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Abstract

The study examines the impact of liquidity risk on freight derivatives returns. The Amihud liquidity ratio and bid-ask spreads are utilized to assess the existence of liquidity risk in the freight derivatives market. Other macroeconomic variables are used to control for market risk. Results indicate that liquidity risk is priced and both liquidity measures have a significant role in determining freight derivatives returns. Consistent with expectations, both liquidity measures are found to have positive and significant effects on the returns of freight derivatives. The results have important implications for modeling freight derivatives, and consequently, for trading and risk management purposes.

Keywords: Forward Freight Agreements, Liquidity risk, Bid-ask spreads, Shipping, Panel data.

JEL Classification: G12, G13, G14, C23.

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1. Introduction

International shipping is an industry characterized by significant operational and commercial risks, with the latter occurring predominately from high volatility in freight rates and vessel prices as well as in operating and capital costs. These fluctuations in rates and costs subsequently affect the cash flows and profitability of the economic agents operating within the sector, including shipowners, ship-operators and charterers. As a result, shipping derivatives instruments, such as Forward Freight Agreements (FFAs), freight futures and freight options, have been developed and evolved over time to enable these agents involved in international shipping to manage risks that arise from fluctuations in freight rates (see Kavussanos and Nomikos, 1999; and Kavussanos and Visvikis, 2004) and vessel prices (Alizadeh and Nomikos, 2012).

To hedge against freight rate volatility and to diversify their asset base, participants in shipping markets began trading, through an international network of FFA brokers, Over-the-Counter (OTC) FFAs since 1992. An FFA is defined as a cash-settled contract between two counterparties to settle a freight rate for a specified quantity of cargo or hire rate type of vessel in one (or a basket) of the major shipping routes in the dry bulk, tanker and container shipping sectors at a certain date in the future. At the same time, freight rate derivatives give the opportunity to non-shipping related market participants to gain exposure to international maritime transportation and to the shipping freight markets as an asset class within their investment portfolios.[1] The underlying asset of the FFA contracts can be any of the routes (or basket of routes) that constitute the freight indices produced mainly by the Baltic Exchange or by other providers of freight market information.[2]

Following the growth in the freight derivatives market since mid-1990s, there has been a large body of literature on different aspects of freight derivatives, such as their dynamic behavior, hedging effectiveness, market microstructure and information content of these instruments for forecasting purposes. Kavussanos and Visvikis (2006b and 2008) provide thorough surveys of the available empirical studies on the freight derivatives market. For

[1] For a detailed discussion and analysis of the freight derivatives markets, see Kavussanos and Visvikis (2006a and 2011) and Alizadeh and Nomikos (2009).

[2] FFA contracts can be written on dry bulk routes of the Baltic Capesize index (BCI), the Baltic Panamax Index (BPI), the Baltic Supramax Index (BSI) and the Baltic Handysize Index (BHSI). Similarly, tanker FFAs can be written on routes of the Baltic Dirty Tanker Index (BDTI) to represent the dirty oil cargoes and of the Baltic Clean Tanker Index (BCTI) to represent the clean petroleum product cargoes. Finally, in the container sector the routes of the Shanghai Containerized Freight Index (SCFI), constructed by the Shanghai Shipping Exchange (SSE), and the routes of the World Container Index (WCI), which is a joint venture between Drewry Shipping Consultants and Cleartrade Exchange, are used as underlying assets of container freight derivatives.

example, Kavussanos and Visvikis (2011) provide market participants' different viewpoints for the uses of freight derivatives. Kavussanos and Visvikis (2004) examine the return and volatility interactions between spot and forward freight rates in the dry bulk sector. In another study, Batchelor *et al*. (2005) focus on the relationship between the bid-ask spread and the volatility of FFA prices and conclude that as bid-ask spread increases, indicating the rise of economic agent's uncertainty, the volatility of FFA prices eventually increases. Batchelor *et al*. (2007) reveal that the use of FFA prices together with spot freight rates in a multivariate dynamic model, improves the forecasting performance of spot freight rates. Tezuka *et al.* (2012) derive an equilibrium price model of spot and forward shipping freight markets, while Alizadeh (2013) investigates the interaction between trading volume and volatility of FFA prices. Finally, Kavussanos *et al*. (2014) investigate economic spillovers between the freight and commodity derivatives markets. However, despite the plethora of literature on freight derivatives, there has not been any investigation into the existence and importance of liquidity risks in FFA price changes.

In financial markets, the term liquidity is used to describe the extent to which investors are able to trade large quantities quickly, at low cost, and with little price impact. Similarly, liquidity risk refers to the uncertainty of having to trade large contracts with significant impact on prices, incurring high transaction costs or delays in transactions. The liquidity of the FFA market has always been an important issue to the market participants, as it is a relatively new market, still developing, with some unique characteristics. For instance, the introduction of clearing systems, electronic trading and the arrival of non-shipping participants as well as changes in the overall shipping market conditions have all resulted in the evolvement of the market to its current state. Therefore, this study attempts to extend the literature by investigating the role of liquidity risk and the existence of a relationship between liquidity measures and excess returns in the FFA derivatives market.

The contributions of this study are drawn upon three important viewpoints. First, the results provide important evidence of liquidity risks in an OTC derivatives market where the underlying asset is the non-storable ocean freight service. Following the seminal study by Amihud and Mendelson (1986), several studies in equity and fixed income markets have shown that assets with lower liquidity have lower prices and require higher expected returns. However, there are only a few studies that have examined the effect of liquidity on derivatives markets (see Brenner *et al*. 2001, Bongaerts *et al*. 2011 and Deuskar *et al*. 2011) and none, to the best of our knowledge, on shipping freight derivatives markets. In this study, a panel-estimation methodology is used to examine the effects of liquidity, as expressed by the Amihud illiquidity measure (Amihud, 2002) and the bid-ask spread on FFA excess returns after controlling for industry-specific and macroeconomic variables. Furthermore, a modified version of Fama-MacBeth two-step methodology is utilized to assess the liquidity effects along other risk factors on FFA excess returns. Second, the effect of liquidity on FFA prices is examined by testing whether liquidity measures can explain the difference between FFA prices and future settlement prices, or in other words, deviations from the Unbiasedness Hypothesis which postulates that a forward price should be an unbiased predictor of the realized price of the underlying asset at the settlement. Third, the investigation of liquidity risks in a continuously evolving freight derivatives market, where the underlying asset is the non-storable shipping freight service and with no active market makers, allows for direct comparisons with other well-developed commodity derivatives markets.[3]

Results indicate that both liquidity measures used in this investigation (a liquidity measure which incorporates trading volumes and the bid-ask spread measure) have a significant role in determining *near-month* dry bulk FFA returns and are in accordance with the liquidity theory and expectations. More specifically, the Amihud trading volume-related liquidity measure and the bid-ask spread measure are both found to be positive and statistically significant in explaining returns on FFA contracts, providing new evidence, for the first time, that market participants incorporate transaction costs in their required returns. For *near-quarter* FFA returns, in contrast, only the volume-related liquidity measure has a significant role.

Information on how illiquidity affects returns in freight derivatives markets is of primary interest not only to shipowners and charterers, but also to financial institutions, individual and institutional investors, traders and regulators alike. This is due to the fact that market liquidity influences the frequency of transactions and the level of tradable prices, and consequently, affects the overall portfolio performance. For instance, discovering any liquidity related component of FFA returns as well as information about the historical level of relative bid-ask spreads are essential for the process of pricing FFA returns, especially when the average level

[3] Szymanowska *et al*. (2014) provide evidence for the existence of liquidity-related premia in the futures commodities market.

of transaction costs could be as high as 2% of the trade notional amount. This is important not only for the shipping market participants, but also for other investors and financial institutions interested in diversifying their portfolios by using freight derivatives. The latter emerges from the fact that several major financial institutions, including banks and funds of different types, have already entered the FFA market as active participants, and consider it as an alternative investment market with diversification benefits.

In addition, information on the existence of liquidity risk in the FFA market is important for clearing houses and regulatory authorities. Clearing houses calculate the required margins for clearing FFA contracts, by considering the liquidity of the underlying asset. Although the main driver of initial margin levels is the volatility of the underlying asset, limited liquidity has also a significant impact on setting margin curves, due to the higher potential slippage effects and costs of closing contracts in the case of default. Low liquidity has an indirect effect on the freight rate volatility, as it implies larger price movements for relatively large orders and as such clearing houses may require a higher initial margin. Therefore, accurate information on the nature and behavior of liquidity is essential for setting margin curves, for the alteration of the available contract maturities or for any other features, such as the contract settlement process.

The rest of the study is organized as follows; Section 2 focuses on the previous literature relating to liquidity theories. Section 3 provides a detailed analysis of the main liquidity measures. Section 4 outlines the theoretical considerations and followed methodology. Section 5 presents the empirical results and discusses the findings. Finally, section 6 concludes the study.

2. Review of the Existing Literature

There is a growing strand of literature that examines the impact of liquidity risk on the price behavior and returns on different financial and commodity markets, as well as, the determinants of liquidity risk premia. Mikkelson and Partch (1985) argue that an increase in a security's liquidity leads to an increase in its price, due to lower transaction costs. Accordingly, Amihud and Mendelson (1986) suggest that the price of a financial asset incorporates the present value of its expected trading cost, which implies that a variation in the asset's liquidity should be reflected as a change in the liquidity premium, followed by an adjustment in the asset's equilibrium value.

In addition, market makers and traders in different markets constantly adjust the bid and ask prices for assets according to market conditions, including the levels of volatility and liquidity. Therefore, the bid-ask spread is considered as a form of transaction cost, which incorporates information on market liquidity and on the liquidity premium. Demsetz (1968) was the first to formalize the use of bid-ask spread as a trader's transaction cost. Later, Copeland and Galai (1983) highlight the use of bid-ask spread as indicative for liquidity and Bessembinder (1994) argues that spot and forward bid-ask spreads widen during times when net suppliers of foreign exchange have higher liquidity risk. More recently, Chordia *et al.* (2005) use the bid-ask spread to investigate liquidity in stock and bond markets.

In the equity market, various studies have been conducted to measure the effect of illiquidity on stock returns (Amihud, 2002) as well as the effect of certain events on stocks' liquidity measured by bid-ask spreads (Erwin and Miller 1998) and intraday trading volumes (Kappou *et al.* 2010), relating the Liquidity Cost Hypothesis to long-term price performance. Pastor and Stambaugh (2003) argue that illiquidity is systematic, as expected stock returns are cross-sectionally related to innovations in aggregate liquidity. Acharya and Pedersen (2005) find that investors should be concerned about the performance of a stock in market downturns and when liquidity decreases. Similarly, in the corporate bond pricing literature, Longstaff *et al.* (2005) and Chen *et al.* (2007) reveal that individual bond illiquidity is priced by the market and reflected in bond spreads. Acharya *et al.* (2013) study the exposure of the US corporate bond returns to liquidity shocks of stocks and Treasury bonds and suggest the existence of time-varying liquidity risk of corporate bond returns, conditional on episodes of flight to liquidity. Annaert *et al.* (2013) provide evidence of the existence of liquidity related risk premia for the Credit Default Swap (CDS) market. In another study, focusing on the pricing mechanism of derivatives contracts in the presence of liquidity risk, Bongaerts *et al.* (2011) argue that part of the CDS spread is due to liquidity factors. They report that the effect of liquidity on pricing CDS derivatives contracts can be a premium or a discount, depending on the heterogeneity in investor's non-traded risk exposure, risk aversion, hedge horizon and relative wealth of buyers and sellers.

Furthermore, Deuskar *et al*. (2011) point out that the liquidity premium in asset prices, as documented in the exchange-traded equity and bond markets, cannot be generalized to the OTC derivatives markets. In fact, examining the Euro interest rate options market, Deuskar *et al*. (2011) highlight that the effect of liquidity on prices or returns of derivatives contracts is not clear, since both the buyers and sellers are exposed to the illiquidity risks. They argue that it is not obvious whether marginal investors would take a long or a short position. This depends on their exposures and hedging needs, and hence, the prices of illiquid derivatives could be higher or lower than more liquid derivatives. In other words, in the derivatives market, the liquidity risk premia can be dependent on the aggregate trading needs of the market participants, which can have a negative or positive pressure on prices (see also Garleanu *et al*., 2009 for similar results). In one of the few maritime-related studies on liquidity, Panayides *et al*. (2013) examine the presence of liquidity risk premia in the US traded water freight transportation companies over the period 1960-2009. They report that in addition to the Fama-French Small Minus Big (SMB) and High Minus Low (HML) risk factors, the market-wide liquidity factor and the illiquidity risk premium are also significant in explaining returns on water transportation stocks.

In this study, the impact of liquidity on FFA excess returns is investigated using of a panel data estimation framework, with two-way clustered adjusted standard errors enabling robust statistical inferences (see Petersen 2009). Such an adjustment of standard errors has been shown to be important for obtaining unbiased estimations, when using panel data models in shipping applications (see Kavussanos and Tsouknidis, 2014). In addition, an alternative approach, which is based on a modified version of the Fama-MacBeth model, is also adapted to investigate the existence of the relationship between liquidity measures and FFA excess returns in the presence of other risk factors.[4] Finally, the role of liquidity in FFA price formation is examined by assessing whether liquidity measures can explain any deviation from the Unbiasedness Hypothesis in the FFA market, which is believed to link FFA prices to settlement prices (expected spot prices at maturity).

3. Liquidity Measures in the Freight Derivatives Market

The freight derivatives market has experienced significant developments in terms of electronic trading screens, settlement mechanisms and clearing processes over the last ten

[4] In the second step of this procedure, a panel data estimation framework is used with two-way clustered adjusted standard errors.

years. For instance, prior to 2007, the majority of the dry bulk FFA trading activity was taking place as OTC agreements, with cleared contracts representing less than 20% of the trades on average (for example, 12.5% of the trades in 2006).[5] Following the financial crisis of 2008, the percentage of cleared transactions reached 99.5% of the trades in 2014.[6] Figure 1 depicts this rapid change in investor's counterparty risk aversion with the rate of OTC trades relative to cleared transactions dropping from 42% in 2008 to less than 1% in 2014. In line with regulatory pressures (Dodd Frank Wall Street Reform and Consumer Protection Act in the US and European Markets Infrastructure Regulation – EMIR and Markets in Financial Instruments Directive – MiFID II in Europe) and participants' urge to eliminate counterparty exposure, almost all of the FFA trades are now cleared. In addition, with the introduction of the Baltic Exchange's trading screen (Baltex) in London, the Cleartrade Exchange in Singapore, and the Shanghai Shipping Freight Exchange (SSEFC), shipbroker quotes and trades are combined into electronic trading screens, providing better transparency and price discovery to market participants.

Although central clearing of FFAs has largely mitigated counterparty risk, liquidity risk is the most important risk that the market is still facing. Despite the use of electronic trading screens, participants believe that interaction with shipbrokers over the phone is essential, especially for processing larger or less standardized transactions. Since the premia paid for large trades depend on the prevailing market conditions, it is necessary for bid-ask spreads and trading volumes to be empirically examined in detail, to determine the market's depth and the extent to which the market can absorb large orders without any significant impact on prices.

Recent trading volume data from the Baltic Exchange reveal a remarkable growth in the number of traded dry bulk FFA contracts between the years 2003-2008, reaching a peak of 2.3 million lots in 2007 (see Alizadeh, 2013). These numbers indicate increased participation of not only shipping related participants, but also non-shipping related participants such as banks, hedge funds, trading houses and other financial institutions. The latter market participants entered the FFA market to diversify their dry bulk related commodity portfolios

[5] According to Baltic Exchange records.

[6] Freight derivatives are cleared in NASDAQ OMX Clearing (previously NOS Clearing), in Chicago Mercantile Exchange (CME), in LCH.Clearnet in London, in Singapore Exchange (SGX) AsiaClear, and in Shanghai Clearing House (SHCH). Furthermore, freight derivatives are also traded as futures contracts on organized derivatives markets (CME and ICE Futures Europe) and as options contracts (LCH.Clearnet, CME and ICE Futures Europe).

and to gain indirect exposure to global trade and maritime transportation. FFAs can provide an efficient way in accessing the shipping market as a whole, without facing the operational risks that emanate from the physical shipping business. Following the financial crisis of 2008, the volume of the dry bulk FFA market has been stabilized on over 1 million traded lots during the years 2009-2011.

The breakdown of trading volume for each of the four types of dry bulk vessels, also plotted in Figure 1, shows that Capesize and Panamax FFAs are the most liquid, whereas the volume of trade in Supramax and Handysize FFAs is low and negligible, respectively. The number of traded lots for Capesize and Panamax vessels is of a similar magnitude, with the speculators' trading activity most likely to be concentrated more on Capesize FFAs, due to the higher volatility of freight rates in this sector. Capesize vessels carry a relatively smaller variety of commodities (primarily iron ore and coal) and only a few ports around the world have the infrastructure to accommodate vessels of this size. Due to their higher capacity, Capesize freight rates have historically been the highest of all four dry bulk vessel-types (see Figure 2) and have experienced the highest levels of USD trading volume.

The bid-ask spread is typically considered the most important variable reflecting liquidity in financial and commodity markets (see Copeland and Galai, 1983 and Chordia *et al*., 2005, amongst others). Generally, bid and ask prices are posted by market makers, who are prepared to trade at these prices at any point in time, and constantly adjust them according to market conditions, volatility, liquidity and trading depth. Figure 3 presents the actual values of bid-ask spreads against their corresponding *near-quarter* FFA rates (both in USD terms) during 2008-2014 for Capesize, Panamax and Supramax vessels. It can be seen that the spreads experience important variations in line with market conditions, with the Supramax bid-ask spreads being the highest and most volatile through time. The relative bid-ask spreads also show a marginal decrease, which could be attributed to the improvements in central clearing, trading via electronic screens and a more transparent price discovery.[7] These implications are very important and will be discussed further in Section 5, where a thorough examination of liquidity risk, in the context of freight derivatives pricing, is presented.

[7] We would like to thank an anonymous reviewer for this observation.

4. Data and Methodology

This study uses FFA prices, bid-ask quotes, and trading volume for three types of dry bulk vessels as well as industry and macroeconomic specific factors to investigate the existence of a relationship between liquidity measures and *near-month* and *near-quarter* FFA returns.[8] Data are collected on a weekly basis, from November 2008 to September 2014, for Capesize, Panamax and Supramax types of vessels.[9] Furthermore, as the majority of FFA transactions have been cleared through clearing houses following the financial crisis of 2008, FFA prices in the sample have not been experiencing pressures due to counterparty default risk. The *near-month* sample comprises of 262[10] observations for each sector and 786 observations for the pooled sample, while the *near-quarter* sample comprises of 306 observations for each sector and 918 observations for the pooled sample. Handysize FFA contracts are excluded, due to their very limited trading activity and gaps in data. The FFA specific variables obtained from the Baltic Exchange are: (i) the Baltic Forward Assessments (*BFA*)[11], which are considered the most representative FFA prices as they include information from the most active FFA brokers and (ii) the FFA trading volumes (*V*), defined as the total number of traded lots for both cleared and OTC FFA contracts over each week for each type of dry bulk vessel.[12] Although the Baltic Exchange started reporting BFA prices for all four vessel-types in January 2005, it started reporting volume data on a weekly basis only from July 2007.[13]

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[8] The term *near-quarter* refers to the series of the nearest quarter FFA contract (for example, in November 2014, a *near- quarter* contract is Q1 2015; that is January, February and March of 2015). However, the *near-quarter* contract is rolled over to the next *near-quarter* contract at the end of the first month of the quarter. For instance, the Q1 2015 contract is rolled over to Q2 2015 on the last trading day of January 2015. This is because the *near-quarter* contract is traded as a "*quarterly contract*" until the last day of the first month of the quarter, when it breaks into two monthly contracts (e.g. February 2015 and March 2015), which are traded separately for the remaining days of the quarter. Similarly, the term *near-month* contract refers to the time series of prices for the monthly FFA contract for the *near-month* (for example, in November 2014, a *near-month* contract is December 2014). The continuous near-month contract is constructed by rolling over to the next *near-month* contract at the last trading day of the month preceding the settlement month. Given that most of the market's trading activity is concentrated within the nearest quarter, and the fact that bid-offer quotes are consistently reported for full quarter contracts where none of their months have settled, it is only practical and appropriate to use the *near-quarter* and *near-month* contracts in this analysis.

[9] A weekly frequency is chosen in order to match the Baltic Exchange's reporting schedule of dry bulk FFA trading volumes.

[10] The variable with the shortest available time series data for the near month sample are the FFA prices, starting on September 2009, and for the near quarter sample the bid-ask spreads, starting on November 2008.

[11] The BFAs are based on mid FFA prices provided by a panel of FFA brokers appointed by the Baltic Exchange. These panelists assess and report to the Baltic Exchange every business day their professional judgment of mid FFA market prices on each index publication day for the routes defined by the Baltic Exchange. Then, the Baltic Exchange reports the BFAs to the market by 17:30 (London time).

[12] One lot is defined as one hire day or 1,000 metric tonnes of transported cargo under time charter or voyage contracts, respectively.

[13] It is also important to note that the sample period does not include the period of the extreme market volatility environment that occurred when the Baltic Dry Index (BDI) reached its highest point of 11,793 index points in May 2008, followed by the Lehman Brothers collapse in September 2008, where it reached low historical levels

In any OTC market, there are active market makers who post their bid and offer quotes and are willing to trade at any point time, while there are brokers who facilitate the trades. However, in the FFA market, due to the absence of active market makers to post firm bid and offer quotes, transactions take place through a network of FFA brokers, who receive bid and ask quotes from both buyers and sellers (traders) throughout the day. This means that published bid and ask quotes by FFA brokers reflect actual transactions during the day. The bid and ask quotes for corresponding FFA contracts are collected from Clarkson's Shipbrokers Limited.[14] This is because not only Clarksons is one of the largest and most active brokers in the dry bulk FFA market, but also their quotes are available to the public via Bloomberg, which increases the transparency of the reported data.

It is well documented in the literature that the liquidity of an asset is linked to its trading activity and almost all of the studies on liquidly risk and asset pricing use the trading volume or a function of that as a proxy for market liquidity. For instance, Amihud (2002) proposes a liquidity measure that is computed as the annual average ratio of the absolute return over the trading volume. Therefore, the Amihud measure of liquidity is adapted in this study and the liquidity variable ($LIQ_{i,t}$) is defined for each vessel-type FFA contract *i* (Capesize, Panamax, Supramax) at time *t* as:

$$LIQ_{i,t} = \frac{1}{w_{i,Y}} \sum_{y=1}^{Y} \frac{|r_{i,t-y}|}{V_{i,t-y}} \tag{1}$$

where, $w_{i,y}$ is the number of trading weeks in window over which $LIQ_{i,t}$ is estimated (for example, 52 weeks), $|r_{i,t-y}|$ is the absolute return on FFA for vessel *i* on week *t-y*, $V_{i,t-y}$ is the volume of the FFA contract *i* traded on week *t-y*. For a given level of trading volume, the larger the absolute return of an FFA contract the more illiquid is the contract and as such the larger the illiquidity ratio. Equally, for a given level of absolute return, lower volume will result into a higher illiquidity ratio for an FFA contract.

(663 index points in December 2008). In particular, the BDI had already dropped by more than 90% before the beginning of the sample period, and therefore, the data are not affected by the extremities of the third quarter of 2008, which could be deemed as outliers.

[13] The use of a major shipbroker's bid-ask quotes ensures that the calculated relative bid-ask spreads are good representatives of the whole market.

Another measure of liquidity is the size of the bid-ask spread. This is because market makers adjust their bid-ask prices according to what they demand as compensation against lower liquidity and potential loss for not being able to execute transactions or close trading positions (see Demsetz, 1968, and Copeland and Galai, 1983, amongst others). As typically in the literature, the bid-ask spread of vessel *j* with maturity *t*, is calculated as the midpoint:

$$BAS_{j,t} = \frac{ask_{j,t} - bid_{j,t}}{(ask_{j,t} + bid_{j,t})/2} \tag{2}$$

where, $ask_{j,t}$ and $bid_{j,t}$ are ask and bid prices in US dollars for the freight rate of vessel *j* and maturity *t*, respectively. Thursday's BFA and BAS rates are matched with next Monday's total volume of FFA contracts.[15] This approach is followed for two reasons: First, the Monday's or Friday's values for the BFA and BAS variables are avoided due to potential *weekend effect*s (see French, 1980; Lakonishok and Levi, 1982, amongst others). Second, the Baltic Exchange reports the total volumes each Monday and they are referring to the total number of lots traded over the previous trading week.[16]

The industry specific and macroeconomic factors used to control for industry and economy-wide effects in the analysis include: (i) the Baltic Dry Index (BDI), which is a composite index, comprising of the Baltic Capesize, Panamax, Supramax and Handysize average time charter rates and reflects the general dry bulk freight market conditions; (ii) the historical volatility of the BDI (HVB), estimated as the standard deviation of first logarithmic differences computed with one-month rolling window; and (iii) the Standard & Poor's (S&P's) Goldman Sachs Commodities Index (GSCI), defined as a representative index for the returns attainable in the commodities markets.[17]

The existence and impact of liquidity risk on FFA excess returns is examined by estimating pooled cross-sectional time-series (panel) regressions considering the three dry bulk shipping

[15] Instead of calculating the weekly mean BAS, Thursday BAS are reported as the weekly value of the bid-ask spread, to avoid amplifying the fluctuation in the spread.

[16] Although volume data is available per vessel type, there is no breakdown of the trades for the individual FFA maturities and as such the total weekly volume per vessel type is used instead. As liquidity is generally concentrated towards the front part of the FFA forward curve, changes in total weekly volumes are good estimators in explaining FFA returns for the *near-month* and *near-quarter* contracts.

[17] According to S&P, the GSCI index is a composite index of commodity sector returns representing an unleveraged, long-only investment in commodity futures that is broadly diversified across the spectrum of commodities.

sectors. The use of a panel regression approach to test for the relationship between liquidity and FFA excess returns increases the efficiency of the estimation technique by pooling the time-series of all three types of vessels. Also panel data regressions are adopted in order to report unbiased estimated coefficients and standard errors.[18] Panel data estimation techniques take into account the unobserved heterogeneity, which refers to the possibility that any omitted explanatory variables may be relevant in explaining the observed variation in FFA prices:

$$r_{i,t} - r_{f,t} = a_i + a_t + \beta_1 LIQ_{i,t-1} + \beta_2 BAS_{i,t-1} + \beta_3 r_{BDI,t-1} + \beta_4 HVB_{t-1} + \beta_5 r_{GSCI,t-1} + u_{i,t} + v_{i,t} \ ; \quad u_{i,t}, v_{i,t} \sim iid(0, \Sigma) \quad (3)$$

where, i identifies the type of vessel (Capesize, Panamax or Supramax); t denotes the time period; $r_{i,t} - r_{f,t}$ is the excess return on FFA contract over the three-months US Treasury Bill for vessel i in week t; $LIQ_{i,t\text{-}1}$ and $BAS_{i,t\text{-}1}$ are the lagged Amihud and bid-ask spread liquidity measures, respectively; while, $r_{BDI,t\text{-}1}$, $HVB_{t\text{-}1}$ and $r_{GSCI,t\text{-}1}$ are the industry and macroeconomic specific variables as explained earlier; a_i is a vessel specific constant term to capture any unobserved heterogeneity among the different vessels; a_t is a time specific constant term to capture any unobserved heterogeneity over time; and $u_{i,t}$ and $v_{i,t}$ are vectors of white-noise error-terms, following a multivariate distribution with mean zero and variance-covariance matrix Σ. The explanatory variables introduced into this model are both time-varying vessel specific variables ($LIQ_{i,t\text{-}1}$ and $BAS_{i,t\text{-}1}$) and time-varying common variables ($r_{BDI,t\text{-}1}$, $HVB_{t\text{-}1}$ and $r_{GSCI,t\text{-}1}$).

In a fixed-effects model the constant term is vessel-variant (a_i) and $u_{i,t}$ represents the error-terms, while in a random-effects model the constant term is not vessel-variant (a) and $u_{i,t}$ and $v_{i,t}$ represent the error-terms, which stand for the between-vessels errors and for the within-vessels errors, respectively. The rationale for the random-effects model is that, in contrary to a fixed-effects model, the variation across FFA returns for each vessel is assumed to be random and uncorrelated with the dependent and independent variables included in the model. Since most of the variables are non-stationary in levels, Equation (3) is estimated in logarithmic first differences, which results into dropping the α_i term.

[18] The OLS estimation method imposes a number of assumptions for obtaining unbiased standard errors. One of these is that the residuals of the estimated model have to be independent and identically distributed (i.i.d.). However, when the residuals exhibit correlation across observations in the sample, which is quite often in a panel data sample, the OLS estimated coefficients and standard errors are biased.

Petersen (2009) argues that: (i) in the presence of a firm effect, standards errors are biased when estimated by OLS, White, Newey-West (modified for panel data sets), Fama-MacBeth or Fama-MacBeth corrected for first-order autocorrelation. In contrast, clustered standard errors by firm are unbiased, with correct confidence intervals, whether the firm effect is permanent or temporary in nature; also the fixed effects and random effects models generate unbiased standard errors when the firm effect is permanent; (ii) in the presence of a time effect, standard errors clustered by time also generate unbiased standard errors and correctly sized confidence intervals (similar to Fama-MacBeth, 1973); and (iii) in the presence of both a firm and time effect, standard errors clustered on both firm and time dimensions are unbiased and generate correctly sized confidence intervals, whether the firm effect is permanent or temporary.[19]

Furthermore, we also use a two-step methodology as described by Fama and MacBeth (1973) to investigate the liquidity effects on FFA excess return in the presence of macro and industry risk factors (see Ferson and Harvey, 1999, that accounts for asset pricing issues). In the first step, Equation (4) is estimated using an Ordinary Least Squares (OLS) regression for each vessel-type to obtain beta coefficients over a one-year (52 weeks) rolling window. Rolling betas (β) represent the sensitivity of FFA excess returns to industry and macroeconomic factors:

$$r_t - r_{f,t} = \alpha_i + \beta_{BDI} r_{BDI_{t-1}} + \beta_{HVB} HVB_{t-1} + \beta_{GSCI} r_{GSCI_{t-1}} + \varepsilon_t \quad ; \; \varepsilon_t \sim iid(0, \sigma_\varepsilon^2) \qquad (4)$$

where, r_t is the return on FFA contract in week t; $r_{f,t}$ is the three-months US Treasury Bill risk-free rate, $r_{BDI,t-1}$ is the lagged change in the BDI, HVB_{t-1} is the lagged historical volatility of the BDI, and $r_{GSCI,t-1}$ is the lagged change in the GSCI. In the second step, the estimated betas from Equation (4) are used to explain the excess returns of FFAs, in a similar approach to the second step of the Fama and MacBeth methodology. However, the second step cross-sectional regression of the original Fama-MacBeth framework cannot be applied here, due to the limited number of observations in the cross-section (three vessels). Typically, a cross-

[19] There are several other studies in the literature in favor of the panel data estimation framework. For example, Simpson and Grossmann (2014) report that panel data techniques in asset pricing allow for more efficient estimations, by increasing the number of observations and decreasing potential collinearity issues. Moreover, Asparouhova, *et al*. (2010) show that almost half of the estimate of the return liquidity premium, obtained in cross-sectional Fama-MacBeth regressions of returns on effective bid-ask spreads, is attributable to bias arising from microstructure noise; that is, from either a bid-ask bounce, non-synchronous trading or orders originating from uninformed traders. Also, studies focusing on the liquidity effects in the bond markets adopt the panel estimation framework (see Dick-Nielsen *et al*. 2012 and Fiewald *et al*. 2012, amongst others).

section of more than 30 assets is required to run the Fama-Macbeth second step regression. Thus, in this step a cross-sectional time-series (panel) regression is adopted to investigate the existence and the impact of liquidity in FFA excess returns for the three vessels.

$$r_{i,t} - r_{f,t} = \gamma_{0,i,t} + \gamma_1 LIQ_{i,t-1} + \gamma_2 BAS_{i,t-1} + \gamma_3 \beta_{BDI_{i,t-1}} + \gamma_4 \beta_{HVB_{i,t-1}} + \gamma_5 \beta_{GSCI_{i,t-1}} + u_{i,t} + v_{i,t} \ ; \quad u_{i,t}, v_{i,t} \sim iid(0, \Sigma) \quad (5)$$

where, i identifies the type of vessel, t denotes the time period, $r_{i,t} - r_{f,t}$ is the excess return on FFA contract for vessel i in week t, $LIQ_{i,t-1}$ is the lagged Amihud liquidity measure, $BAS_{i,t-1}$ is the lagged relative bid-ask spread of the FFA contract, and $\beta_{j,i,t-1}$ are the estimated risk coefficients for factors j (*BDI*, *HVB* and *GSCI*). Finally, $u_{i,t}$ and $v_{i,t}$ are vectors of white-noise error-terms, following a multivariate distribution with zero mean and variance-covariance matrix Σ. Significance of estimated coefficients γ_1 and γ_2 in the above panel regression indicates the existence of an impact of liquidity measures on FFA excess returns.

In all above panel regression estimations, in order to select between the fixed-effects and random-effects empirical models, the Hausman (1978) test is used, having under the null hypothesis that the unique errors are not correlated with the regressors; that is, a random-effects estimator is more efficient versus the alternative of a fixed-effects estimator (see Greene, 2012). Next, the selected fixed-effects or random-effects model is tested against a pooled OLS model, which does not account for unobserved heterogeneity. For instance, if a fixed-effects specification is favored by the Hausman test, then an *F*-test is conducted to test the null hypothesis that all the fixed-vessel terms introduced into a fixed-effects model, are equal to zero. Another *F*-test is used to test for the existence of a fixed-time effect in the data versus a pooled OLS one, with the null hypothesis favoring the pooled OLS model.[20] In cases where a random-effects model is selected by the Hausman test, then the Breusch and Pagan (1980) BP Lagrange Multiplier (LM) test is followed to test a random-effects model superiority versus a pooled OLS one (for more details, see Wooldridge, 2002). Petersen (2009) shows that estimating unbiased standard errors in a panel data regression setting requires the estimation of two-way cluster adjusted standard errors. All variables in Equations (3) and (5) and their definitions are presented in Table 1.

[20] A fixed-time effects model can be estimated by introducing time dummies.

Table 2a presents the descriptive statistics for each of the variables used in the analysis. When looking at the BFA returns per vessel type, it is shown that the standard deviation of returns depends positively on vessel size (both for *near-month* and *near-quarter* contracts). As expected, Capesize vessels have the highest standard deviation, while Supramax vessels have the lowest. This is also consistent with the number of available vessels in each sector; that is, Capesize vessels, although they are the largest in terms of capacity, they comprise the lowest percentage of global dry bulk fleet. Regarding relative bid-ask spreads, which can be seen as the average cost of completing a transaction, it is shown that Capesize vessels have on average the highest level in the *near-month* contracts. In particular, they have a mean value of 2.602%, relative to 2.064% and 2.051% for Panamax and Supramax vessels, respectively. In the case of the *near-quarter* FFA contracts, the mean values of bid-ask spreads for Capesize and Supramax vessels are very similar (1.805% for Capesize and 1.815% for Supramax), whereas Panamax vessels have on average lower spreads (with a mean value of 1.573%). Overall and in line with expectations, liquidity, as expressed by the width of the average bid-ask spread, is better for the *near-quarter* contract across all vessels. The Jarque-Bera (1980) normality test indicates departures from normality in most of the cases for all variables. Finally, the Philips and Perron (1990) unit root test indicates that all variables are stationary. Table 2b presents the descriptive statistics of the variables in a panel form, including also the Levin *et al*. (2002) and Im *et al*. (2003) panel data unit root tests. It can be seen that the *near-month* and *near-quarter* BFA variables are non-stationary in levels, but stationary in first-differences, while all other variables are found stationary in their level representation. Table 2c reports the descriptive statistics of the estimated betas (β), while Tables 3a and 3b present the correlation coefficients matrix of the variables used in Equations (3) and (5) respectively, indicating no evidence of multicollinearity, with relatively low correlations between the different explanatory variables.

5. Empirical Results

The model described in Equation (3) is estimated for the *near-month* and *near-quarter* FFA excess returns as presented in Tables 4 and 5, respectively. In order to arrive to the appropriate panel estimation, the Hausman (1978) test is performed to select between a fixed-effects or a random-effects estimator, and subsequently, the selected estimator is tested versus a pooled OLS regression, as described in the previous section. In all cases, results suggest the use of a random-effects model, but the Breusch-Pagan statistic rejects the use of a random-effects model in favor of a pooled OLS specification. Thus, one step further, we also employ two separate *F*-tests testing the joint significance of vessel- and time-dummies, respectively. The null hypothesis that the estimated dummies coefficients are jointly zero is rejected in any standard significance level for the vessel dummies case.[21] Thus, a vessel-fixed effects model with two-way adjusted clustered standard errors is estimated in all cases.

The *near-month* results presented in Table 4 indicate that the illiquidity ratio (LIQ_{t-1}) and the bid-ask spread (BAS_{t-1}) are both positive and statistically significant, with values 2.584 and 0.902, respectively, in the largest parameterized model (M4) containing all used factors. These results are in accordance with the liquidity theory, supported by previous studies (see Amihud, 2002, amongst others), as the higher the illiquidity in the market and the wider the bid-ask spread, the higher is the expected excess return on the *near-month* FFA contracts, as a form of extra compensation for the existence of liquidity risk. Thus, the BAS_{t-1} factor is positive and statistically significant throughout all model specifications (from M1 to M4), indicating that its significance is not affected by model parameterizations.[22] The same does not hold for LIQ_{t-1} factor, as it is found insignificant in model specification M2. Also, lagged freight market performance (BDI_{t-1}) has a positive and significant estimated coefficient. All the remaining independent variables have the expected signs although they are not statistically significant; the FFA excess returns positively depend on the lagged freight market performance (BDI_{t-1}) and the lagged freight market volatility (HVB_{t-1}) as well as the lagged benchmark for the direction of the commodity market ($GSCI_{t-1}$).

The *near-quarter* results presented in Table 5 indicate that the illiquidity ratio (LIQ_{t-1}) is again positive and statistically significant, throughout all four model specifications, as dictated by the liquidity theory. However, the bid-ask spread (BAS_{t-1}) becomes statistically insignificant in all four model specifications, indicating that shipping market participants do not take into account bid-ask spread levels when trading *near-quarter* contracts. Regarding the remaining independent variables, they all have the expected signs, although only the lagged freight market performance (BDI_{t-1}) appears to be significant.

To summarize the above findings, in the *near-month* contracts, the relationship between FFA returns and the two liquidity measures is consistent with the liquidity theory, but in the *near-quarter* contracts, FFA returns are driven by the Amihud measure, which incorporates trading

[21] For the sake of brevity, the results are not shown, but are available upon request.
[22] Models M1-M4 are reported to assess the incremental explanatory power of each of the variables included in the model.

volumes, but not by the bid-ask spread measure. Given the above, one could argue that in the case of *near-quarter* FFAs, even if they are considered the most liquid contracts with tighter spreads (see Table 2a), the bid-ask spread level is determined by other exogenous factors and is insensitive to realized returns. The best explanation for this result stems from the absence of active and dedicated market makers to set the bid and ask prices according to market conditions and liquidity as well as from the absence of a centralized trading platform. This implies that brokers are the main hub for price discovery and bid-ask spreads are set according to supply and demand, as they have to be bilaterally negotiated between sellers and buyers. There are search costs associated with finding bid-ask quotes, especially when traders dynamically rebalance their hedge portfolio (Deuskar, *et al*. 2011). Accordingly, changes in bid-ask levels do not necessarily imply that a transaction took place and as such relationships between FFA returns and bid-ask prices, coming from *near-quarter* contracts, may not be significant. The above observations are important and imply that market participants may trade in *near-quarter* no matter the level of transaction costs. Accordingly, in periods of high bid-ask spreads, market participants may realize lower than expected FFA returns.

The results of the alternative test of liquidity effects on excess returns based on the modified Fama-MacBeth two-step methodology are reported in Tables 6 and 7, respectively. The *near-month* results (Table 6) are similar to the previous panel regression analysis for the case of the bid-ask spreads. The illiquidity ratio (LIQ_{t-1}) is again positive but appears statistically significant in the M3 and M4 model specifications. *Near-month* FFA excess returns also seem to be positively and significantly affected by the broader commodity market (β_{GSCI}), while the remaining variables are found insignificant. In the case of the *near-quarter* results (Table 7), the results are very similar to the previous panel regression analysis, showing a significant relationship between FFA excess returns and the illiquidity ratio (LIQ_{t-1}), in line with expectations, but an insignificant relationship between FFA excess returns and bid-ask spreads. The same explanation for these comparable results given above applies for the insignificant relationships between *near-quarter* FFA returns and bid-ask spreads.

5.1 Forward Premium and Liquidity

Bessembinder (1994) argues that rational economic agents (market makers) would require to be compensated for the liquidity risk and this would be reflected in the bid-ask spreads. He demonstrates that bid-ask spreads increase during times when net suppliers of foreign exchange carry higher liquidity risk. Simpson and Grossmann (2014) find that the spot and forward bid-ask spreads (as a form of transactions costs) are related to the forward prediction error. Huisman, *et al*. (1998) argue that such transactions costs may prevent arbitrage from taking place when the forward premium is small. Therefore, in this section the effect of liquidity on FFA prices is investigated in terms of the extent to which liquidity measures can explain changes in the forward premia. It is interesting to examine whether the forward premium can be linked to liquidity; that is, whether illiquidity can cause or explain the forward premium.

According to the Unbiasedness Hypothesis, FFA prices should be unbiased estimates of their expected settlement rates (see Kavussanos *et al*. 2004); that is, $F_{t,t+n} = E_t(\bar{S}_{t+n})$, where $F_{t,t+n}$ is the FFA at time t for maturity $t+n$, and $E_t(\bar{S}_{t+n})$ is the expected settlement rate at time $t+n$, which is the average of spot freight rates over the business days of the settlement month.[23] Therefore, assuming that the Unbiasedness Hypothesis holds, we can write:

$$F_{t,t+n} = \bar{S}_{t+n} + u_t \qquad (6)$$

where, u_t is the error-term with zero mean and constant variance. According to the Unbiasedness Hypothesis, there shouldn't be any statistically significant difference between the forward prices and their respective settlement values, and any difference should be due to a time-varying risk premium separating market expectations and the forward rate. Therefore, to investigate the effect of liquidity on the forward premium ($u_t = F_{t,t+n} - \bar{S}_{t+n}$) the Amihud liquidity ratio and the bid-ask spread are used as measures of transaction costs in a regression, where the forward premium is the dependent variable. Although, this is not a formal test for liquidity risk premium, it can reveal whether liquidity affects forward prices and explain any deviation of the forward prices from the expected settlement prices. As typically in the literature, monthly (n*ear-month*) FFA contracts and actual settlement prices are used to construct the time-series of forward premia for each of the dry bulk vessel-types.

[23] Since the underlying asset of freight derivatives contracts is a service (based on expectations) it cannot be stored and carried forward in time, unlike storable commodities. This implies that freight rates and freight derivatives prices are not linked by a cost-of-carry (storage) relationship, as in other derivatives markets, and as such, the arbitrage strategies required to enforce the cost-of-carry relationship cannot be executed in freight markets. Therefore, the economic links between spot and derivatives prices may not be as strong as it is for storable commodities. Consequently, freight derivatives prices should reflect expectations of where the freight rates will be at the settlement of the contracts (see Kavussanos and Visvikis, 2004).

Under the Unbiasedness Hypothesis, the forward premium ($u_t = F_{t,t+n} - \bar{S}_{t+n}$) should not be predictable and has a zero mean. However, if the mean of the forward premium is found to be significantly different from zero or if it can be predicted by any variable in the information set, then it means that forward prices do not purely reflect the settlement prices and there might be additional costs involved in FFA trading. The forward premium ($u_t = F_{t,t+n} - \bar{S}_{t+n}$), therefore, reflects the premium hedgers are prepared to pay for the transfer of risk, and is linked to the number of days remaining until expiry due to the higher uncertainty about the expected settlement rates. Also, the forward premium may be related to the trading activity and liquidity in the FFA market, since higher trading volumes lead to higher liquidity in the market that can lead to lower transaction costs and to a more efficient price discovery function. Accordingly, a higher level of bid-ask spread implies a lower interest on behalf of market makers to provide liquidity, which will adversely affect price discovery, causing more market inefficiencies and an increase in the forward premium. Hence, in Equation (7) the dependent variable is the forward premium for each vessel-type and the regressors are a dummy variable for the days to maturity (DTM_t), the two previous liquidity measures (LIQ_{t-1} and BAS_{t-1}) and the control variables ($r_{\text{BDI},t-1}$, HVB_{t-1}, and $r_{\text{GSCI},t-1}$) in the following form:

$$F_{t,t+n} - \bar{S}_{t+n} = \gamma_0 + \delta DTM_t + \gamma_1 LIQ_{t-1} + \gamma_2 BAS_{t-1} + \gamma_3 r_{BDI_{t-1}} + \gamma_4 HVB_{i,t-1} + \gamma_5 r_{GSCI_{t-1}} + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma_\varepsilon^2) \qquad (7)$$

Equation (7) can also be defined and estimated as a panel regression using the information from the three vessel-types as follows:

$$F_{i,t,t+n} - \bar{S}_{i,t+n} = a_i + a_t + \delta DTM_t + \gamma_1 LIQ_{i,t-1} + \gamma_2 BAS_{i,t-1} + \gamma_3 r_{BDI_{i,t-1}} + \gamma_4 HVB_{i,t-1} + \gamma_5 r_{GSCI_{i,t-1}} + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \Sigma) \qquad (8)$$

The estimation results of Equations (7) and (8) are reported in Table 8, for the three individual vessel-types and as a panel (pooled) regression. As expected, the estimated coefficient of the lagged bid-ask spread (BAS_{t-1}) is positive and significant in the Capesize and panel regression models. These results indicate that an increase in the bid-ask spread, reflects higher transaction costs, which can result in deviation of FFA prices from the expected settlement prices. In contrast, the estimated coefficient of the Amihud measure (LIQ_{t-1}) is negative but statistically insignificant in the panel and Supramax models, except for the case of Capesize and Panamax models, where it is negative and statistically significant. This result implies that higher liquidity can cause the forward premium to increase and the Unbiasedness Hypothesis to fail. However, a possible explanation for such a result could be the excessive speculative trading taking place in the Capesize and Panamax markets (Alizadeh, 2013). Excessive speculative trading, by increasing trading activity, may drive FFA prices away from their fair value, causing disruptions in the price discovery function. This is also re-enforced by the absence of a spot-forward arbitrage relationship in the shipping market, meaning that there is no correction mechanism to bring the forward premium back in equilibrium.[24] This result is also consistent with the framework suggesting that liquidity theories may not always hold for OTC derivatives (see Deuskar, *et al*. 2011). The lagged freight market volatility appears insignificant in explaining the forward premium in the case of Supramax and panel models, whereas it is negative and statistically significant in the case of Capesize and Panamax models in contrast to expectations. Finally, estimated coefficients of lagged changes in GSCI returns ($r_{GSCI,t-1}$) are positive and statistically significant in Panamax, Supramax and panel regression models, whereas estimated coefficients of return on BDI ($r_{BDI,t-1}$) and days to maturity (DTM_t) are insignificant in all models.

6. Conclusion

The study examines the pricing of liquidity risk in the dry bulk FFA market over the period 2008-2014, using FFA (BFA) prices and the Amihud liquidity measure (FFA returns over trading volume) both obtained by the Baltic Exchange, and bid-ask spreads obtained from Clarksons Shipbrokers. The liquidity measures together with other shipping industry specific and macroeconomic (control) variables are used to determine the importance of liquidity risk in the freight derivatives market. It is shown that liquidity risk is priced in the *near-month* FFA market and both liquidity measures have a significant role in determining the returns of freight derivatives. In particular, and consistent with expectations, both the Amihud liquidity measure and the relative bid-ask spread are found to have positive and statistically significant effects on the returns of FFA contracts, once controlled for other possible risk factors. In the case of the *near-quarter* contracts, FFA returns are explained by the Amihud measure but are insensitive to bid-ask spreads, which indicates that they may be determined by exogenous

[24] The underlying asset is freight rates, which cannot be stored as in other financial or commodities markets when exploring arbitrage opportunities between the spot and the forward market.

factors. Despite that *near-quarter* contracts are considered to be the most liquid, market participants do not seem to take into account the level of bid-ask spreads in their investment decisions, and may decide to trade quarterly contracts no matter the level of transaction costs. This is important evidence of a demand and supply driven market, which relies on broker information for price discovery. The study also attempts to shed light on the determinants of the forward premium, by testing whether the two liquidity measures have any explanatory power in determining the spread between the FFA prices and their expected settlement values. The findings suggest that although bid-ask spreads seem to positively affect the forward premium, there is no clear relationship in the case of the Amihud measure or the other independent variables.

The results have important implications for modelling FFA returns, and consequently, for trading and risk management purposes. They suggest that performance measurement of FFA portfolios should not underestimate the costs of transacting, especially in cases where a trading strategy involves frequent trading. Bid-ask spread levels should be incorporated when performing investment strategies based on historical information. The broker market still remains the most important information channel of FFA price discovery and further research should be conducted in order to determine investors' returns in periods of thin liquidity using tradable prices.

REFERENCES

Acharya, V.V., Amihud, Y., Bharath, S.T., 2013. Liquidity risk of corporate bond returns: conditional approach. Journal of Financial Economics 110, 358-386.

Acharya, V.V., Pedersen, L.H., 2005. Asset pricing with illiquidity risk. Journal of Financial Economics 77, 375-410.

Alizadeh, A.H., 2013. Trading volume and volatility in the shipping forward freight market. Transportation Research Part E: Logistics and Transportation Review 49, 250-265.

Alizadeh, A.H., Nomikos, N., 2009. Shipping derivatives and risk management, Palgrave Macmillan.

Alizadeh, A.H., Nomikos, N., 2012. Ship finance: Hedging ship price risk using freight derivatives, in Wayne K Talley (ed.), *Blackwell Companion to Maritime Economics*, ed. 1st , Wiley-Blackwell, p.433-451.

Amihud Y., 2002. Illiquidity and stock returns: Cross-section and time-series effects. Journal of Financial Markets 5, 31-56.

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid-ask spread. Journal of Financial Economics 17, 223-249.

Annaert J., De Ceuster M. Van Roy P., Vesrpo C., 2013. What determines euro area bank CDS spreads? Journal of International Money and Finance 32, 444-461.

Asparouhova, E., Bessembinder, H., Kalcheva, I. 2010. Liquidity biases in asset pricing tests. Journal of Financial Economics 96, 215-237.

Batchelor, R, Alizadeh A.H., Visvikis, I.D., 2005. The relation between bid–ask spreads and price volatility in forward markets. Derivatives Use, Trading and Regulation 11, 105-125.

Batchelor, R., Alizadeh, A.H., Visvikis, I.D., 2007. Forecasting spot and forward prices in the international

freight market. International Journal of Forecasting 23, 101-114.
Bessembinder, H., 1994. Bid-ask spreads in the interbank foreign exchange markets. Journal of Financial Economics 35, 317-348.
Bongaerts, D., De Jong, F, Driessen, J. 2011. Derivative pricing with liquidity risk: Theory and evidence from the credit default swap market. The Journal of Finance 66, 203-240.
Brenner, M., Eldor, R., Hauser, S., 2001. The price of options illiquidity. The Journal of Finance 56, 789-805.
Breusch, T.S., Pagan, A.R., 1980. The Lagrange Multiplier test and its applications to model specification in econometrics. Review of Economic Studies 47, 239-253.
Chen, L., Lesmond, D.A., Wei, J., 2007. Corporate yield spreads and bond liquidity. The Journal of Finance 62, 119-149.
Chordia, T., Sarkar, A., Subrahmanyam, A., 2005. An empirical analysis of stock and bond market liquidity. Review of Financial Studies 18, 85-129.
Copeland T.E., Galai D., 1983. Information effects on the bid-ask apread. The Journal of Finance 38, 5, 1457-1469
Demsetz, H., 1968. The cost of transacting. The Quarterly Journal of Economics 82, 1, 33-53.
Deuskar, P., Gupta, A., Subrahmanyam, M.G., 2011. Liquidity effect in OTC options markets: Premium or discount?. Journal of Financial Markets 14, 127-160.
Dick-Nielsen, J., Feldhütter, P., Lando, D., 2012. Corporate bond liquidity before and after the onset of the subprime crisis. Journal of Financial Economics 103, 471-492.
Erwin G., Miller J., 1998. The liquidity effects associated with addition of a stock to the S&P 500 index: Evidence from bid/ask spreads. The Financial Review 33, 131-146.
Fama, E.F., MacBeth, J.D., 1973. Risk, return, and equilibrium: Empirical tests. Journal of Political Economy 81, 607-636.
Ferson, W.E., Harvey, C.R., 1999. Conditioning variables and the cross-section of stock returns. Journal of Finance, 54, 4, 1325-1360.
French, K.R., 1980. Stock returns and the weekend effect. Journal of Financial Economics 8, 1, 55-69.
Friewald, N., Jankowitsch, R., Subrahmanyam, M.G., 2012. Illiquidity or credit deterioration: A study of liquidity in the US corporate bond market during financial crises. Journal of Financial Economics 105, 18-36.
Garleanu, N., Pedersen, L.H., Poteshman, A.M., 2009. Demand-based option pricing. Review of Financial Studies 22, 4259-4299.
Greene, W.H., 2012. Econometric analysis. Prentice Hall, Boston.
Hausman, J.A., 1978. Specification tests in econometrics. Econometrica 46, 1251-1271.
Huisman, R., Koedijk, K., Kool, C., Nissen, F., 1998. Extreme support for uncovered interest parity. Journal of International Money and Finance 17, 211-228.
Im, K.S., Pesaran, M.H., Shin, Y., 2003. Testing for unit roots in heterogeneous panels. Journal of Econometrics 115, 53-74.
Jarque, C.M., Bera, A.K., 1980. Efficient tests for normality, homoscedasticity and serial independence of regression residuals. Economics Letters 6, 255-259.
Kappou K., Brooks C., Ward C., 2010. The S&P 500 index effect reconsidered: Evidence from overnight and intraday stock price performance and volume. Journal of Banking & Finance 34, 1, 116-126.
Kavussanos M.G., Nomikos, N., 1999.The forward pricing function of the shipping freight futures market. Journal of Futures Markets 19, 3, 353-376.
Kavussanos, M.G., Tsouknidis, D.A., 2014. The determinants of credit spreads' changes in global shipping bonds. Transportation Research Part E: Logistics and Transportation Review 70, 55-75.
Kavussanos M.G., Visvikis, I.D., Menachof D., 2004. The unbiasedness hypothesis in the freight forward market: Evidence from co-integration tests. Review of Derivatives Research 7, 241-266.
Kavussanos, M.G., Visvikis, I.D., 2004. Market interactions in returns and volatilities between spot and forward Shipping freight markets. Journal of Banking & Finance 28, 2015-2049.
Kavussanos, M.G., Visvikis, I.D., 2006a. Derivatives and risk management in shipping, Witherbys Publishing Limited & Seamanship International.
Kavussanos, M.G., Visvikis, I.D., 2006b. Shipping freight derivatives: A survey of recent evidence. Maritime Policy & Management 33, 233-255.
Kavussanos, M.G., Visvikis, I.D., 2008. Freight derivatives and risk management: A review. (In Eds.) Geman, H., Risk Management in Commodity Markets: From Shipping to Agriculturals and Energy, John Wiley & Sons Ltd.
Kavussanos, M.G., Visvikis, I.D., 2011. Theory and practice of shipping freight derivatives, Risk Books.
Kavussanos, M.G., Visvikis, I.D., Dimitrakopoulos, D.N., 2014. Economic spillovers between related derivatives markets: The case of commodity and freight markets. Transportation Research Part E: Logistics and Transportation Review 68, 79-102.

Lakonishok J., Levi M., 1982. Weekend effects on stock returns: A note. The Journal of Finance 37, 3, 883-889.

Levin, A., Lin, C-F., James Chu, C-S., 2002. Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics 108, 1-24.

Longstaff, F.A., Mithal, S., Neis, E., 2005. Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market. The Journal of Finance 60, 2213-2253.

Mikkelson H., Partch M., 1985. Stock price effects and costs of secondary distributions. Journal of Financial Economics 14, 165-194.

Panayides, P., Lambertides, N., Cullinane, K, 2013. Liquidity risk premium and asset pricing in US water transportation. Transportation Research E: Logistics and Transportation Review 52, 3-15.

Pastor, L., Stambaugh, R, 2003. Liquidity risk and expected stock returns. Journal of Political Economy 111, 642-685.

Petersen, M.A., 2009. Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies 22, 435-480.

Phillips, P.C.B., Perron, P., 1988. Testing for a unit root in time series regression. Biometrika 75, 335-346.

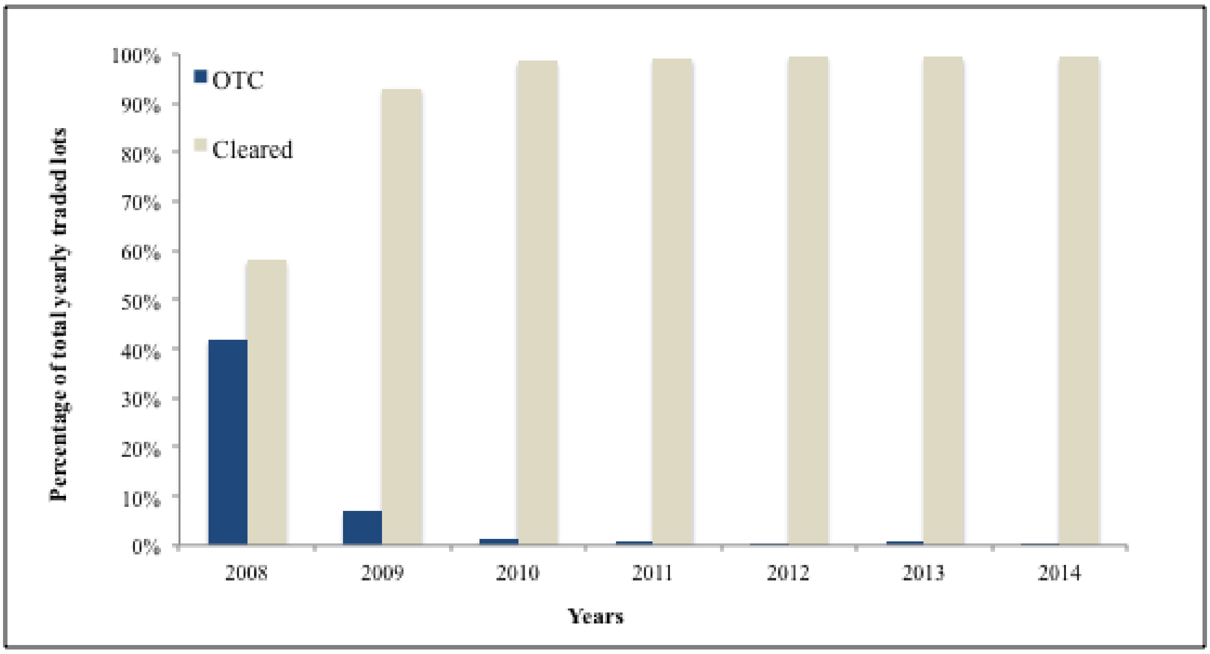
Simpson, M.W., Grossmann, A., 2104. An examination of the forward prediction error of US dollar exchange rates and how they are related to bid-ask spreads, purchasing power parity disequilibria, and forward premium asymmetry. North American Journal of Economics and Finance 28, 221-238.

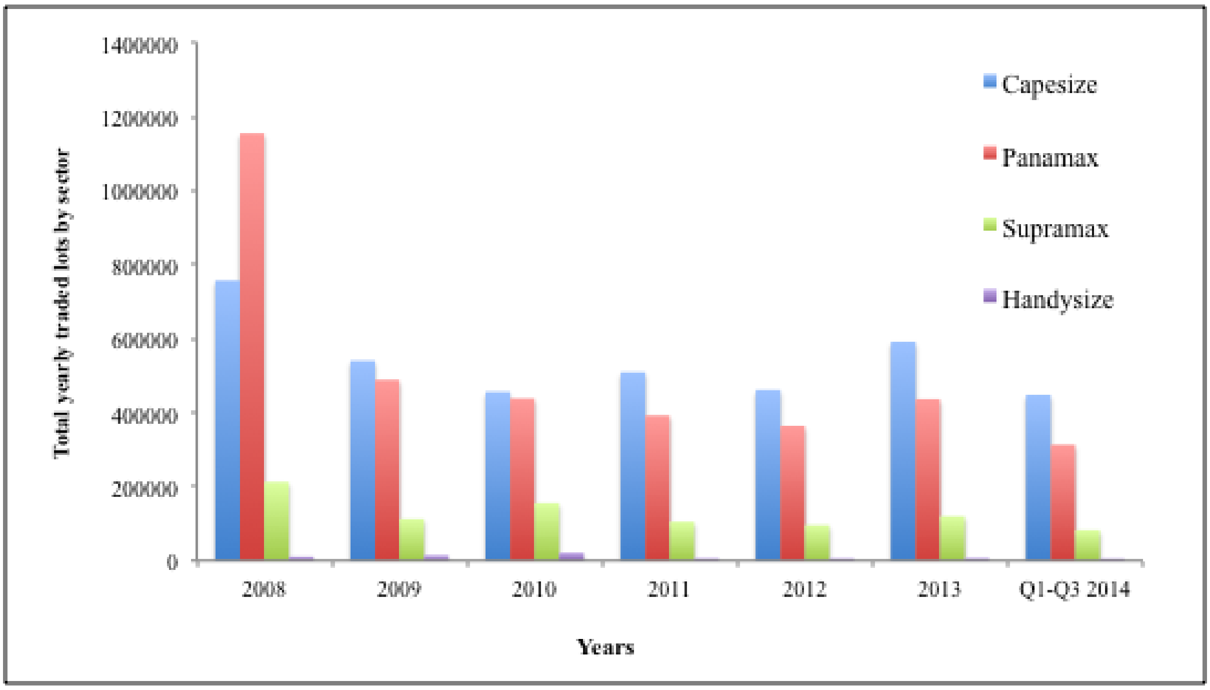
Szymanowska, M., De Roon, F., Nijman, T., Van Den Goorbergh, R., 2014. An Anatomy of Commodity Futures Risk Premia. The Journal of Finance 69, 453-482.

Tezuka K, Ishii M., Ishizaka M. 2012. An equilibrium price model of spot and forward shipping freight markets. Transportation Research Part E: Logistics and Transportation Review 48, 4, 730-742.

Wooldridge, J.M., 2002. Econometric analysis Cross Section Panel. MIT Press.

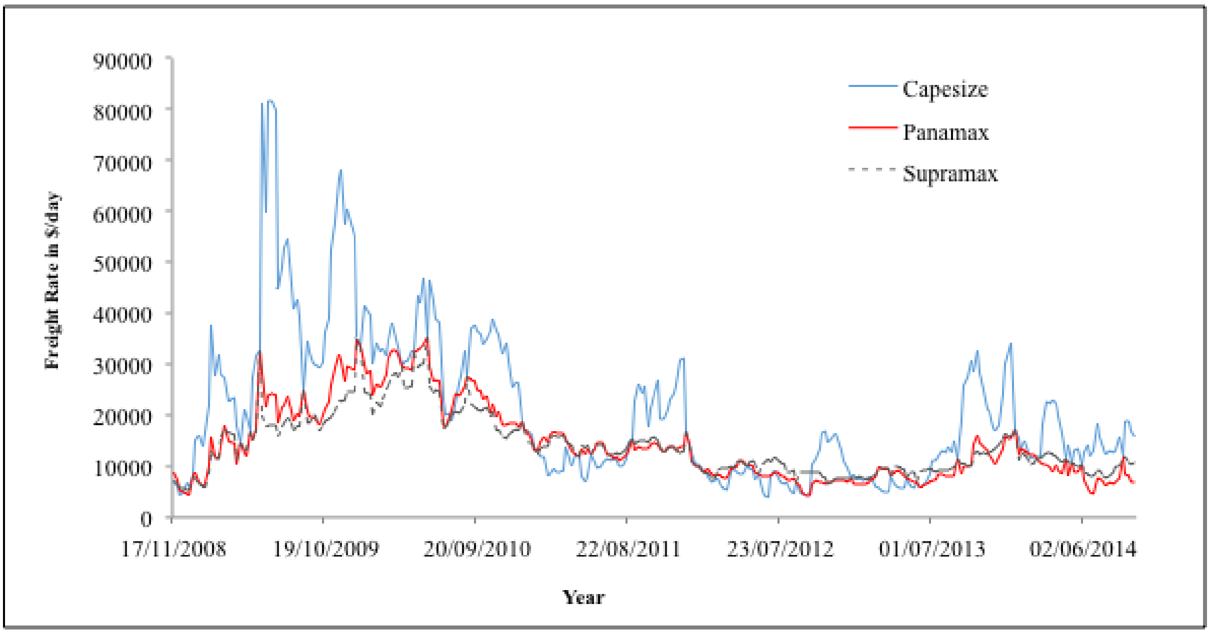
Figure 1- Historical Cleared versus OTC FFA Trading Activity (top) and Yearly Trading Volumes by Sector (bottom)





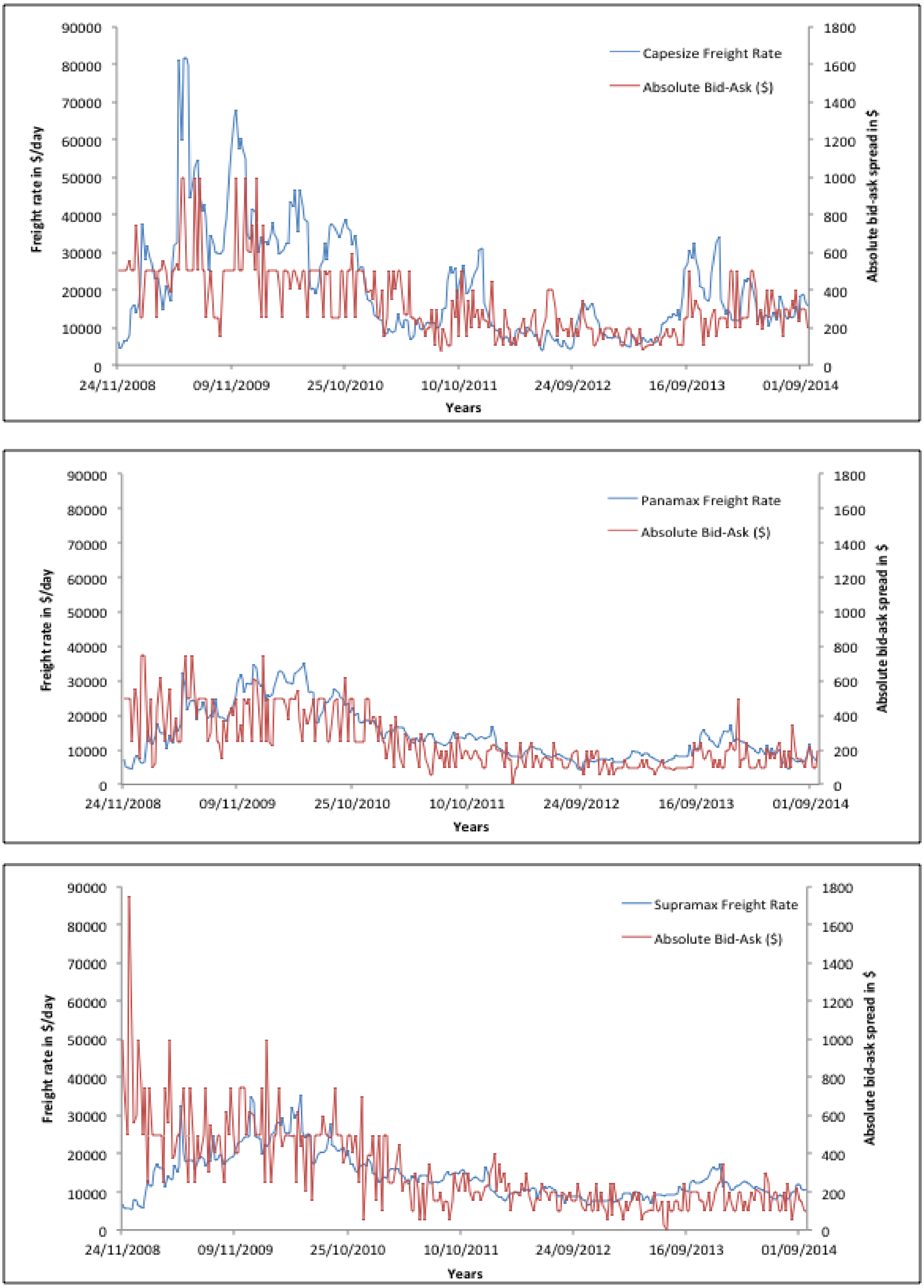
Source: Baltic Exchange

Figure 2 - Historical FFA Rates (near-quarter) of Capesize, Panamax and Supramax Vessels



Source: Baltic Exchange

Figure 3 - Historical Actual Bid–Ask Spreads (in USD) versus FFA Near-Quarter Rates for Capesize, Panamax and Supramax Vessels



Source: Clarkson's Shipbrokers Limited

Table 1: Description of Variables

Type of Risk Factors	Description
Dependent Variable	*Excess Return on FFA*: Logarithmic return on the Baltic Exchange's assessments of dry bulk FFA's, as average of assessment prices provided by a panel of FFA brokers appointed by the Baltic Exchange minus the three-months US Treasury Bill risk-free rate.
FFA specific factors	*LIQ:* The Amihud ratio is equal to the average value of the ratio of the absolute return over the volume traded (*V*). It is computed with a 52-week rolling window. *Relative Bid-Ask spread (BAS):* The relative bid-ask spread is obtained from the Clarkson's Shipbrokers Limited daily reports and is defined as *ask* price minus *bid* price over the *mid*-price of the FFA contract.
Industry and Macroeconomic specific factors	*Baltic Dry Index (BDI):* A composite index of average spot freight rates for Capesize, Panamax, Supramax and Handysize dry bulk carriers. *Historical Volatility of BDI (HVB):* The one-month rolling moving average of historical standard deviation of the *Baltic Dry* index. *Goldman Sachs Commodities Index (GSCI)*: This is an index constructed and published by S&P as representative for the returns attainable in the commodities markets.

The factors can be classified broadly into two categories: (i) shipping specific and (ii) macroeconomic specific.

Table 2a: Descriptive Statistics of the Variables

	Mean	Standard Deviation	Skewness	Kurtosis	Normality [*p*-value]	PP Test
			Panel A: Capesize			
***ΔBFA* Near-Month (%)**	-0.233	19.061	-0.188	3.164	1.836 [0.401]	-223.232 [0.000]
***ΔBFA* Near-Quarter (%)**	-0.471	19.206	0.332	5.236	18.101 [0.000]	-232.424 [0.000]
***LIQ* Near-Month (%)**	1.835	0.345	0.802	2.436	22.124 [0.000]	-236.752 [0.000]
***LIQ* Near-Quarter (%)**	1.748	0.427	0.938	2.804	25.346 [0.000]	-279.78 [0.000]
***BAS* Near-Month (%)**	2.602	1.416	1.409	5.205	44.874 [0.000]	-83.388 [0.000]
***BAS* Near-Quarter (%)**	1.805	0.788	1.175	5.254	44.701 [0.000]	-154.462 [0.000]
			Panel B: Panamax			
***ΔBFA* Near-Month (%)**	-0.601	12.481	0.510	4.552	15.621 [0.000]	-224.474 [0.000]
***ΔBFA* Near-Quarter (%)**	-0.512	11.867	0.466	6.658	28.846 [0.000]	-271.634 [0.000]
***LIQ* Near-Month (%)**	1.213	0.323	0.489	2.151	22.367 [0.000]	-192.148 [0.000]
***LIQ* Near-Quarter (%)**	1.151	0.357	0.583	2.196	22.971 [0.000]	-241.57 [0.000]
***BAS* Near-Month (%)**	2.064	0.841	0.849	4.445	24.064 [0.000]	-155.513 [0.000]
***BAS* Near-Quarter (%)**	1.573	0.612	1.042	4.878	37.531 [0.000]	-227.942 [0.000]
			Panel C: Supramax			
***ΔBFA* Near-Month (%)**	-0.441	9.792	-0.043	3.291	1.146 [0.564]	-227.224 [0.000]
***ΔBFA* Near-Quarter (%)**	-0.236	9.993	-0.525	5.799	25.977 [0.000]	-274.397 [0.000]
***LIQ* Near-Month (%)**	3.519	0.582	0.424	2.132	22.542 [0.000]	-264.124 [0.000]
***LIQ* Near-Quarter (%)**	3.111	0.552	1.011	4.005	38.228 [0.000]	-298.861 [0.000]
***BAS* Near-Month (%)**	2.051	0.864	0.961	4.795	29.232 [0.000]	-147.022 [0.000]
***BAS* Near-Quarter (%)**	1.815	0.784	0.791	3.896	22.596 [0.000]	-255.227 [0.000]
			Panel D: Other Variables (Near Month)			
r_{GSCI} **(%)**	-0.004	2.328	-0.324	6.181	16.141 [0.000]	-222.164 [0.000]
r_{BDI} **(%)**	-0.469	8.323	-0.091	4.245	6.003 [0.0485]	-135.221 [0.000]
***HVB* (%)**	0.793	0.414	1.758	6.229	54.467 [0.000]	-23.072 [0.011]

The sample is weekly from November 2008 to September 2014. *Near-month* sample comprises of 262 observations for each sector and 786 observations for the pooled sample. *Near-quarter* sample comprises of 306 observations for each sector and 918 observations for the pooled sample. *ΔBFA* is the logarithmic return on FFA; *BAS* is the relative bid-ask spread in percentage form; r_{GSCI} is the return on *GSCI*; r_{BDI} is the logarithmic return on BDI; and *HVB* is the 52-week rolling estimate of standard deviation of BDI as a measure of market volatility. *p*-values are reported in square brackets [.]. Skewness and kurtosis are the third and fourth moments of the data**.** Normality is an equivalent to the Jarque and Bera (1980) test for normality; the statistic follows a $\chi^2_{(2)}$. PP Test is the Philips and Perron (1990) unit root test.

Table 2b: Descriptive Statistics of the Variables in Panel Form

	Mean	Standard Deviation	Skewness	Kurtosis	LLC [*p*-value] Levels	LLC [*p*-value] 1st Differences	IPS [*p*-value] Levels	IPS [*p*-value] 1st Differences
***ΔBFA* Near-Month (%)**	-0.425	14.295	-0.026	4.416	-2.488	-18.816	-3.546	-19.746
					[0.061]	[0.000]	[0.0478]	[0.000]
***ΔBFA* Near-Quarter (%)**	-0.406	14.236	0.293	7.275	-2.501	-21.579	-2.105	-21.211
					[0.060]	[0.000]	[0.0816]	[0.000]
***V* (lots/week)**	6,912	4,436	1.045	4.685	-12.864	-32.611	-14.487	-23.979
					[0.000]	[0.000]	[0.000]	[0.000]
***LIQ* Near-Month (%)**	2.189	1.066	0.667	2.311	-17.349	-32.119	13. 941	-23.227
					[0.000]	[0.000]	[0.000]	[0.000]
***LIQ* Near-Quarter (%)**	2.003	0.937	6.223	2.590	-19.341	-34.667	-14.772	-26.338
					[0.000]	[0.000]	[0.000]	[0.000]
***BAS* Near-Month (%)**	2.239	1.102	1.624	7.341	-8.958	-28.579	-12.964	-22.018
					[0.000]	[0.000]	[0.000]	[0.000]
***BAS* Near-Quarter (%)**	1.731	0.742	1.071	4.898	-9.903	-25.117	-9.671	-23.672
					[0.000]	[0.000]	[0.000]	[0.000]

See Notes in Table 2a. LLC and IPS are the Levin *et al*. (2002) and Im *et al*. (2003) panel data unit root tests, respectively.

Table 2c: Descriptive Statistics of the Variables in Equation (5) - Including betas

	N	Mean	Median	St Dev.	Min	Max
Panel A: Capesize						
Near-Month						
***LIQ* (%)**	211	1.835	1.696	0.345	1.374	2.625
***BAS* (%)**	211	2.602	2.222	1.416	0.523	8.451
β_{BDI}	211	0.859	0.944	0.281	-0.022	1.266
β_{HVB}	211	-5.905	-4.367	10.911	-33.979	12.383
β_{GSCI}	211	0.701	0.732	0.513	-0.832	1.928
Near-Quarter						
***LIQ* (%)**	254	1.748	1.583	0.427	1.191	2.871
***BAS* (%)**	254	1.805	1.705	0.788	0.441	5.128
β_{BDI}	254	0.924	0.963	0.245	0.341	1.513
β_{HVB}	254	0.490	0.103	10.807	-35.039	20.496
β_{GSCI}	254	1.052	0.968	0.860	-0.339	3.404
Panel B: Panamax						
Near-Month						
***LIQ* (%)**	211	1.213	1.132	0.323	0.785	2.001
***BAS* (%)**	211	2.064	1.980	0.841	0.576	5.309
β_{BDI}	211	0.364	0.414	0.171	0.039	0.661
β_{HVB}	211	0.351	2.408	7.281	-12.995	12.743
β_{GSCI}	211	0.123	0.208	0.641	-2.899	1.104
Near-Quarter						
***LIQ* (%)**	254	1.151	1.063	0.357	0.730	2.059
***BAS* (%)**	254	1.573	1.526	0.612	0.399	4.416
β_{BDI}	254	0.438	0.412	0.216	0.067	1.039
β_{HVB}	254	3.485	4.591	6.098	-9.627	15.742
β_{GSCI}	254	-0.016	-0.016	0.503	-1.899	1.166
Panel C: Supramax						
Near-Month						
***LIQ* (%)**	211	3.519	3.431	0.581	2.646	4.934
***BAS* (%)**	211	2.051	1.941	0.864	0.647	6.128
β_{BDI}	211	0.327	0.411	0.193	-0.072	0.581
β_{HVB}	211	2.154	1.898	5.528	-10.284	12.245
β_{GSCI}	211	-0.115	0.007	0.506	-1.671	0.847
Near-Quarter						
***LIQ* (%)**	254	3.111	3.018	0.552	2.319	4.979
***BAS* (%)**	254	1.815	1.722	0.784	0.281	4.761
β_{BDI}	254	0.325	0.368	0.167	-0.023	0.644
β_{HVB}	254	2.835	2.996	6.751	-12.078	20.703
β_{GSCI}	254	-0.127	-0.072	0.473	-1.115	0.789

See notes of Table 2a. *LIQ* (Amihud illiquidity ratio) and betas for the remaining risk factors are estimated using a 52-week rolling window.

Table 3a: Correlation Coefficients of Variables in Equation (3)

	Near-Month					Near-Quarter				
Capesize										
	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.01	1.00				0.01	1.00			
BDI_{t-1}	0.11	-0.13	1.00			0.08	-0.24	1.00		
HVB_{t-1}	-0.24	-0.05	0.11	1.00		-0.21	-0.06	0.09	1.00	
$GSCI_{t-1}$	-0.03	0.01	-0.01	0.02	1.00	-0.02	-0.00	-0.09	-0.02	1.00
Panamax										
	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.15	1.00				-0.06	1.00			
BDI_{t-1}	0.14	-0.06	1.00			0.12	-0.06	1.00		
HVB_{t-1}	-0.54	0.00	0.11	1.00		-0.44	-0.06	0.09	1.00	
$GSCI_{t-1}$	-0.09	0.05	-0.01	0.02	1.00	-0.07	0.04	-0.09	-0.02	1.00
Supramax										
	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$	LIQ_{t-1}	BAS_{t-1}	BDI_{t-1}	HVB_{t-1}	$GSCI_{t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.11	1.00				0.12	1.00			
BDI_{t-1}	0.08	-0.15	1.00			0.00	-0.24	1.00		
HVB_{t-1}	-0.41	-0.02	0.11	1.00		-0.27	-0.00	0.09	1.00	
$GSCI_{t-1}$	-0.04	0.02	-0.01	0.02	1.00	-0.02	0.13	-0.09	-0.02	1.00

This table reports the correlation coefficients of variables entering Equation (3), which is the baseline panel data regressions.

Table 3b: Correlation Coefficients of Variables in Equation (5)

	Near-Month					Near-Quarter				
Capesize										
	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.01	1.00				0.01	1.00			
$\beta_{BDI,t-1}$	0.24	0.13	1.00			0.32	0.02	1.00		
$\beta_{HVB,t-1}$	-0.23	0.31	0.29	1.00		-0.21	0.08	-0.18	1.00	
$\beta_{GSCI,t-1}$	0.04	-0.01	-0.23	-0.06	1.00	0.49	-0.00	0.05	-0.61	1.00
Panamax										
	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.15	1.00				-0.06	1.00			
$\beta_{BDI,t-1}$	-0.73	0.25	1.00			-0.14	0.11	1.00		
$\beta_{HVB,t-1}$	-0.84	0.19	0.81	1.00		-0.72	0.14	0.38	1.00	
$\beta_{GSCI,t-1}$	-0.46	-0.01	0.12	0.42	1.00	-0.27	-0.11	0.22	0.39	1.00
Supramax										
	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$	LIQ_{t-1}	BAS_{t-1}	$\beta_{BDI,t-1}$	$\beta_{HVB,t-1}$	$\beta_{GSCI,t-1}$
LIQ_{t-1}	1.00					1.00				
BAS_{t-1}	-0.11	1.00				0.12	1.00			
$\beta_{BDI,\,t-1}$	-0.20	0.35	1.00			0.12	0.35	1.00		
$\beta_{HVB,t-1}$	-0.61	0.29	0.62	1.00		-0.25	0.27	0.66	1.00	
$\beta_{GSCI,t-1}$	-0.63	-0.01	-0.04	0.12	1.00	-0.17	0.02	0.02	0.09	1.00

This table reports the correlation coefficients of variables entering Equation (5), which is the second step regression of the Fama and McBeth (1973) methodology.

Table 4: Panel Regression Results of Near Month FFA Returns

$$r_{i,t} - r_{f,t} = \beta_{0,i,t} + \beta_1 LIQ_{i,t-1} + \beta_2 BAS_{i,t-1} + \beta_3 r_{BDI,t-1} + \beta_4 HVB_{t-1} + \beta_5 r_{GSCI,t-1} + u_{i,t} + v_{i,t} \;; \quad u_{i,t} + v_{i,t} \sim iid(0, \Sigma) \quad (3)$$

	M1	**M2**	**M3**	**M4**
Constant	-0.065**	-0.063*	-0.085***	-0.085***
	(-2.137)	(-1.939)	(-2.832)	(-2.847)
LIQ_{t-1}	2.262*	2.029	2.576**	2.584**
	(1.844)	(1.492)	(2.068)	(2.092)
BAS_{t-1}	0.770**	0.878**	0.903***	0.902***
	(2.107)	(2.545)	(2.614)	(2.606)
$r_{BDI,t-1}$		0.128*	0.118	0.118
		(1.763)	(1.629)	(1.632)
HVB_{t-1}			1.407	1.404
			(1.321)	(1.320)
$r_{GSCI,t-1}$				0.033
				(0.158)
Observations	630	630	630	630
Adjusted R^2	0.75%	1.29%	1.43%	1.43%
Hausman Test (re vs. fe)	2.20	1.75	2.48	2.49
[*p*-value]	[0.332]	[0.626]	[0.648]	[0.778]
***F*-stat (vessel fe vs. pooled)**	3.90	4.01	4.41	4.56
[*p*-value]	[0.045]	[0.043]	[0.036]	[0.033]
***F*-stat (time fe vs. pooled)**	1.52	2.60	2.30	2.70
[*p*-value]	[0.201]	[0.121]	[0.141]	[0.114]
BP test (re vs. pooled)	0.00	0.00	0.00	0.00
[*p*-value]	[1.000]	[1.000]	[1.000]	[1.000]
Estimation Method	vessel-fe	vessel-fe	vessel-fe	vessel-fe

The table presents the results of the regressions between the logarithmic first differences of current quarter FFA contracts minus the risk-free rate and the independent variables proposed. *t*-statistics and *p*-values are reported in parenthesis (.) and square brackets [.], respectively. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively. *LIQ* (Amihud illiquidity ratio) is calculated using a 52-week rolling window. The sample is weekly based on Monday observations, covering the period September 2009 to September 2014 minus 52 weeks to enable the estimation of the Amihud measure. This corresponds to 211 observations for each sector and 633 observations for the pooled sample. However, the total observations used for estimation are equal to 630 due to the use of one lag for each type of vessel in all independent variables. The Hausman (1978) test statistic is followed to choose among the fixed-effects (fe) and random-effects (re) estimators. After one of the specifications is favored by Hausman test then an *F*-test is followed to test between the fixed-vessel effects versus the pooled OLS specifications and between fixed-time-effects versus pooled OLS specifications. In case a random-effects model is favored by Hausman the Breusch-Pagan (BP, 1980) test is then followed in order to choose among the random effects estimator and the pooled OLS. Vessel dummies are included to account for vessel fixed effects but their estimated coefficients are not reported in the table. The null hypothesis is that groups are homoscedastic. All model specifications are reported with two-way cluster-adjusted standard errors (see Petersen, 2009).

Table 5: Panel Regression Results of Near Quarter FFA Returns

$$r_{i,t} - r_{f,t} = \beta_{0,i,t} + \beta_1 LIQ_{i,t-1} + \beta_2 BAS_{i,t-1} + \beta_3 r_{BDI,t-1} + \beta_4 HVB_{t-1} + \beta_5 r_{GSCI,t-1} + u_{i,t} + v_{i,t} \;;\quad u_{i,t} + v_{i,t} \sim iid(0,\Sigma) \quad (3)$$

	M1	M2	M3	M4
Constant	-0.026	-0.030	-0.049***	-0.050***
	(-1.164)	(-1.183)	(-3.956)	(-4.412)
LIQ_{t-1}	1.705***	1.332*	1.740***	1.804***
	(3.499)	(1.668)	(3.151)	(3.615)
BAS_{t-1}	-0.498	0.141	0.150	0.106
	(-0.546)	(0.205)	(0.225)	(0.165)
$r_{BDI,t-1}$		0.277***	0.269***	0.275***
		(2.653)	(2.686)	(2.681)
HVB_{t-1}			1.467	1.521
			(1.052)	(1.091)
$r_{GSCI,t-1}$				0.287
				(1.357)
Observations	759	759	759	759
Adjusted R^2	0.35%	3.01%	3.17%	3.41%
Hausman Test (re vs. fe)	1.29	0.84	1.41	1.51
[*p*-value]	[0.524]	[0.839]	[0.842]	[0.911]
***F*-stat (vessel fe vs. pooled)**	9.43	4.13	7.38	9.83
[*p*-value]	[0.002]	[0.041]	[0.006]	[0.001]
***F*-stat (time fe vs. pooled)**	1.41	1.92	2.22	2.57
[*p*-value]	[0.227]	[0.152]	[0.149]	[0.119]
BP test (re vs. pooled)	0.00	0.00	0.00	0.00
[*p*-value]	[1.000]	[1.000]	[1.000]	[1.000]
Estimation Method	vessel-fe	vessel-fe	vessel-fe	vessel-fe

In this table the sample is weekly based on Monday observations, covering the period November 2008 to September 2014 minus 52 weeks to enable the estimation of the Amihud measure. This corresponds to 254 observations for each sector and 762 observations for the pooled sample. However, the total observations used for estimation are equal to 759 due to the use of one lag for each type of vessel in all independent variables. Also see notes in Table 4.

Table 6: Panel Regression Results of Near-Month FFA Returns on Risk Factors (betas)

$$r_{i,t} - r_{f,t} = \gamma_{0,i,t} + \gamma_1 LIQ_{i,t-1} + \gamma_2 BAS_{i,t-1} + \gamma_3 \beta_{BDI_{i,t-1}} + \gamma_4 \beta_{HVB_{i,t-1}} + \gamma_5 \beta_{GSCI_{i,t-1}} + u_{i,t} + v_{i,t} \; ; \quad u_{i,t} + v_{i,t} \sim iid(0, \Sigma) \quad (5)$$

Variable	Coefficient	M1	M2	M3	M4
Constant	λ_0	-0.065**	-0.055	-0.062	-0.119**
		(-2.137)	(-1.029)	(-1.244)	(-2.424)
$\boldsymbol{LIQ_{t-1}}$	γ_1	2.262*	2.190*	1.591	3.011
		(1.844)	(1.682)	(0.839)	(1.415)
$\boldsymbol{BAS_{t-1}}$	γ_2	0.770**	0.818**	0.923***	0.957***
		(2.107)	(2.516)	(2.627)	(3.057)
$\boldsymbol{\beta_{BDI,t-1}}$	γ_3		-0.012	0.000	0.010
			(-0.335)	(0.017)	(0.526)
$\boldsymbol{\beta_{HVB,t-1}}$	γ_4			-0.001	-0.001
				(-0.645)	(0.782)
$\boldsymbol{\beta_{GSCI,t-1}}$	γ_5				0.030***
					(2.676)
Observations		630	630	630	630
BP LM		92.50	92.59	92.18	93.43
		[0.000]	[0.000]	[0.000]	[0.000]
Wald test		153.22	153.42	150.67	143.14
		[0.000]	[0.000]	[0.000]	[0.000]
Estimation Method		vessel-fe	vessel-fe	vessel-fe	vessel-fe

t-statistics and *p*-values are reported in parenthesis (.) and square brackets [.], respectively. *, ** and *** represent significance at the 10%, 5% and 1% levels, respectively. *LIQ* (Amihud illiquidity ratio) is calculated using a 52-week rolling window. Betas for the remaining risk factors are estimated using a 52-week rolling window. BP LM is the Breusch and Pagan (1980) test for cross sectional correlation (independence), which follows a $\chi^2_{(2)}$ distribution. The modified Wald test is a test for group-wise heteroscedasticity in fixed effects regression models (see Greene, 2012). Vessel dummies are included to account for vessel fixed effects but their estimated coefficients are not reported in the table. The null hypothesis is that groups are homoscedastic. The model specifications are reported with two-way cluster-adjusted standard errors (see Petersen, 2009).

Table 7: Panel Regression Results of Near-Quarter FFA Returns on Risk Factors (betas)

$$r_{i,t} - r_{f,t} = \gamma_{0,i,t} + \gamma_1 LIQ_{i,t-1} + \gamma_2 BAS_{i,t-1} + \gamma_3 \beta_{BDI_{i,t-1}} + \gamma_4 \beta_{HVB_{i,t-1}} + \gamma_5 \beta_{GSCI_{i,t-1}} + u_{i,t} + v_{i,t} \;; \quad u_{i,t} + v_{i,t} \sim iid(0, \Sigma) \quad (5)$$

Variable	Coefficient	M1	M2	M3	M4
Constant	λ_0	-0.026	-0.015	-0.016	-0.025
		(-1.164)	(-0.400)	(-0.446)	(-0.677)
$\boldsymbol{LIQ_{t-1}}$	γ_1	1.705***	1.784***	2.119***	2.135***
		(3.499)	(3.910)	(5.258)	(4.066)
$\boldsymbol{BAS_{t-1}}$	γ_2	-0.498	-0.439	-0.527	-0.536
		(-0.546)	(-0.500)	(-0.615)	(-0.607)
$\boldsymbol{\beta_{BDI,t-1}}$	γ_3		-0.015	-0.018	-0.023
			(-0.592)	(-0.894)	(-1.240)
$\boldsymbol{\beta_{HVB,t-1}}$	γ_4			0.001	0.001
				(0.972)	(1.556)
$\boldsymbol{\beta_{GSCI,t-1}}$	γ_5				0.013
					(1.624)
Observations		759	759	759	759
BP LM		107.09	107.30	107.31	107.53
		[0.000]	[0.000]	[0.000]	[0.000]
Wald test		78.58	78.23	78.70	78.37
		[0.000]	[0.000]	[0.000]	[0.000]
Estimation Method		vessel-fe	vessel-fe	vessel-fe	vessel-fe

See notes in Table 6.

Table 8: Regression Results of Near Month Forward Premium and Liquidity

$$F_{i,t,t+n} - \bar{S}_{i,t+n} = \gamma_0 + \delta DTM_t + \gamma_1 LIQ_{i,t-1} + \gamma_2 BAS_{i,t-1} + \gamma_3 r_{BDI_{i,t-1}} + \gamma_4 HVB_{i,t-1} + \gamma_5 r_{GSCI_{i,t-1}} + \varepsilon_t \quad (8)$$

Variable	Coefficient	Capesize	Panamax	Supramax	Panel
Constant	γ_0	0.849***	0.287**	0.137*	0.460**
		(4.414)	(2.519)	(1.788)	(2.449)
DTM_t	δ	0.001	0.002	-0.001	0.000
		(0.325)	(0.931)	(-0.972)	(0.297)
LIQ_{t-1}	γ_1	-31.966***	-10.263**	-2.599	-12.075
		(-4.299)	(-2.163)	(-1.480)	(-1.311)
BAS_{t-1}	γ_1	4.745**	1.493	1.660	3.392**
		(2.216)	(0.865)	(1.347)	(2.068)
$r_{BDI,t-1}$	γ_3	0.019	-0.097	-0.070	-0.069
		(0.050)	(-0.390)	(-0.435)	(-0.506)
HVB_{t-1}	γ_4	-19.537**	-11.260**	-2.791	-12.226
		(-2.502)	(-2.102)	(-0.896)	(-1.635)
$r_{GSCI,t-1}$	γ_5	2.277	1.260**	1.183***	1.615***
		(1.399)	(2.303)	(2.804)	(3.153)
Observations		205	205	205	615
Adjusted R^2		9.05%	2.70%	1.47%	9.11%
Hausman Test (re vs. fe)		-	-	-	23.34
[*p*-value]		-	-	-	[0.000]
***F*-stat (vessel fe vs. pooled)**		-	-	-	5.31
[*p*-value]		-	-	-	[0.028]
***F*-stat (time fe vs. pooled)**		-	-	-	2.52
[*p*-value]		-	-	-	[0.1287]
BP test (re vs. pooled)		-	-	-	-
[*p*-value]		-	-	-	-
Estimation Method		OLS	OLS	OLS	vessel-fe

See notes in Table 4.