverage coefficient and δ reflects the leverage effect. A positive ξ_j implies that negative information has a stronger impact on the freight rate volatility than positive information. [1]

2.1. Robustness Tests

The purpose of using multiple risk and return measures is to ensure that the relationship is robust regardless of the method and model used. $SVAR$ and $EWMA$ models investigate time-lag effects and capture the relationship between current freight rate changes and variations in the previous 6-, 12- and 36-months. Additionally, using different GARCH models overcomes the problem of identification that arises when mean and variance are calculated using the same variable and the variance is measured ex-post rather than ex-ante.

The sample period (i.e. from January 1990 to October 2019) also includes the period of the 2008 global financial crisis period. To account for this, as this event may have affected the risk-return relationship, we have included dummy variables for the intercept (i.e. $Crisis = 1$) and the slope ($Crisis \times VAR_{t-1ij}$) in equation (1).[2] Finally, all GARCH models have been estimated under the assumption of conditional normality; for robustness the GARCH models

[1] An additional candidate model for capturing the long-memory process in the return series is the Fractionally Integrated GARCH (FI-GARCH) model which has been applied in the tanker freight market by Gavriilidis et al (2018). However, we believe that this model will offer little incremental benefits over the models considered in this paper.

[2] We follow Albertijn, Bessler, and Drobetz (2011) and define as crisis period for shipping the period from August 2008 to February 2009. The coefficients are found to be jointly insignificant in the vast majority of cases, which implies that the crisis did not affect the risk-return relationship. These empirical findings are available from the authors upon request.

are also estimated using Student's-t and Generalized Error Distribution (GED), yet the empirical findings remain qualitatively similar.

Measuring the risk-return relation using equation (1) may be subject to model misspecification. More specifically, Campbell (1987) and Scruggs (1998) support that changes in the investment opportunity set are captured not only by the conditional variance but also by state variables which should be included in equation 1. State variables are a series of macroeconomic variables that proxy the freight rate fluctuations and are included in model in order to increase the testing power and identify areas of misspecification. The Real Economic Activity index (REA) (Kilian, 2009), OECD Industrial Production (IP) and newbuilding ship prices are also included as additional control variables.

2.2. The risk-return relationship under Prospect Theory

We examine whether the relationship between risk and return in shipping investments is associated with risk attitudes governed by Prospect Theory (Tversky and Kahneman, 1979, 1992). The theory supports that decision makers are risk seekers when performance has been below some target level and risk averse when performance has been above a certain point. In other words, the prospect theory argues that individuals use targets or reference points when evaluating risky choices. Furthermore, individuals are not uniformly risk averse but adopt a mixture of risk-seeking characteristics when their outcomes are below the target level and become risk-averse when their outcomes are above that level. In order to determine the investors' risk attitudes, Tversky and Kahneman (1992) proposed estimating the utility function of each outcome as follows:

$$u(x) = R^a \qquad if\ R \geq 0$$
$$u(x) = -\lambda(-R)^a \qquad if\ R < 0 \tag{11}$$

where u is the utility value function, with $R \geq 0$ denoting returns above the target level, which in turn is zero. Parameter a measures the curvature of the value function and λ represents the loss aversion parameter. A value of $a < 1$ implies that individuals are risk averse over gains and risk seeking over losses, while $\lambda > 1$ implies that individuals are loss averse.

In their original paper, Tversky and Kahneman (1992) estimate the curvature parameter, a, to be equal to 0.88 and the loss aversion parameter, λ, to be 2.25, by collecting primary data through surveys. Replicating this for shipping is beyond the scope of this paper which is why we follow the alternative approach of testing whether the empirical risk and return relation in shipping follows the risk averse and risk-seeking behavior under different target return levels as conceptualized in the prospect theory's utility function. Alpha (a) is a curvature parameter while $\lambda > 0$ represents the loss aversion parameter that measures the relative sensitivity to gains versus losses. Values of $\lambda > 1$ ($i.e.\ \lambda \in [1{,}3]$) imply a higher sensitivity to losses compared to gains (loss aversion). Values of $0 < \lambda < 1$ suggest a higher affinity to gains (gain seekingness), however this is not assessed in this study since Abdellaoui et al (2007) and von Gaudecker et al (2011) find that only a small proportion of individuals exhibit gain seekingness.

There is no general rule that defines the appropriate target level for each situation although Tversky and Kahneman (1979) drew a close analogy between a target return level and a reference point. For instance, Lev (1969) suggests that firms adjust their performance to the industry average and Frecka and Lee (1983) demonstrate that firms dynamically adjust financial ratios to targets that appear to be industry-wide averages. In the finance literature, forward- and backward-looking models have been proposed as the reference point. In the forward-looking models, the reference point relates to the expectation of future outcomes (Koszegi and Rabin, 2006, 2007, and 2009). However, the plausibility of such forward looking models in finance is unclear given the high degree of uncertainty in financial markets. The backward-looking reference point models are motivated by experimental evidence that prior outcomes affect individuals' subsequent risk taking (Thaler and Johnson, 1990; Gertner, 1993). As suggested by Barberis et al (2001), the gain/loss utility that an investor derives from asset returns depends on a measure of his historical investment performance which is assumed to adapt sluggishly to his past gains/losses.

This paper assesses and reports risk attitudes on the basis of the loss-gain dichotomy meaning that any return greater than zero is considered a gain and any return below zero is considered a loss. At the same time, we investigate whether historical returns obey the risk averse and risk-seeking behavior conceptualized in the prospect theory's utility function.[3] A risk-averse behavior is expected when the market is turning downwards (i.e. loss) because a long-term contract guarantees a fixed income for a predetermined period and minimizes the risk of having vessels chartered in low freight rates. On the other hand, when the market is turning upwards (i.e. gains) shipowners want to take advantage of the rising freight market and operate their vessels under spot contracts. Therefore, it is expected that shipowners' preferences will not support prospect theory preferences.

3. Data Description and Preliminary Empirical Analysis

The empirical analysis is conducted for the Capesize and Panamax dry bulk sectors. The data consists of monthly averages of spot earnings as well as six-month, one-year and

[3] For robustness, a reference point that is equal to historical average returns is also considered. We find no significant differences in the utility functions based on the two different reference points.

three-year period charter rates, from January 1990 to October 2019, resulting in a sample of 358 monthly observations. Spot rates are calculated as the Time-Charter Equivalent (TCE) of individual voyage rates and are expressed in US $/day. Data are provided from Clarksons Shipping Intelligence Network.

Table 1 presents descriptive statistics of the return series for a Capesize (Panel A) and Panamax (Panel B) vessel for a large diversified fleet. The descriptive statistics across contracts of different duration are estimated for two separate sample periods:

1. The *full* sample for the period from January 1990 to October 2019 (Panel Ai and Panel Bi)
2. The *no crisis* sample, that is the full sample after excluding the period of the shipping crisis from August 2008 to February 2009 (Panel Aii and Panel Bii)

The distribution of the return series in the full sample for the different vessels and contract durations used are leptokurtic and negatively skewed. The negative skewness in annualized returns in the full sample is also consistent with the lower returns compared to the ones in the no crisis sample; the latter also reflects the strong rally in freight rates in the period up to the financial crisis.

It is observed that the volatility of the freight rates returns is downward sloping which is consistent with the view that short-maturity contracts are more volatile compared to long-maturity contracts (Kavussanos, 1996a,b and Kavussanos and Alizadeh, 2001, 2002). Similarly, Capesize vessels are more volatile than Panamax vessels across all contract maturities and samples. This can be explained by the fact that smaller vessels are more versatile in terms of the number of commodities they can carry, as well as being subject to fewer geographical restrictions and therefore, have better employment opportunities when freight markets are depressed. A larger vessel (i.e. Capesize) offers greater economies of scale but, at the same time, fewer ports can accommodate her large size whilst the type of commodities that can be transported is also limited. Finally, as can be seen from the ADF test (Dickey and Fuller, 1981), all return series appear to be stationary at a 5% significance level.

4. Empirical Results

This section presents the empirical results of the risk-return relationship. Having demonstrated that returns are stationary, heteroscedastic[4] and serially correlated, equation 1 is estimated using Ordinary Least Squares with Newey and West (1987) standard errors. The regression coefficients measure the sensitivity of freight rate returns to changes in the level of risk. A negative coefficient implies that there is a negative relationship between risk and return. In other words, as the risk in the freight market increases, the expected change in freight rates is negative.

Tables 2 and 3 report the results from equation 1 for a Capesize and a Panamax vessel respectively. Each table reports the $AR(1)$ coefficient b from equation 1 for all possible combinations of return and risk measures. Coefficients in green (red) are negative (positive) and statistically significant. Coefficients in bold indicate a 5% significance level whilst in all other instances, the significance level is 10%. Looking at Tables 2 and 3, the risk-return relationship appears to become more negative when moving away from the spot market and considering longer-dated contracts. Additionally, the risk and return relationship remains negative for the long-term contracts under the majority of risk measures used to assess this relationship. This indicates that as the duration of the contract increases, shipowners require a discount to compensate for the loss of flexibility in the time-charter market. In addition, long-

[4] The ARCH test values are not reported but are available from the authors upon request.

term contracts (e.g. P36m) are more sensitive to changes in volatility compared to short-term contracts (e.g. P6m). Long-term contracts imply loss of flexibility that results in a negative association between risk and return. In other words, the sign and magnitude of these relationships allows the assessment of the loss of flexibility.

These empirical findings support the existence of a paradoxical relationship that contradicts the CAPM theory. Nevertheless, a negative association between risk and return seems logical for investments in a highly volatile shipping market where ship-owners need to commit to long-term contracts. The risk-return relationship is expected to be positive at an aggregate level however, when returns are estimated using longer time lags, the relationship becomes negative. This is mainly due to the construction lags and the time required for a contract to be executed, in combination with the volatile shipping cycles which all affect the risk-return relationship. A long-term contract guarantees a fixed freight rate for a predetermined period and minimizes both the risk of not finding a new contract for the vessel when the current one expires and the potential decrease in freight rates by the time the next contract commences. As a result, shipowners are willing to accept a discount in time-charter rates over spot rates (Kavussanos and Alizadeh, 2002).

The risk-return relation using equation (1) may be subject to model misspecification. For that, we include additional state variables in equation (1) as proxies for market conditions in shipping markets in order to increase the testing power and identify areas of misspecification (Campbell, 1987 and Scruggs, 1998). The Real Economic Activity index (Kilian, 2009) and OECD Industrial Production (IP) are incorporated as control variables as they are widely accepted as being indicators of market conditions and economic activity, respectively. Additionally, newbuilding ship prices are also incorporated into the model as a third control variable since they reflect the current state of the shipping market. At the same time, ship prices are also affected by factors such as shipyard capacity, construction lags as well as willingness of investors to commit to shipping investments meaning that they capture the level of optimism or pessimism of the current market environment.

Tables 4 to 5 present the AR(1) slope coefficient *b* calculated using equation 1 for all combinations of return and risk measures after controlling for the aforementioned macroeconomic variables. Coefficients in green (red) are negative (positive) and statistically significant. Coefficients in bold indicate a 5% significance level whilst in all other instances, the significance level is 10%. It is observed that, when including control variables in equation (1), the magnitude and significance of some of the estimated coefficients is reduced especially for the spot and six-month period rates. Nevertheless, the risk and return relationship remains significant and negative for longer-dated contracts, consistent with the results presented in Tables 2 and 3.

Having identified that the relationship between risk and return is negative for longer dated contracts, it is interesting to see how that can be translated into risk preferences for the shipowners, using value functions. There are only a few studies that investigate risk preferences or risk attitudes in the shipping industry. Norman (1971) attempted to estimate risk preferences from market data whilst Lorange and Norman (1971) examined risk preferences in the Norwegian tanker industry. They assumed that Norwegian shipowners acted in accordance with the von Neumann-Morgenstern (1953) axioms in terms of choice under uncertainty and took under consideration capital market imperfections by specifying different liquidity positions. They suggested that risk preferences fall into three distinct groups: (1) shipowners are risk seekers under the assumption of good liquidity but are risk averse when faced with liquidity constraints; (2) shipowners are risk neutral when market liquidity is good and become risk averse under conditions of weak liquidity; (3) risk preferences are linked to a series of business policy parameters, such as: distribution of fleet across trades rate of expansion in various trades, age and size distribution of the fleet and chartering policy.

The utility function conceptualized in prospect theory is S-shaped and the expectation is that there is a negative risk-return association above target levels and a positive risk-return association below target-levels. Positive risk-return association implies that during losses investors are acting as risk-seekers which means that as their gains (returns) decrease, they are willing to take more risks. Correspondingly, negative risk-return association above target levels, implies that investors are risk averse when their gains increase. In other words, the utility function is convex above target levels and concave below target levels.

However, shipping entrepreneurs' behavior when it comes to risk differs compared to that of a typical financial institution (Stopford, 2009). For instance, when market conditions are poor, they tend to operate their vessels under long-term contracts, indicating that they tend to be risk-averse during losses. Similarly, in good market conditions, there is a preference for spot contracts meaning that there is a risk seeking tendency during gains. As can be seen from Table 1, long term contracts are less volatile compared to short-term ones. Therefore, long-term (short-term) contracts can be considered to be an option usually preferred by risk averse (risk-seeker) investors. Additionally, a risk-averse behavior is expected in a weak market because a long-term contract guarantees a fixed income for a predetermined period and minimizes the risk of having vessels chartered at low freight rates. On the other hand, when market conditions are good shipowners prefer to take advantage of the rising freight market therefore, they operate their vessels under spot contracts.

Figures 1 and 2 present the utility functions for Capesize and Panamax vessels. The curvature parameter, α, ranges from 0.5 to 1 and the loss aversion parameter, λ, is varies from

1 to 3. Utility functions in the dry bulk freight market are concave and convex during losses and gains respectively, indicating that shipowners are risk-averse during losses and risk-seekers during gains. This is the opposite from the risk attitudes conceptualized by the prospect theory's utility function; i.e. concave for gains and convex for losses.

Figure 3 presents the utility functions for a Capesize and Panamax vessel for the upper, median and lower bound values of curvature, a , and loss aversion, λ. As the loss aversion parameter λ increases from 1 (solid line – see Figure 3) to 3 (dotted line – see Figure 3) the utility value functions become less concave, implying that shipowners are less risk-averse in losses. Additionally, as alpha increases from 0.5 (solid line) to 1 (dotted line), the utility value function above target returns become less convex, implying that shipowners are less risk-seekers in gains.

The utility functions are similar for spot and P6m contracts and for P12m and P36m contracts. Losses and gains appear to be greater for spot and P6m contracts compared to losses and gains for the 12- and 36-month contracts which explains why utilities are more concave for losses in the spot and P6m contracts. For instance, a Capesize (Panamax) spot utility function in gains is almost 2% (1%) while in losses, the spot utility function is approximately -5% (-4%). In the same gains region of the graph, the P36m utility function for a Capesize (Panamax) vessel is equal to 0.5% (0.3%), while when in the losses part, the P36m utility function is equal to -2% (-2%). Therefore, as contract duration increases, utility value follows a decreasing trend for both losses and gains. This can be seen for example by comparing the spot and 36 months contracts. In other words, the larger the loss, the more risk-averse a shipowner is, while, the greater the gain the more risk-seeker he becomes.

Additionally, it is observed that a Panamax vessel has lower losses and gains compared to a Capesize vessel. Smaller vessels are more versatile in terms of the commodities they can carry as well as being subject to fewer geographical restrictions and as such, when freight markets are depressed, they have better chartering prospects. Therefore, shipowners choose spot contracts in gains to maximize their utility whilst preferring period contracts to minimize their losses. For instance, it can be seen that the value of the P36m utility function is lower at losses compared to the value of the spot utility function. Therefore, by operating under a long-term contract in a weak market, the shipowner minimizes the potential loss. Similarly, in a strong freight market, shipowners tend to select spot contracts because they provide the highest utility compared to other alternatives.

As mentioned before, a negative risk-return association implies that during gains (losses) investors appear to be risk-seekers (risk-averse) which means that as gains increase (decrease) investors are (not) willing to take more risks. The risk and return regressions (see Tables 2 and 3) show that the coefficients become more negative when moving away from the spot market and considering longer-dated contracts, confirming the shape of the utility functions.

Shipowners decide on the duration of the charter contracts for their vessels, a decision that needs to balance risk and flexibility. The expected level of freight rates is the main driver for the selection of the optimal type of contract. For instance, shipowners need to mitigate the price risks resulting from operating in the freight market by taking into account the spot and period freight rate dynamics. In essence, a long-term contract guarantees a fixed freight rate for a predetermined period and minimizes the risk of having vessels chartered in low freight rates, however one cannot take advantage of an interim increase in freight rates during that period, therefore flexibility is low. On the other hand, a short-term contract has high flexibility which comes at the cost of higher risk.

The negative association between risk and return implies that shipowners that do not follow a diversified chartering strategy and operate exclusively using one type of contract (i.e. only spot or period contracts) are expected to have sub-optimal portfolios that might also lead to losses. Additionally, the negative risk and return relationship suggests that the opportunity cost of physical freight instruments should be taken into consideration when owners decide whether they should commit their vessels to short- or long-term contracts. Therefore, shipowners should assess the profitability of active chartering strategies that combine both short- and long-term contracts in order to transform the distribution of returns by minimizing the downside risk and enhancing the upside potential.

5. Conclusion

This paper investigates the relationship between risk and return in shipping markets over different time periods and risk attitudes using multiple risk and return measures. The empirical findings support the existence of a paradoxical relationship that contradicts the CAPM theory. Nevertheless, a negative association between risk and return seems logical for the highly volatile shipping market where ship-owners need to commit to long-term contracts. The risk-return relationship is expected to be positive at an aggregate level however, when returns are estimated using longer time lags, the relationship becomes negative due to the construction lags and the time required for a contract to be executed in combination with the volatile shipping cycles which all affect the risk- return relationship.

Long-term contracts provide a guaranteed fixed freight rate for a predetermined period and minimize the risk of having vessels chartered in low freight rates or not finding new contracts. As a result, shipowners are willing to offer a discount in time-charter rates over spot rates to compensate for the loss of flexibility. Additionally, given the unusual shipping risk-return profile this study investigates whether shipping investments obey risk attitudes conceptualized in the prospect theory's utility function which suggests that shipowners should be risk-averse in gains and risk seekers in losses. The empirical utility functions suggest that during losses, shipowners are risk averse whilst being risk-seekers during gains. This finding is consistent with the view that when the freight market is prosperous, the preference is to operate their vessels in the spot market (that offers higher return and higher risk) while when the market is in a downward trend, ship owners are inclined to sign period contracts (with lower returns yet also lower risk). This also confirms the view that shipping entrepreneurs have different risk preferences compared to the behavior indicated by traditional finance theory.

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Table 1: Descriptive Statistics

	Panel Ai: FULL Sample *from January 1990 to October 2019*				Panel Aii: NoCrisis Sample *controlling for the period from August 2008 to February 2009*			
Capesize	**spot**	**P6m**	**P12m**	**P36m**	**spot**	**P6m**	**P12m**	**P36m**
Ann Mean	0.130%	1.402%	0.422%	-0.222%	6.339%	7.898%	6.925%	5.585%
Ann StD	120.90%	68.09%	49.20%	36.69%	113.54%	57.60%	40.90%	27.59%
Sharpe Ratio	0.001	0.021	0.010	0.006	0.056	0.137	0.169	0.203
Skewness	-0.337	-0.870	-2.157	-3.344	-0.113	0.118	0.136	-0.125
Kurtosis	7.520	12.603	22.619	37.267	7.878	4.795	4.671	5.449
Min	-1.471	-1.451	-1.297	-1.111	-1.471	-0.624	-0.358	-0.304
Max	1.622	0.868	0.508	0.368	1.622	0.586	0.509	0.274
Q test	68.585	81.187	89.648	98.295	346.788	47.657	41.701	88.097
ADF test	-16.750	-14.312	-13.111	-12.128	81.339	60.454	45.636	60.940
Panamax	**Panel Bi: FULL Sample** *from January 1990 to October 2019*				**Panel Bii: NoCrisis Sample** *controlling for the period from August 2008 to February 2009*			
Ann Mean	0.788%	0.274%	0.117%	0.196%	6.648%	5.963%	6.278%	5.473%
Ann StD	63.40%	49.03%	39.50%	29.96%	55.92%	40.38%	33.48%	24.16%
Sharpe Ratio	0.012	0.008	0.010	0.005	0.119	0.148	0.188	0.227
Skewness	-0.591	-1.531	-1.778	-2.655	0.244	0.242	0.203	-0.106
Kurtosis	10.526	18.476	18.849	27.574	4.032	5.301	6.238	7.678
Min	-1.284	-1.195	-0.967	-0.823	-0.426	-0.448	-0.474	-0.389
Max	0.812	0.590	0.409	0.270	0.650	0.547	0.409	0.271
Q test	41.670	98.863	127.67	149.18	18.965	80.419	154.86	318.94
ADF test	-16.559	-12.908	-11.810	-11.669	34.425	43.880	67.230	79.009

Notes: Table 1 presents the descriptive statistics of the freight rates returns with different maturities for Capesize and Panamax vessels from January 1990 to October 2019 (Panel Ai and Bi) and for the same period after excluding the period for the financial crisis period from August 2008 to February 2009 (Panel Aii and Bii). The *Ann Mean* is the annualized average of each return series and *Ann StD* is the annualized standard deviation. *Sharpe Ratio* ($SR = \frac{[R-R_f]}{\sigma}$) provides the excess return per unit of deviation in each series, R_f is assumed to be zero. *Skewness* and *kurtosis* are the centralized third and fourth moments of the data. The *Ljung-Box* (1978) Q-*test* examines the autocorrelation of the series and the ADF is the Augmented Dickey and Fuller (1981) test that examines whether a series has a unit root. The critical values for LBQ and ADF tests are 31.41 and -1.94, respectively.

Table 2: Capesize regressions for spot, P6m, P12m & P36m returns vs the risk measures

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Panel A: SPOT											
Beta	0.021	0.054	0.047	0.068	-0.003	-0.047	0.147	0.173	0.193	-0.097	
p_{value}	0.796	0.580	0.607	0.581	0.975	0.772	0.253	0.111	0.085	0.340	
Panel B: P6m											
Beta	-0.058	-0.079	-0.039	-0.103	-0.097	-0.426	-0.165	**-0.412**	-0.179	**-0.185**	-0.217
p_{value}	0.539	0.577	0.708	0.547	0.469	0.126	0.205	0.003	0.144	0.008	0.135
Panel C: P12m											
Beta	**-0.240**	**-0.765**	-0.187	**-0.675**	-0.188	**-1.265**	**-0.376**	**-0.385**	**-0.301**	**-0.118**	**-0.388**
p_{value}	0.011	0.000	0.071	0.002	0.150	0.000	0.003	0.000	0.003	0.031	0.003
Panel D: P36m											
Beta	**-0.318**	**-0.957**	**-0.189**	**-0.763**	-0.198	**-1.643**	**-0.518**	**-0.532**	**-0.301**	-0.060	**-0.497**
p_{value}	0.000	0.000	0.031	0.000	0.066	0.000	0.000	0.000	0.000	0.130	0.000

Notes: Table 2 presents the estimated slope coefficient and its associated p-value of the *AR(1)* regression in equation (1) that assesses the risk and return relationship in the dry bulk freight market for a Capesize vessel for the period from January 1990 to October 2019, using Newey-West (1987) standard errors. Coefficients in green (red) are negative (positive) and statistically significant. The bold coefficients indicate a 5% significance level whilst in all other instances, the significance level is 10%. The blank cells are due to the fact that the GARCH for the return series did not converge and as a result the regression could not be estimated. Intercept (i.e. $Crisis = 1$) and slope dummies ($Crisis \times VAR_{t-1ij}$) for the period of the Financial Crisis (from August 2008 to February 2009) are jointly insignificant and hence not reported here.

Table 3: Panamax regressions for spot, P6m, P12m & P36m returns vs the risk measures

Panel A: SPOT

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	0.139	0.196	0.038	0.033	-0.051	-0.362	0.027	-0.156	-0.106	-0.106	0.336
p_{value}	0.201	0.314	0.751	0.881	0.743	0.298	0.919	0.548	0.561	0.713	0.295

Panel B: P6m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	-0.024	-0.202	-0.028	-0.214	-0.111	**-0.789**	**-0.610**	**-0.716**	**-0.578**	**-0.139**	**-0.508**
p_{value}	0.806	0.301	0.786	0.326	0.380	0.023	0.000	0.000	0.000	0.007	0.003

Panel C: P12m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	**-0.198**	**-1.094**	-0.121	**-0.736**	-0.163	**-1.353**	**-0.884**	**-1.312**	**-0.869**	**-0.124**	
p_{value}	0.047	0.000	0.239	0.012	0.180	0.002	0.000	0.000	0.000	0.009	

Panel D: P36m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	**-0.354**	**-1.789**	**-0.241**	**-1.589**	-0.185	**-1.928**	**-0.636**	**-1.966**	**-0.618**	**-0.166**	**-0.521**
p_{value}	0.000	0.000	0.009	0.000	0.083	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Table 3 presents the estimated slope coefficient and its associated p-value of the *AR(1)* regression in equation (1) that assesses the risk and return relationship in the dry bulk freight market for a Panamax vessel for the period from January 1990 to October 2019, using Newey-West (1987) standard errors. Coefficients in green (red) are negative (positive) and statistically significant. The bold coefficients indicate a 5% significance level whilst in all other instances, the significance level is 10%. The blank cells are due to the fact that the GARCH for the return series did not converge and as a result the regression could not be estimated. Intercept (i.e. $Crisis = 1$) and slope dummies ($Crisis \times VAR_{t-1ij}$) for the period of the Financial Crisis (from August 2008 to February 2009) are jointly insignificant and hence not reported here.

Table 4: Capesize regressions for spot, P6m, P12m & P36m returns vs the risk measures and control variables

Panel A: SPOT

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	-0.007	0.029	0.010	0.032	-0.085	-0.196	0.106	0.162	0.183	-0.138	
pvalue	0.934	0.785	0.916	0.807	0.463	0.263	0.445	0.169	0.137	0.194	

Panel B: P6m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	0.027	0.102	0.046	0.105	-0.011	-0.184	-0.041	**-0.340**	-0.071	**-0.147**	-0.088
pvalue	0.782	0.507	0.680	0.574	0.936	0.532	0.768	0.021	0.596	0.042	0.581

Panel C: P12m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	-0.068	**-0.474**	-0.002	-0.275	-0.001	**-0.776**	-0.233	**-0.296**	-0.179	-0.061	-0.226
pvalue	0.497	0.016	0.988	0.250	0.993	0.038	0.075	0.003	0.089	0.277	0.100

Panel D: P36m

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Beta	**-0.194**	**-0.753**	-0.054	-0.441	-0.068	**-1.285**	**-0.344**	**-0.440**	**-0.248**	-0.029	**-0.408**
pvalue	0.031	0.000	0.567	0.067	0.555	0.001	0.024	0.000	0.000	0.459	0.000

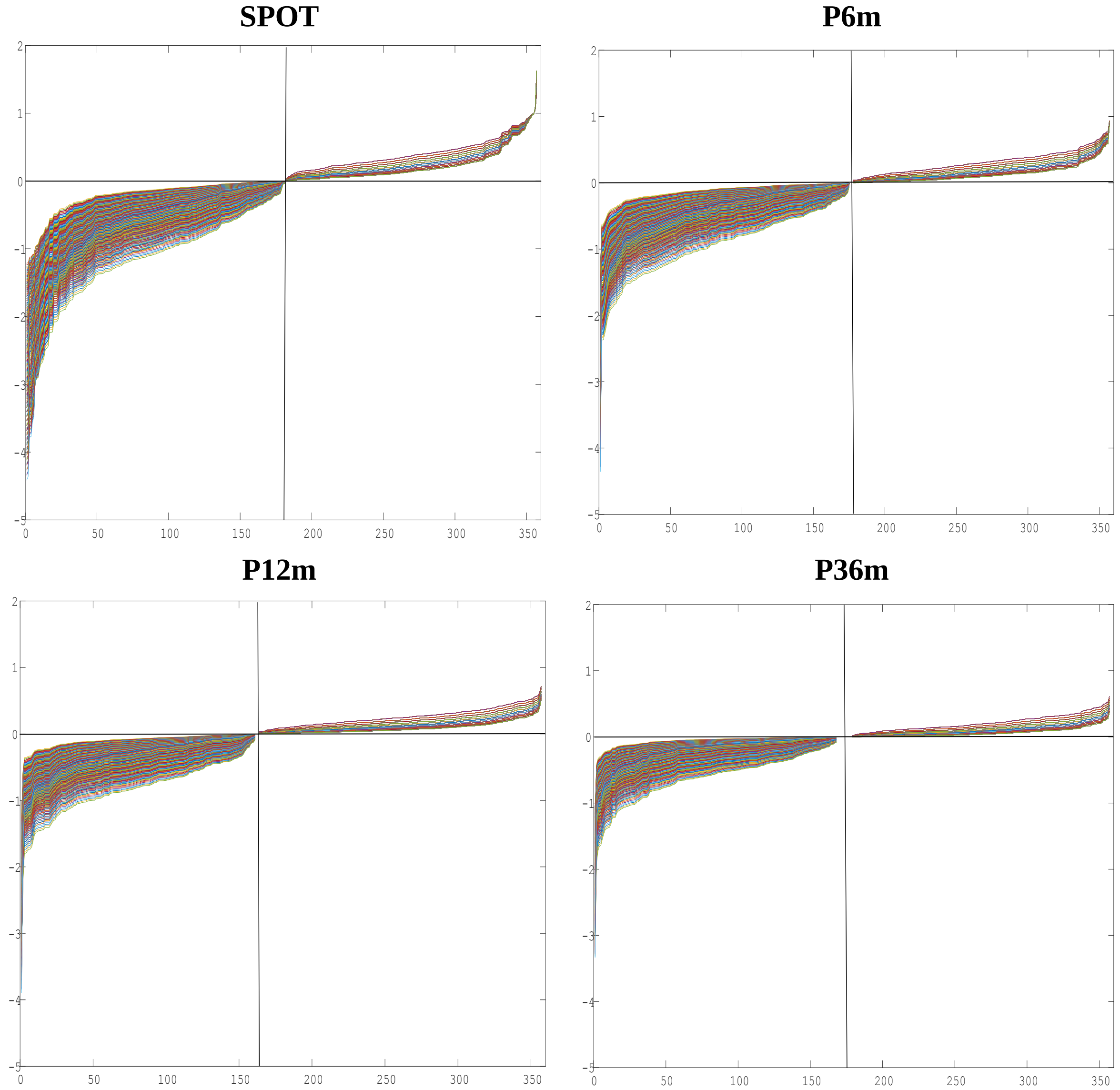
Notes: Table 4 presents the estimated slope coefficient and its associated p-value of the *AR(1)* regression in equation (1) that assesses the risk and return relationship in the dry bulk freight market for a Capesize vessel for the period from January 1990 to October 2019 after controlling for the following macroeconomic factors: REA Index (Kilian, 2009), OECD Industrial Production and Capesize Newbuilding prices. Coefficients in green (red) are negative (positive) and statistically significant. The bold coefficients indicate a 5% significance level whilst in all other instances, the significance level is 10%. The blank cells are due to the fact that the GARCH for the return series did not converge and as a result the regression could not be estimated. Intercept (i.e. $Crisis = 1$) and slope dummies ($Crisis \times VAR_{t-1ij}$) for the period of the Financial Crisis (from August 2008 to February 2009) are jointly insignificant and hence not reported here.

Table 5: Panamax regressions for spot, P6m, P12m & P36m returns vs the risk measures and control variables

	SVAR6	EWMAV6	SVAR12	EWMAV12	SVAR36	EWMAV36	GARCH	EGARCH	GJRGARCH	IGARCH	APARCH
Panel A: SPOT											
	SVAR6	**EWMAV6**	**SVAR12**	**EWMAV12**	**SVAR36**	**EWMAV36**	**GARCH**	**EGARCH**	**GJRGARCH**	**IGARCH**	**APARCH**
Beta	**0.284**	**0.564**	0.186	0.408	0.102	0.107	0.468	0.291	0.236	0.036	**1.122**
pvalue	0.010	0.005	0.128	0.075	0.514	0.764	0.088	0.307	0.241	0.612	0.002
Panel B: P6m											
	SVAR6	**EWMAV6**	**SVAR12**	**EWMAV12**	**SVAR36**	**EWMAV36**	**GARCH**	**EGARCH**	**GJRGARCH**	**IGARCH**	**APARCH**
Beta	0.187	0.264	0.178	0.302	0.107	-0.088	**-0.391**	**-0.533**	**-0.440**	-0.085	-0.219
pvalue	0.066	0.209	0.088	0.189	0.411	0.814	0.025	0.001	0.001	0.095	0.245
Panel C: P12m											
	SVAR6	**EWMAV6**	**SVAR12**	**EWMAV12**	**SVAR36**	**EWMAV36**	**GARCH**	**EGARCH**	**GJRGARCH**	**IGARCH**	**APARCH**
Beta	0.045	-0.386	0.129	0.102	0.093	-0.315	**-0.555**	**-0.865**	**-0.572**	-0.067	
pvalue	0.662	0.177	0.228	0.743	0.470	0.506	0.004	0.000	0.000	0.143	
Panel D: P36m											
	SVAR6	**EWMAV6**	**SVAR12**	**EWMAV12**	**SVAR36**	**EWMAV36**	**GARCH**	**EGARCH**	**GJRGARCH**	**IGARCH**	**APARCH**
Beta	**-0.204**	**-1.341**	-0.059	**-0.915**	0.015	**-1.144**	**-0.374**	**-1.557**	**-0.363**	**-0.136**	**-0.312**
pvalue	0.040	0.000	0.568	0.016	0.903	0.036	0.016	0.000	0.014	0.000	0.011

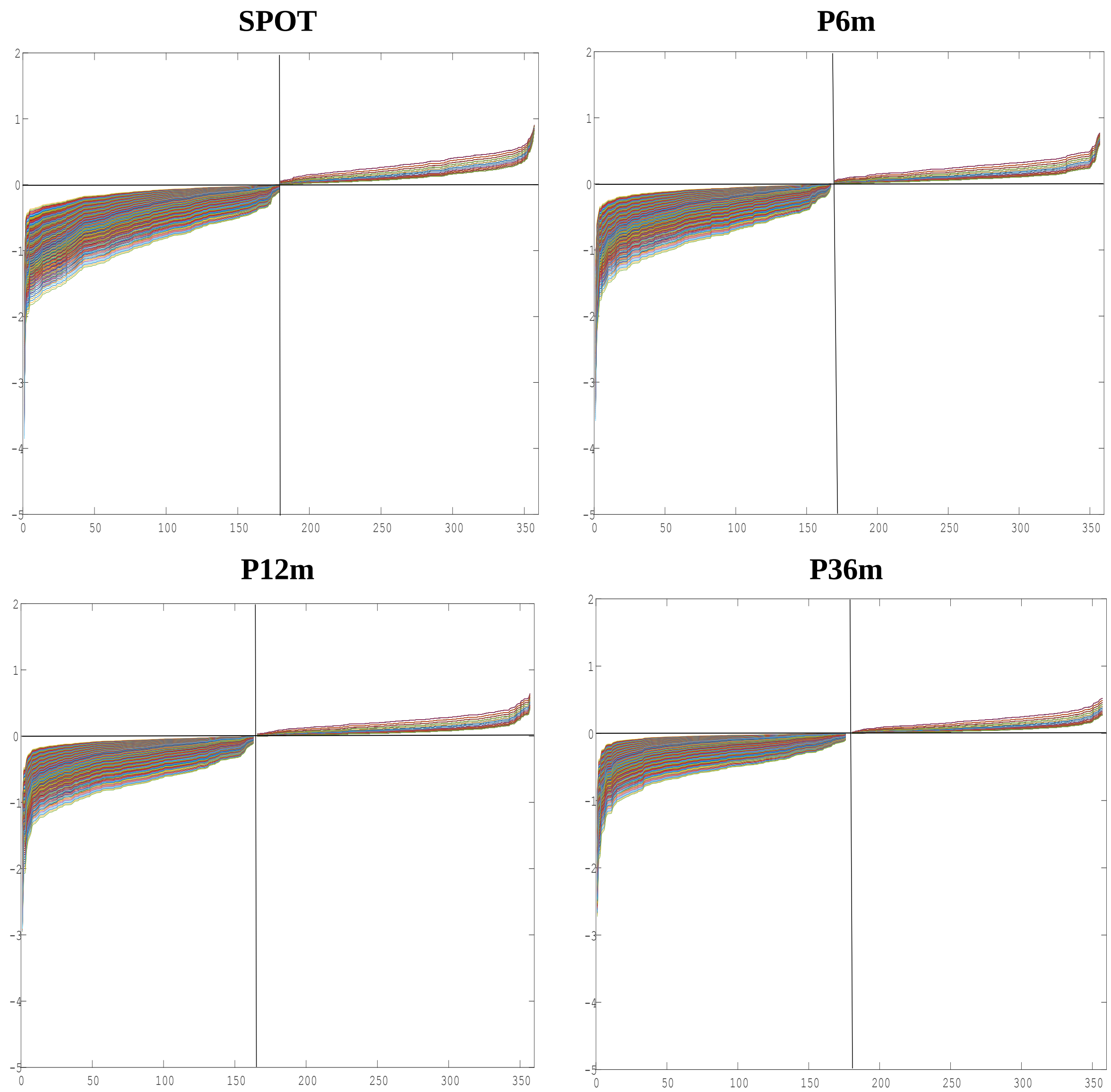
Notes: Table 5 presents the estimated slope coefficient and its associated p-value of the *AR(1)* regression in equation (1) that assesses the risk and return relationship in the dry bulk freight market for a Panamax vessel for the period from January 1990 to October 2019 after controlling for the following macroeconomic factors: REA Index (Kilian, 2009), OECD Industrial Production and Panamax Newbuilding prices. Coefficients in green (red) are negative (positive) and statistically significant. The bold coefficients indicate a 5% significance level whilst in all other instances, the significance level is 10%. The blank cells are due to the fact that the GARCH for the return series did not converge and as a result the regression could not be estimated. Intercept (i.e. $Crisis = 1$) and slope dummies ($Crisis \times VAR_{t-1ij}$) for the period of the Financial Crisis (from August 2008 to February 2009) are jointly insignificant and hence not reported here.

Figure 1: Capesize Utility Functions



Notes: Figure 1 presents the utility functions for the spot, P6m, P12m and P36m contracts for a Capesize vessel for the period between January 1990 to October 2019. The reference level is zero, the curvature parameter alpha is ranging from 0.5 to 1 and the loss aversion parameter lambda is ranging from 1 to 3.

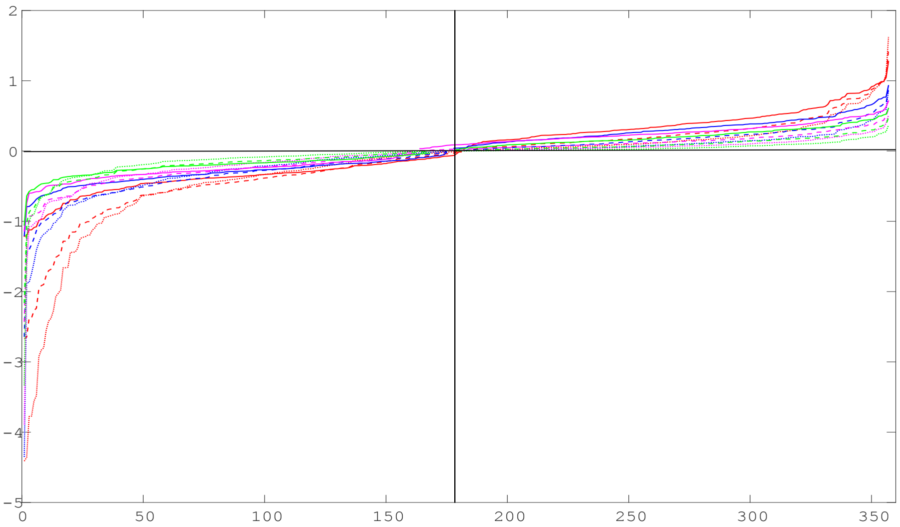
Figure 2: Panamax Utility Functions



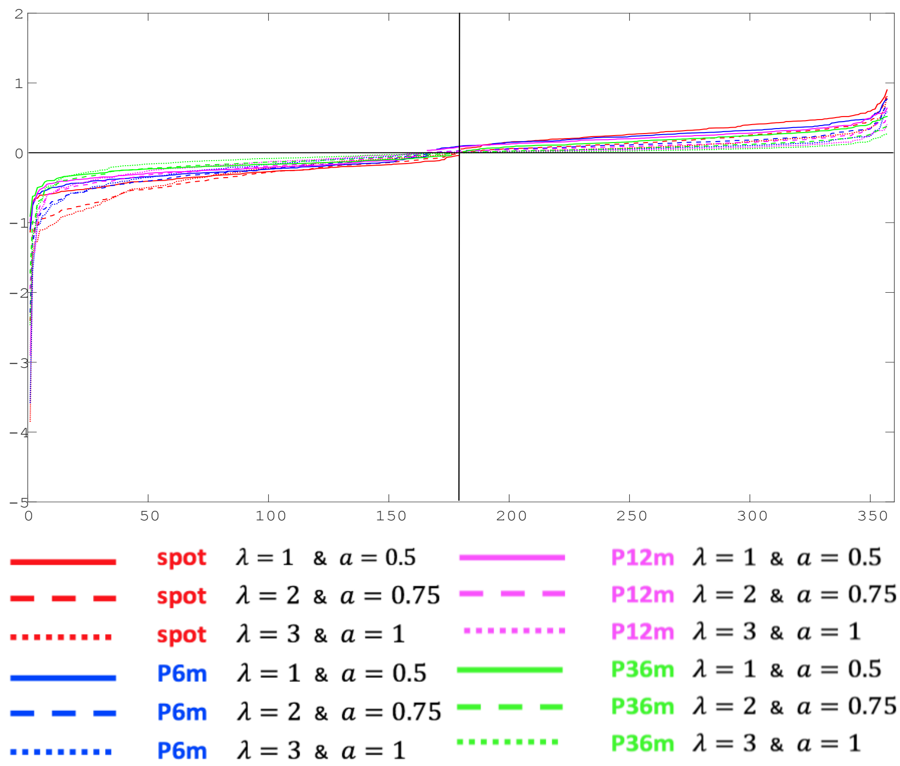
Notes: Figure 2 presents the utility functions for the spot, P6m, P12m and P36m contracts for a Panamax vessel for the period between January 1990 to October 2019. The reference level is zero, the curvature parameter alpha is ranging from 0.5 to 1 and the loss aversion parameter lambda is ranging from 1 to 3.

Figure 3: Utility functions of a Capesize and Panamax vessel for the lower, mean and upper value of α and λ

Panel A: Capesize



Panel B: Panamax



Notes: Figure 3 presents the spot, P6m, P12m and P36m utility functions for a Capesize and a Panamax vessel for the period from January 1990 to October 2019. The reference level is zero, while the parameter alpha and lambda are equal to the lower, mean and upper value of alpha and lambda.