View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Bradford Scholars

UNIVERSITY OF BRADFORD
MAKING KNOWLEDGE WORK

Learner Support Services

The University of Bradford Institutional Repository

http://bradscholars.brad.ac.uk

This work is made available online in accordance with publisher policies. Please refer to the repository record for this item and our Policy Document available from the repository home page for further information.

To see the final version of this work please visit the publisher's website. Available access to the published online version may require a subscription.

Author(s): : Kavussanos, M. G. and Tsouknidis, D. A.

Title: The determinants of credit spreads changes in global shipping bonds.

Publication year: 2014

Journal title: Transportation Research Part E: Logistics and Transportation Review.

Publisher: Elsevier.

Link to original published version: http://dx.doi.org/10.1016/j.tre.2014.06.001

Citation: Kavussanos, M. G. and Tsouknidis, D. A. (2014) The determinants of credit spreads changes in global shipping bonds. Transportation Research Part E: Logistics and Transportation Review, 70 (October): 55–75.

Copyright statement: © 2014 Elsevier. This is the author's version of a work that was accepted for publication in Transportation Research Part E. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in Transportation Research Part E: Logistics and Transportation Review, 70 (October): 55-75. http://dx.doi.org/10.1016/j.tre.2014.06.001

The determinants of credit spead changes in global shipping bonds

Manolis G. Kavussanos[1] **and Dimitris A. Tsouknidis**[2]

Keywords: Bond spreads; Shipping finance; Panel data; Two-way clustered standard errors; Shipping.

JEL Classification: G21, G32, G33, E32.

Corresponding author: Manolis G. Kavussanos, Department of Accounting and Finance, Athens University of Economics and Business, 76 Patission St, 10434, Athens, Greece. Email: mkavus@aueb.gr, Tel: +30 210 8203167, Fax: +30 210 8203196.

[1] Manolis Kavussanos, Department of Accounting and Finance, Athens University of Economics and Business, Athens, Greece.

[2] Dimitris Tsouknidis, Department of Accounting, Finance and Economics, Regent's University London, London, UK.

The determinants of credit spead changes in global shipping bonds

Abstract

This paper investigates whether bond, issuer, industry and macro-specific variables account for the observed variation of credit spreads' changes of global shipping bond issues before and after the onset of the subprime financial crisis. Results show that conclusions as to the significant variables of spreads depend significantly on whether two-way cluster-adjusted standard errors are utilized, thus rendering results in the extant literature ambigious. The main determinants of global cargo-carrying companies' shipping bond spreads are found in this paper to be: the liquidity of the bond issue, the stock market's volatility, the bond market's cyclicality, freight earnings and the credit rating of the bond issue.

Keywords: Bond Spreads; Shipping Finance; Panel Data; Two-way clustered standard errors, Shipping.

1. Introduction

Public debt became popular as a source of funds for the ocean-going shipping industry from the mid-90's onwards – see for e.g. Stopford (2009). This has reflected: First, the increasing move of many shipping companies from family to corporate entities, providing thus the structure which can facilitate corporate bond issues; second, the realization that there are tax advantages in raising funds through bonds. This is because, accounting wise, interest coupon payments are considered as costs and are thus reducing the tax-bill, and as a consequence the cost of capital for the shipping company; third, access to capital markets through this channel can provide an alternative to traditional bank finance, particularly in periods when the banking sector has been strugling to provide funding. This has been particularly a problem following the onset of the banking-financial crisis of 2007. As discussed in Albertijn et al. (2011), utilizing data from ABN AMRO (2011), before the subprime financial crisis of the years 2007-2009, 75% of the external funding in shipping came from banks, while bonds and public equity provided only about 5%. However, alternative sources of funding, including bond issues has assumed an increasing role during the bank-funding shortage periods.

Public debt then is a multi-billion dollar source of capital for the maritime industry – see for e.g. Stopford (2009) and Albertijn et al. (2011). A major issue that determines the final cost of capital to the shipping company issuing bonds as well as for the return that investors make by placing their money in them, is the spreads that such bonds bear. Bond spreads are premiums above the risk free rate, which investors require as compensation for the risks undertaken when investing in them. These "extra" returns compensate bondholders for undertaking several types of risks associated with the bond issue. They include: default risk, defined as the probability of default of a bond issue; liquidity risk, representing the risk that a bondholder cannot sell a bond at will within a short period of time or without a substantial discount in its price; and market risk, which refers to the risk of there being a significant discount in the market price of a bond as a consequence of a depressed market.

The identification of the determinants of shipping bonds spreads is of primary interest to participants in the market, such as to shipowners, banks, and individual or institutional investors. A number of finance professionals, such as bond portfolio managers working for hedge or mutual funds, are interested in the pricing of shipping bonds, since many of them consider investments in shipping as an alternative investment category. Holding shipping bonds enables them to create well diversified portfolios – see for e.g. Drobetz et al. (2010). Moreover, the identification of the determinants of shipping bond spreads, provides shipping companies with a better indication of the factors that eventually determine the cost of capital for funds which emanate from public debt. In this way, shipping companies can compare more effectively the cost of capital arising from issuing public debt with that from alternative sources of capital and thus allow for more accurate estimations of the Weighted Average Cost of Capital (WACC) they face.

Corporate bonds pricing

Efforts, to understand the pricing of corporate bonds have been made amongst others by Fridson and Garman (1998), Collin-Dufresne et al. (2001), Longstaff et al. (2005), and Ericsson and Renault (2006). Typically, the factors proposed fall into three categories: bond, industry and macro-specific ones. For instance, Fridson and Garman (1998), using a sample of high yield bonds for the US market over the period 1995 to 1996, investigate the determinants of bond spreads for the high yield segment[3]. The factors they find significant are credit ratings and terms to maturity. In another study, Collin-Dufresne et al. (2001) utilize a sample of investment-grade corporate bond issues for the US market over the period 1988 to 1997. They show that there is an unknown common factor which affects all bond issues and creates a large unexplained component of credit spreads. Longstaff et. al. (2005) use credit default swap (CDS) data for the US market over the period 2001-2002. They show that the majority of the variation in corporate spreads is due to default risk, whereas the non-default component is time varying and is strongly related to measures of bond-specific illiquidity as well as to macroeconomic measures of bond market liquidity. Ericsson and Renault (2006), using data for corporate bonds in the US market for almost a decade, suggest that liquidity risk is the missing factor for the unexplained component of bond spreads variation, but they could not explain much of the variation observed in credit spreads. Chen et al. (2007) utilize a sample of corporate bonds for the US market over the period 1995 to 2003 and show that liquidity risk is a major determinant of corporate bond spreads both in investment and non-investment grade bonds. They conclude that default risk measures cannot fully explain the variation of corporate bond spreads in levels or in changes. Dick-Nielsen et

[3] These are bond issues rated BB+ and below in the Standard and Poor's credit rating scale.

al. (2012) investigate the liquidity of bond spreads before and after the onset of the subprime crisis and show evidence that liquidity risk measures account for a large part of the observed variation in corporate bond spreads after the onset of the crisis.

Shipping bonds pricing

The majority of corporate bonds issued by the cargo-carrying shipping companies fall into the high yield segment, bearing relatively higher spreads compared to issuers in other segments of the economy. The same holds for the sample utilized in this paper, which comprises 83% high-yield and only 17% investment grade bond issues. The mean spread of shipping bond issues for the sample period 2003-2010, used in this paper, is 676.19 basis points. For the period before the subprime financial crisis, covering the period January 2003 to July 2007, the average spread is 426.58 basis points, while for the period after the onset of the crisis, covering the period August 2007 to June 2010, the average spread is 963.95 basis points. In comparison to these, Friewald et al. (2012) report a mean spread of 287 basis points for a sample that includes the great majority of corporate bonds traded in the US market, covering the period 2004 to 2008, while Helwege et al., (2014) report a mean spread of 334 basis points for a wide sample of US corporate bonds over the period 2002-2010.

The underlying reason for the majority of the shipping bonds being classified in the high yield segment and as a consequence for the high spreads displayed, is that the potential cash flows of shipping companies are subject to substantial volatility (Kavussanos, 2003), pronounced cyclicality (Stopford, 2009) and distinct seasonality (Kavussanos and Alizadeh, 2001). The main reason for these is that, shipping companies operate in extremely competitive international markets, where the freight rates of the vessels are determined on a day-to-day basis by prevailing demand and supply conditions. Supply for freight services is relatively flat at low levels of freight rates as there is a surplus capacity in the market in terms of laid up vessels and slow steaming of the vessels that are at sea; as a consequence increases in demand can be absorbed by raising speeds and taking vessels out of lay up to satisfy the increased demand without the need for overly increase in freight rates. At higher freight rates, supply is inelastic, as it takes two to three years to build new vessels and put them into the market in response to increases in the demand for freight services; as a consequence, freight rates respond sharply to clear the market. On the demand side, the demand curve is inelastic, as typically the freight cost is only a small proportion of the final value of the commodity carried; as a consequence, changes in freight rates have a small impact on the demand for freight services. Both global and local demand for freight services can fluctuate substantially over short time intervals and contain seasonal components, due to the seasonal demand for commodities carried by vessels, such as grains, oil, etc. All the above create substantial volatility in freight rates, in the cash flows that vessels generate and in the value of the assets themselves, the ships. As a consequence, there is increased uncertainty regarding the ability of shipping companies, that have borrowed funds, to generate sufficient cash-flows to cover the operating costs of vessels and to service debt repayments due[4]. This uncertainty is exacerbated by volatile bunker fuel costs, exchange rates, interest rates, political events, as well as global and local conditions in regions and ports around the world, all of which affect shipping companies' balance sheets – see for example Kavussanos and Visvikis (2006) for details. Such uncertainty about cash flows is perceived to be risky by investors, requiring compensation for undertaking these risks, in the form of higher coupons and higher spreads.

The objective of this paper is to enhance the following very thin literature on bonds issued by shipping companies. Leggate (2000) considers a sample of 33 newly issued European shipping bonds, over the period 1997-2000, and identifies among others, a negative relationship between credit ratings and shipping bond spreads and a positive relationship between coupons and these spreads. Grammenos and Arkoulis (2003) investigate the determinants of pricing of new high yield bond offerings of US shipping companies for the period 1993–1998, during which 30 high yield bonds were issued. Credit ratings are found to be the major determinant of the yield spread of the bond offerings, with financial leverage and shipping market conditions following. However, both studies follow cross-sectional pooled regression analysis. As explained later in the paper, this analysis considers relationships at a specific point in time and misses the time series dimension that may be prevalent in the data. In a later study, Grammenos et al. (2007) re-examine the issue by using a sample of 40 seasoned[5] high yield bond offerings from shipping companies in the US market for the period 1998-2002, where panel data techniques are utilized and the time series dimension of the data is captured. The main factors found significant in explaining bond

[4] Credit Rating Agencies (CRA) rate shipping companies and their bond issues, according to their creditworthiness. Due to the aforementioned high volatility in freight incomes and vessel values, CRA's typically classify shipping companies mostly in the high yield segment.

[5] A "seasoned bond" is a bond which is trading into the secondary market, as opposed to being a new issue.

spreads were credit ratings, terms to maturity, changes in earnings in the shipping market, the yield of 10-year Treasury bonds and the yield of the Merrill Lynch single-B index.

However, the above studies suffer from a number of shortcomings, which this paper addresses as follows: First, as shown by Petersen (2009) and Thompson (2011), studies which use panel data should base inferences on adjusted for firm and time effects' standard errors. Such two-way adjustment produces the "correct" higher standard errors and makes them robust to correlation and heterogeneity effects. These adjusted standard errors have been shown to be necessary, to enable reliable inferences in panel data models. Earlier studies in shipping bonds literature did not do that, rendering their inferences questionable. This paper applies the Petersen-correction and shows through simulations, that explanatory variables may be falsely uncovered as significant in explaining shipping bond spreads, due to the this reason. Second, a number of risk factors are examined for the first time and found significant as explanatory variables of shipping bonds spreads. They include the Merrill Lynch's (ML) GISC Global Services Cyclical Bond Index that includes all corporate bonds issued by cyclical services issuers at a global scale, thereby capturing any cyclical effects present in industries; a constructed freight rate index, representing freight income, based on the vessel profile of the bond issuer and the VIX Index, as an indication of the expected stock market's volatility. Finally, the paper examines for the first time the effect of the financial crisis on the determinants of shipping bond spreads. Third, the paper utilizes a sample of 54 shipping bonds, which cover the 'global' shipping bond market and not only the US or only Europe. This is deemed important, as the main market players in shipping markets include shipowners aiming to raise capital for their business through bond issues, banks financing shipping projects, and individual or institutional investors who act as global investors. Such market players are likely to consider shipping bond issues across the globe, and not limit themselves to a particular geographical region of the world. To this extent, it seems rational to examine shipping bonds across international markets. Fourth, this paper utilizes a larger sample compared to the aforementioned studies, both in terms of the number of bond issues (and geographical dispersion as mentioned before) and in terms of the time span - covering a time period of almost 8 years, from 2003 to 2010. Such a longer period of time covers entire shipping business cycles, which typically last between 5 and 7 years, as Stopford (2009) suggests. As a consequence, factors that influence the variability of shipping bond spreads, which are directly related to the phase of the shipping freight market can be accommodated in the model.

The rest of this paper is organized as follows. Section 2 outlines the methodology. Section 3 describes the dataset. Section 4 presents the results. Section 5 discusses the main findings of the paper, whereas Section 6 concludes the paper.

2. Methodology

The following generic panel data regression model is used to explain the bond spreads of global shipping companies' bond issues:

$$y_{it} = \mu + a_i + \alpha_t + \sum_{g=1}^{G} \beta_{gi} x_{git} + \sum_{k=1}^{K} \gamma_{ik} z_{kt} + u_i + \varepsilon_{it} \; ; \qquad (1)$$

$$\varepsilon_{it} \sim i.i.d.(0, \sigma_\varepsilon^2), E(u_i) = 0, E(u_i^2) = \sigma_u^2, E(\varepsilon_{it} u_j) = 0, for \; \forall \; i, t, j; E(u_i u_j) = 0, if \; i \neq j$$

where the bond spread (y_{it}) is defined as the yield to maturity of the shipping bond minus the yield to maturity of a corresponding, in maturity, US Treasury bond; i=1, 2,…,n identifies the bond issue; t=1, 2,…,T denotes the time period; x_{git} is a matrix of G explanatory variables which are bond-specific; z_{kt} is a matrix of K bond-invariant explanatory variables, which are issuer-specific, industry-specific and/or macro-specific; α_i and α_t are constant terms, which allow for the possibility of (constant) heterogeneous behavior between the bond issues (α_i) and over time periods (α_t), respectively; μ is an overall regressor constant, which is introduced in case both bond and time specific effects are estimated (through the α_i and α_t), to control for perfect collinearity in the model[6]; β_{gi} measures the effect that the g^{th} explanatory variable has on the credit spread of bond i; γ_{ik} estimates the sensitivity of the credit spread of bond i on the k^{th} variable (common to all bond issues)[7]; ε_{it} is a white noise error term, following a distribution with mean zero and variance σ_ε^2 and stands for the within-bonds errors; u_i stands for the between-bonds errors and is introduced in the model in order to allow for the possibility that bond-specific constant terms are randomly distributed across

[6] In that case, one of the α_i or α_t are dropped to enable estimation.
[7] In the analysis, γ_k is used instead of γ_{ik} in order to identify any common patterns on how shipping bonds respond to industry or macro factors.

individual bond issues[8]. A consequence of the above is that both the u_i and ε_{it} are orthogonal with the regressors in the model; that is, $E(u_i x_{git}) = E(u_i z_{kt}) = 0$ and $E(\varepsilon_{it} x_{git}) = E(\varepsilon_{it} z_{kt}) = 0$.

Given the nature of the dataset, which consists of both time series and cross-sectional observations, panel data regressions are utilized to estimate Eq. (1). This is a generic panel data model that allows for bond, time specific and random effects. By placing/testing restrictions on the model one can arrive at restricted versions of it, which may be appropriate in describing the data. Thus, a pooled Ordinary Least Squares (OLS) regression model is the most restricted version, and is obtained when: $\alpha_t = 0$ for $\forall$ t=1,…,T, $\alpha_i = 0$ for i=1,…,n and $E(u_i) = 0$. When $\alpha_t = 0$ for $\forall$ t=1,…,T, $\alpha_i \neq 0$ for i=1,…,n and $E(u_i) = 0$, a fixed-effects OLS model is relevant. This allows for heterogeneity amongst individual shipping bonds, which are constant over time. It is a reasonable model when differences between shipping bonds can be viewed as parametric shifts of the equation. An F-test with (n-1, nT-n-(K+G)) degrees of freedom can be used to test it vs. the pooled OLS model. A time, rather than a bond, fixed-effects model is relevant when α_t's are not equal between them. Even though, such a model is rarely used in practice, the time effect for the data set utilized in this paper is also tested for through an F test. A random effects model (with respect to the bond variation) is relevant when $u_i \neq 0$, for $\forall$ i=1….,n; in this case, the individual impact for each bond is $\alpha_i + u_i$ and is identical for each time period. The u_i term for each bond picks up any factors which are specific to each individual bond, that are not however accounted for explicitly in the regression. As a consequence the u_i's are independent/not correlated with the regressors in the model. In this case Generalized Least Squares (GLS) estimation is needed to obtain efficient estimates of the parameters. To test whether a random-effects model is appropriate vs. a pooled OLS one, Breusch and Pagan (1980) proposed a Lagrange Multiplier (LM) test statistic, which tests $H_0: \sigma_u^2 = 0$ vs. $H_1: \sigma_u^2 \neq 0$, where LM ~ $\chi^2(1)$. The Hausman (1978) Wald test statistic can be used to select between fixed-effects and random-effects specifications by testing the null hypothesis that $H_0: E(u_i x_{git}) = E(u_i z_{kt}) = 0$ vs. $H_1: E(u_i x_{git}) = E(u_i z_{kt}) \neq 0$. Thus, under the null, the random effects model is not rejected, while if H_0 is rejected the fixed effects model is estimated.

[8] This is typical when the bonds sampled are drawn from a large population of data. In this paper, the existence of such effects is determined empirically, as explained later in the paper.

A potential problem with the estimation and testing of Eq. (1) is the presence of endogeneity. This could derive either from reverse causality or an omitted variables bias. A simple, albeit imperfect remedy, is to include a time-constant entity fixed effect. As discussed next, bond-specific fixed effects models are part of the estimation procedure. The following procedure is followed for all the estimated models presented later in the paper. Once selected, the fixed- or random-effects model is tested against a pooled OLS specification. The following possibilities are distinguished: (1) In case a fixed-effects model is favored by the Hausman (1978) test, an *F*-test is performed in order to test the fixed-effects specification versus a pooled OLS one. This is achieved by testing the null hypothesis that all bond-specific constant terms, introduced in a firm fixed-effects specification, are jointly equal to zero (H_0: $\alpha_i = 0$, for i=1,..., n). Also, a time fixed-effects specification is tested vs. the pooled OLS one, through an F-test statistic (H_0: $\alpha_t = 0$, for t=1, 2,...,T). If a fixed-effects model is favored, it is estimated by Maximum Likelihood (ML) methods. (2) In case a random-effects model is favored by the Hausman(1978) test, a Breusch-Pagan (1980) LM test is conducted to test H_0: $\sigma_u^2 = 0$ vs. H_1: $\sigma_u^2 \neq 0$ with LM ~ $\chi^2(1)$. If the null hypothesis is rejected, a random-effects regression is estimated instead of a pooled OLS one. In such a case, GLS methods are used for estimation purposes.

As is well known, one of the assumptions underlying OLS estimation, which is necessary for obtaining unbiased standard errors, is that the error terms are independent and identically distributed. When the latter are correlated across observations, the OLS standard errors are biased downwards, leading to upward biased *t*-statistics. Petersen (2009) shows that with panel datasets, such as the one utilized in this paper, when estimating fixed effects models, bond clustering alone leads to downward biased standard errors for the factors that change over time, and time clustering alone leads to downward biased standard errors for the factors that change over bonds. Such downward biased standard errors lead to higher t-statistics and increase the probability of mistakenly accepting as significant, explanatory variables which may not be so. As Petersen (2009) points out, this is the case for the majority of papers published even in top finance journals. This is also the case for the papers investigating the determinants of US shipping bond spreads. For example, Grammenos et. al. (2007) report white-adjusted standard errors for their panel data regressions, which, however, are not adjusted for the bond- and time- cluster dimensions. Moreover, the reported, white-adjusted standard errors, are biased downwards and thus the t-statistics are biased upwards, exacerbating the problem of biased inferences. Correcting this problem involves estimating both bond and time dimensions cluster-adjusted standard errors, as introduced by Petersen (2009) and described later by Thompson (2011). This two-way clustering is adopted in the fixed effects specifications estimated in this paper. In case a GLS random-effects specification is favored, Petersen (2009) shows that bond clustering alone is adequate to obtain unbiased standard errors and therefore this is adopted here. Finally, it should be noted that, since most variables in Eq. (1) are found to be *I*(1), it is estimated in first differences. This makes the α_i terms vanish.

All, potentially relevant in explaining shipping bond spreads, x_{git} and z_{kt} variables entering Eq. (1), along with their precise definitions and their a priori expected signs, are presented next and summarized in table 1. **Bond-specific factors include**: (1) The *term to maturity*, defined as the remaining life of each bond issue until final settlement. The expected sign is undetermined a priori. As suggested by, for instance, Collin-Dufresne et. al. (2001), when a bond issue survives the first years of payments there is less uncertainty for sudden losses in value and deviations from the scheduled repayments (coupons and principal), which implies a negative expected sign. However, this may not be the case in the risky shipping sector, since surviving the first years is not a guarantee for the repayment of the remaining coupons and principal value payments. This is because, freight rates and vessel values exhibit excess volatility, cyclicality and seasonality, characteristics which are unique to shipping. As a consequence, both a positive and a negative value of the estimated coefficient can be justified. (2) *The market value of the bond issue,* measured as the current market price of the bond multiplied by the number of bonds currently on issue, is used as a proxy[9] for the liquidity of the bond issue. The market value coefficient is expected to be negative, since high market value implies low liquidity risk, leading to expectation of a lower spread. (3) The *credit rating,* assigned to the bond issue by Credit Rating Agencies (CRA's). The credit rating coefficient is expected to have a positive sign, since a higher rating in numeric value

[9] Other proxies for bond liquidity utilized in this study include: the coupon rate, where higher coupon rates are expected to be associated with higher liquidity since short-term investors may be attracted from collecting high coupons by holding the bond for a period of time and then sell it back to the secondary market; the place of trading, where stock exchanges with larger volumes of transactions and total capitalization are expected to be associated with higher liquidity and depth of market; and finally the name of the company, where "stronger" brand names of shipping companies are expected to be associated with larger trading volumes and thus higher liquidity for their public debt issues. However, the aforementioned proxies of bond liquidity were not found significant in explaining shipping bond spreads.

(AAA = 1 to D = 22) indicates a higher probability of default for the bond issue and thus a higher bond spread. The mapping between credit rating scales from Moody's, Standard & Poor's (S&P), Fitch, the composite rating of Merrill Lynch, along with the corresponding numeric values used in this study to estimate the model of Eq. (1), is presented in table 2. This linear mapping of credit ratings with integer numbers is typically used in the literature in similar studies, see for example Fridson and Garman (1998), Collin-Dufresne et al. (2001) and Friewald et al. (2012). (4) The *Seniority* of the bond issue, which refers to the hierarchy of priority, when paying the debt back, in case a company faces default.[10] This variable is introduced as a dummy variable in the estimated models, in higher priority order (1 = "First Mortgage" to 6 = "Senior Subordinated Debt"). The seniority coefficient is expected to be positive since the higher the value of the dummy, the lower is the seniority and so the higher is the spread expected to be.

The **issuer-specific risk factors** include: (1) The *market value of equity of the issuer (the shipping company) / total assets (TA)*. This is expected to have a negative sign since, a high ratio indicates less uncertainty regarding honoring the issuer's debt repayments due. As a consequence, it is expected that the bonds issued by companies with higher "market value of equity to total assets" ratios will be associated with lower spreads. (2) Altman's (1968) z-score, which provides an indication of the likelihood of default for the company that has issued the bond.[11] Its coefficient is expected a priori to have a negative sign. This is because a higher z-score indicates a lower probability of default for the issuer of the bond, leading to a higher bond spread expectation. Altman's z scores are calculated for each company by Bloomberg data vendor.

[10] We thank an anonymous referee for this suggestion.

[11] Altman's (1968) z-score developed by Edward Altman, utilizes financial data to compute the z-score of each company. Five financial ratios are utilized to estimate z-scores, namely: working capital (WC), retained earnings (RE), earnings before interest and taxes, sales (S), total assets (TA), market value of equity (ME) and total liabilities (TL). The z-score for a company is given as: z = 1.2 x (WC/TA) + 1.4 x (RE/TA) + 3.3 x (EBIT/TA) + 0.6 x (ME/TL) + 0.999 (S/TA). The ratio (WC/TA) captures the short-term liquidity of a firm, the RE/TA and EBIT/TA measure the historical and the current profitability respectively, the ME/TL is a measure of leverage and finally the S/TA indicates the market competitiveness of a company. The model is constructed such as the higher the z-score the less the default risk of a company. A z-score above 3 is an indication that default is very unlikely to happen, a z-score below 1.8 indicates that a default is very likely, while values between 1.8 and 3 is a "gray" area. Altman's (1968) z-score coefficients have been originally estimated by Altman using US data.

Industry and macro-specific factors utilized include: (1) The freight earnings of shipping companies in the main subsector(s) of shipping that their income comes from[12], measured either through Clarkson's-constructed freight earnings' index or through the author-constructured *freight rate combined index*, explained later in the paper. The coefficient of freight earnings variables have negative a priori expected sign, since an increase in their value is an indication of stronger shipping markets. Such conditions make it more likely for shipping bonds to be repaid fully and thus their credit spreads are expected to be lower, and vice versa when the freight markets are in decline. (2) Another industry-specific variable, considered for its potential effect on shipping bond spreads, is *Merrill Lynch's (ML) Global Services Cyclical Bond Index (GISC)* [13]. This is a subset of the Merrill Lynch Global Corporate Index and includes all securities of cyclical services issuers. It is used as a proxy for the sentiment of the bond market for the issuers operating in highly cyclical industries, such as that of shipping. Its coefficient is expected a priori to have a positive relationship with shipping bond spreads, since if the bond index price increases this will reflect a price increase in the majority of bonds traded in the market. (3) The *HW00 (ML) Bond Index* is the Merrill Lynch (ML) Global High Yield Bond Index[14]. It is used to capture the sentiment of the the high yield bond market segment, since shipping bonds issued by cargo carrying shipping companies mostly belong to this segment. Its coefficient is expected a priori to have a positive sign, since, the higher the yield of the HW00 bond index the higher the spreads of the high-yield shipping bond issues are expected to be. (4) *The MSCI World Index*[15], which is used to capture the global stock market sentiment. A negative sign is expected, since an

[12] As suggested in Kavussanos(2003), the segmentation of the shipping market is quite distinct, and it is expected that this may also affect the bond spreads' behavior issued by shipping companies operating in different segments of the market (dry cargo, tanker, containers, etc.).

[13] The Bank of America (BofA) Merrill Lynch Global Cyclical Index tracks the performance of cyclical services issuers of corporate debt, which is publicly issued in the major US and eurobond markets. Qualifying currencies and their respective minimum size requirements of the bond issues (in local currency terms) are: Australian Dollar (AUD) 100 million; Canadian Dollar (CAD) 100 million; EUR 250 million; JPY 20 billion; GBP 100 million; and USD 250 million. Qualifying securities must have at least one year remaining term to final maturity and a fixed coupon schedule. Original issue zero coupon, "global" securities (debt issued simultaneously in the eurobond and domestic bond markets), 144a securities, pay-in-kind securities and toggle notes qualify for inclusion in the Index. Callable perpetual securities qualify, provided they are at least one year from the first call date.

[14] The selection of bond issues included in the HW00 index meet the following criteria: They have a below investment grade rating based on: an average of Moody's, S&P and Fitch rating; have an investment grade rated country risk (based on an average of Moody's, S&P and Fitch foreign currency long term sovereign debt ratings); have at least one year remaining term to maturity; a fixed coupon schedule (issues with floating coupon schedule are excluded); and a minimum amount outstanding of USD 100 million (in order to have sufficient size and trading volumes).

[15] The MSCI World Index is a stock market index maintained by MSCI Inc., formerly Morgan Stanley Capital International, and is used as a benchmark for a global stock portfolio. The index includes 1500 stocks from 23 developed markets in the world.

increase in the global stock market returns implies a general increase in the economic sentiment, which is expected to decrease bond spreads. (5) *Moody's Baa Yield*[16] rated bond index is used to account for the yield in the median credit rating of Moody's credit rating scale (Baa). Its coefficient is expected a priori to have a positive sign since a higher yield of the median credit rated bonds would imply a higher yield for the sample of shipping bonds also. (6) *The VIX Index*, is used to capture the 30-day implied volatility (i.e. the expected volatility) of the S&P 500 index. It is expected to have a positive sign since the higher the expected volatility in the market, the higher is the risk that the investors will be undertaking, and as a consequence the higher would be the return required to compensate investors for the extra risk from a bond over the risk-free rate.

In order to consider whether there is an **"interest rate"** effect on bond spreads, the following variables are also considered as explanatory factors in Eq. (1): (1) *The US 10-year Treasury rate* and (2) *The US 2-year Treasury rate.* They represent the risk-free rates at the corresponding maturities as they refer to bonds issued by the US-government. The a priori sign of their coefficient is negative because, ceteris paribus, the higher the risk-free rate the lower should be the spread. This follows since the bond spread is defined as the yield of the shipping bond minus the yield of the risk-free asset. (3) *The Slope (10-2 year)* of the US treasury rates, defined as the difference between the US 10-year and 2-year Treasury rates, is also included as a potential explanatory variable. The a priori expected sign is positive, since a positive slope indicates higher long-term expected interest rates and thus the issuer's future firm valuation will be reduced, potentially leading to an increase of bond spreads. (4) *The Paperbill*, is defined as the difference of the 3-month non-financial commercial paper rate and the 3-month T-bill secondary market rate. The paperbill spread is considered as a predictor of real economic activity and as such has positive a priori expected sign, since higher values of the paperbill imply deteriorating economic conditions in the market, leading to higher bond spreads.

Finally, **Fama and French (1993) three factors** of: (1) *Excess stock market return*, (2) *Small-minus-Big (SMB) market capitalization* and (3) *High-minus-Low (HML) book to*

[16] Moody's Baa spread index is constructed as the average spread of all the bond issues rated Baa by Moody's rating agency. It is indicative of the average spread that a bond issue with average credit rating exhibits.

market value factors are included in the model, in order to investigate whether systematic stock market risk factors have a role to play in determining bond spreads. [17] The expected signs of the FF three factors are not determined a priori. The inclusion of FF factors is supported by the fact that bond returns are shown to exhibit momentum return premia (see for instance Asness et al., 2013).

3. Data

The dataset examined comprises all bond issues from cargo-carrying listed shipping companies around the world, which were issued or traded during the period January 2003 - June 2010. The sources of information which have been cross-matched to identify the bonds issued exclusively by cargo-carrying ocean shipping companies include: Datastream, Bloomberg, Lloyd's list and Clarkson's Research. In order for a shipping bond issue to be included in the sample, the following criteria must be jointly met: a fixed coupon schedule should be followed (issues with floating coupon schedules are excluded[18], convertible bonds are also excluded); the issuer of the bond should be a listed shipping company, in order to have data for its market capitalization; the majority (over 60%) of the income of the issuer should be earned from shipping transportation activities[19]; the spread, the market value and the maturity of the shipping bond should be available in one of the aforementioned databases;

[17] The Fama and French three factors refer to the US stock exchange and are obtained from Kenneth French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html). They are constructed using the 6 value-weighted portfolios formed on size and book-to-market. The SMB factor refers to the average return on the three 'small' portfolios minus the average return on the three 'big' portfolios; HML factor refers to the average return on the two 'value' portfolios minus the average return on the two 'growth' portfolios; and the excess return on the market refers to the value-weight return of all the Center for Research in Security Prices (CRSP) firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ minus the one-month Treasury bill rate. See Fama and French (1993) for a complete description of the factor returns.

[18] Bond issues with floating coupons are excluded from the sample since their inclusion, even if converted to fixed rate bonds may result in a non-homogeneous bonds sample. This is due to the fact that the pricing of corporate bonds which tie their cash flows (coupons) to floating rates can be substantially different than the fixed rate ones, as suggested in the bonds' spreads literature; see for e.g. Lin et al. (2011), Dick-Nielsen et. al. (2012) and Friewald et al. (2012). In fact, floating and fixed rate bonds are investigated separately in the literature.

[19] Thirty-one(31) bond issues falling into the drilling and cruise sectors are excluded from the sample as the companies issuing them do not fall into the cargo carrying segment of shipping. As a consequence, these companies operate and are influenced by factors which are not related to international cargo trade. For instance, cruise shipping companies are affected by events in the leisure industry which are very distinct to the events affecting the carriage of cargo. Previous studies in the literature do not take this into account (for e.g. Grammenos et. al. 2007), and include also the passenger ferry subsector of shipping in their samples; as a consequence, the interpretation of the freight earnings variable used as explanatory variable in their regression equations is not clear, as they attempt to explain bond spreads of shipping companies that include passenger ferrys through a cargo-related freight index.

and finally, balance sheet and income statement data, should be available on a quarterly frequency, for estimating Altman's z-score (obtained from Bloomberg).

The starting sample comprises 125 shipping bonds issued by "shipping related" companies. However, after meeting the above criteria, the sample falls to 54 bonds, issued by 20 shipping companies. These requirements reduce the available sample but aim to preserve its homogeneity and make conclusions more robust. Table 3, in its different panels, summarizes the shipping bond issues, according to the following criteria: Country of residence of the issuer; the stock exchange where the issue is listed; the vessel profile of the issuer, classifying issuers into a particular subsector of cargo carrying shipping if over 60% of the vessels of the issuer are in that subsector; the credit rating and the seniority of each bond issue. As can be observed in the table, most (42) issues are by shipping companies based in the US, followed by Bermuda (4), International issuers (4) and Marshall Islands (2) ones. The most likely stock exchange where shipping bond issues are listed is NYSE (42), followed by NASDAQ (6), then Oslo Stock Exchange (5) and finally Bursa Malaysia (1). Issues by companies with a diversified[20] vessel profile (30) lead the rest (tankers 14, containers 5 and dry bulk 4) of the shipping subsectors in issuing corporate bonds as a vehicle for financing their activities; the credit ratings and average coupon payments reported in panel D of the table show that the overall average coupon rate is 7.98%. Out of the 54 bond issues, 9 (16.66%) are investment grade, bearing an average coupon of 5.91%. The remaining 45 (83.33%) are speculative grade with an average coupon of 8.28%. Friewald et al. (2012) report a mean coupon of 5.98% for a sample of both investment and non-investment grade bonds for a sample covering the great majority of the U S bond market over the years 2004-2008. These figures show that, on average, shipping bonds carry a higher coupon than corporate bonds in general; As observed in panel E of the table, the following seven types of seniority are met in the sample utilized here (reported in order of seniority): first mortgage, company guarantee, notes, senior notes, senior secured, senior unsecured and subordinated.[21] Fourtysix (46) out of

[20] Diversified bond issuers are defined as those having no more than 60% of their total vessels in only one of the shipping subsectors.

[21] Bond issues follow a hierarchy of priority, when paying the debt back, in case a company faces default. The different types of priority are presented next in higher priority order; For full reference see for e.g. Fabozzi(2007). "First mortgage" refers to the case where a lender has a priority, to be repaid in case of liquidation of the collateral of a shipping company's debt issues; "company guarantee" refers to the case where the company itself is liable for the debt due; "notes" and "senior notes" refer to the case where the debt is covered with financial assets. "Senior secured", "senior unsecured" and "subordinated" are the most common seniorities in corporate bonds, where each term refers to the percentage of financial coverage for the debt issued.

the 54 bond issues are classified into three types of seniority; they are company guarantee 17, senior notes 16 and senior unsecured 13, while the rest are dispersed into the rest of the categories.

Shipping bond spreads[22] for each of the above bond issues are obtained from Datastream, as the difference between the yield-to-maturity of the shipping bond and the yield to maturity of the risk-free asset[23] with a maturity as close as possible to that of the shipping bond. Data for the rest of the variables relating to Eq. (1) are obtained from Datastream, except for the following which are obtained from Bloomberg: the average historical credit ratings assigned to each bond from the three dominant CRA's; the historical values of Altman's z-score; the yield to maturity for the following two Merrill Lynch's Bond Indices: Merrill Lynch Global Services Cyclical Index (GISC) and Merrill Lynch Global High Yield index (HW00). Values for the FF three factors are obtained from Kenneth French's website. Finally, freight rate earnings data are obtained from Clarkson's research. Two alternatives are considered: (1) The ClarkSea index[24], published by Clarkson's Research on a weekly basis, as an indicator of earnings for all the main commercial vessel types involved in ocean cargo transportation of various commodities. (2) A freight earnings variable, which is built by the authors to reflect the composition of the fleet of the issuer. This may be important, as subsectors of shipping follow distinct cycles (see for e.g. Kavussanos, 2010), and as a consequence the ability of a bond issuer to repay the loan can be argued to be judged by investors through the freight market segment into which the assets (vessels) of the company operate and earn their income from. This in turn depends on the composition of the fleet of the issuer. Following this rationale, a weekly "tailor-made" freight rate combined index is defined, which is constructed

---

For example, senior secured refers to the highest seniority of the three, where a high percentage (80%-90%) of the issued debt is covered with financial assets. This is typical for large companies, whereas "subordinated" is the lowest seniority, typical in small companies.

[22] Bond spreads are winsorized at 1st and 99th percentiles. Winsorising refers to the transformation of a variable by replacing the extreme values (i.e. values lower than the 1st percentile and higher than the 99th percentile) with the threshold values of the percentiles, respectively. This reduces the effect of spurious outliers that may exist in the data.

[23] The risk-free asset is appropriately defined by Datastream for each shipping bond issue, as an asset considered "safe" for a short-term period, such as for e.g. the US treasury Bond with the corresponding maturity.

[24] The index is constructed as a weighted average of earnings in all shipping subsectors, with the weights used reflecting the number of vessels in each fleet sector. It is constructed from rates directly collected from Clarkson's brokers on a daily and weekly basis. The sectors covered in the ClarkSea Index are oil tankers (VLCC: 200,000 – 399,999 dwt; Suezmax: 120,000 – 199,999 dwt; Aframax: 75,000 – 119,999 dwt and clean product carriers, dry bulk carriers (Capesize, Panamax, Handymax and Handysize), gas carriers (Very Large Gas Carriers) and fully cellular containerships. Individual indices for each of these subsectors are also constructed by Clarkson's.

as follows: for each bond issue of the sample, one out of the following four ClarkSea indices is assigned based on the vessel profile of the bond issuer: the general ClarkSea index, assigned to the bond issuers with “diversified” vessel fleet profile. That is, companies which have no more than 60% of their fleet in only one of the shipping subsectors; the ClarkSea Bulker, Tanker or Container index, which are assigned respectively to the bond issuers who have more than 60%, of their vessels operating into the dry bulk, tanker or container sectors;[25] In other words, shipping companies with well-diversified fleets are assigned the general ClarkSea index, whereas shipping companies with the majority, over 60%, of their vessels in one shipping sub-sector - bulk, tanker or container, are assigned the corresponding ClarkSea index.

The dataset utilized comprises both time series (390 weekly observations for the period January 2003 - June 2010) and cross-sectional (54 bond issues) data on shipping bond issues. The average number of observations available for each bond issue are approximately 250 weeks, resulting in a final sample of 14,081 bond-weekly observations. A more detailed picture of the dataset on bond spreads is presented in table 4. As observed, most of the issuance activity is concentrated around years 2004-2007, reaching a peak of 25 new bond issues in 2004. This coincides with the unprecedented high freight rates prevailing in the shipping industry during that period but also with the very low average spreads, which for that year stood at 393.92 basis points (bps). The needs for extra funds to invest in new and second hand vessels led shipping companies to seek funding through borrowing in public debt markets. However, after 2007 the issuance activity has been reduced to two issues in 2008 and zero issues for years 2009-2010. This reflected the effect of the global financial and shipping sector crisis but also the very high spreads, which stood on average respectively at 882.13 and 753.74 bps for these two years. As can be observed, the average spread for the active shipping bonds in the sample fell substantially from the high of 795.88 in 2003 to only 393.92 basis points in 2004 and 351.65 basis points in 2005. Thereafter they have increased at a steady rate of around 70 bps (0.7%) each year for the period 2006 to 2007. The financial/shipping crisis had a significant impact on spreads, which sees them almost doubling in the period 2007-2009, from 466.48 in 2007 - 882.13 bps in 2009. The standard deviation of the bond spreads per year varies substantially between the low of 393.92 in 2003

[25] The shipping companies’ websites were used in 2010, in order to identify the shipping sub-sectors into which the fleet of bond issuers operate, at the time the shipping bond is first issued.

to the high of 927.05 bps in 2010. The total market value of active bonds has increased substantially, quadrabling between the years 2003 - 2004. Thereafter, it increased at a lower rate, reached a peak in 2007 and started falling thereafter as no new bond issues took place in 2009 or 2010. The average coupon values, apart from the very high value of 9.45% in 2003, range between 7.75% and 8.23%. The annual average credit ratings fall between BB2 and BB3 levels placing shipping bonds in the speculative grade category. Finally, the average maturity of bonds issued by shipping companies is 6.51 years, while it is clearly evident that the average maturity has declined steadily from 8.09 years in 2004 to 4.83 years in 2010, reflecting the riskier economic and shipping environment companies operate in.

Table 5 presents summary descriptive statistics for all the variables utilized to estimate Eq. (1). With the exception of the US 10-year Treasury rate, the rest of the variables deviate significantly from the normal distribution as indicated by Jarque-Bera (1980) test statistics and their corresponding p-values reported in square brackets. The stationarity of the series is examined through Augmented Dickey-Fuller (1981) test, where the lag length of the ADF statistic is determined in each case by minimizing Schwarz's Bayesian Information Criterion (SBIC). At 5% significance levels, Altman’s z-score, seniority, the VIX Index, the paperbill spread, and the FF three factors variables seem to be I(0) series; the rest of the variables are I(1), and are first differenced for estimation purposes.

4. Results

Eq. (1) is estimated for three periods: the whole period, January 2003 - July 2010; the pre-financial crisis period, spanning January 2003 - July 2007;[26] and the period after the onset of the crisis, August 2007 - June 2010. Six different model specifications are estimated for the whole period and for each sub-period and reported in tables 6, 7 and 8, respectively. In each table the six different specifications are as follows: models M1-M5 include variables only from one of the following 4 groups of potential risk factors: bond- and issuer-specific variables; industry and macroeconomic variables; interest rate related variables and the FF three factors. It should be noted here that, models M1 to M5 are estimated solely to assess the

[26] The date of August 2007 is selected as the cut-off point for the initiation of the subprime crisis. This date is shown in the literature as the most representative for the starting point of the subprime financial crisis and is adopted by a number of papers examining bond spreads determinants in the general finance literature (see amongst others: Dick-Nielsen et al. (2012); Longstaff (2010); Friewald et al. (2012) and Eichengreen et al. (2012)).

explanatory power of the different groups of factors and not to draw inferences about the significance of individual variables. Specification M6 plays that role. It is the most parsimonious model, which includes only the statistically significant variables from all groups of risk factors and is selected based on: minimization of the SBIC criterion and the maximization of the Adjusted R^2 values of the estimated models. Specifications M2 and M3 share the same industry and macroeconomic variables, but M2 includes in the specification the ClarkSea index. Model M3 utilizes the freight rate combined index, defined earlier in the paper. This distinction is made in order to assess the explanatory power of each of these two freight rate indices in explaining shipping bonds spreads.

In order to avoid multicollinearity issues in the final M6 models, which would lead to biased estimated coefficients and standard errors, care is taken not to use simultaneously during estimation, variables with linear correlations in excess of 60%.[27] Of course, beyond this rule of thumb, economic intuition guides us to avoid using at the same time in the estimated models, variables which carry similar information. The ClarkSea and the freight rate combined index, the MSCI world stock index and the excess stock market return, the ML GISC, ML HW00 and Moody's Baa are examples of pairs/sets of variables which carry similar information between them. Care is taken not to include them simultaneously in the same model during estimation. As a robustness diagnostic test for the absence of multicollinearity in the estimated models, the Variance Inflation Factors (VIF) are computed for each variable of the M1-M6 specifications.[28, 29] Only the mean (over all coefficients) VIF values are reported in tables 6, 7 and 8. All these values are far lower than 10, verifying that multicollinearity is not detected in any of the reported models.

[27] The same threshold of 60% is adopted in the general literature of bond spreads' determinants (see for e.g. Dick-Nielsen et al., 2012). The correlation matrices for the three periods examined are available from the authors on request. In fact, the great majority of the pairs of variables exhibit linear correlations significantly lower than the threshold of 60%.

[28] We thank an anonymous referee for this suggestion.

[29] VIF coefficients for each explanatory variable are computed through the following formula: $VIF_i = \frac{1}{1-R_i^2}$, where R_i^2 is the coefficient of determination of an auxilliary regression in which the dependent variable is the independent variable under scrutiny for multicollinearity in the original equation, while the independent variables in this auxiliary regression are the rest of the independent variables of the original model (for details see Gujarati and Porter 2008). As a rule of thumb, variables with VIF values greater than 10 indicate high collinearity, i.e. that the variable could be considered as a linear combination of other independent variables. Only the mean VIF values are reported here for economy of space; however, all individual coefficient values are well below 10, indicating the absence of collinearity between the explanatory variables in the estimated models. The analytical results are available from the authors on request.

In order to select the appropriate panel data model, the Hausman (1978) test is utilized to choose between the fixed-effects and the random-effects models. Following that, the selected fixed effects or random-effects specification is tested versus a pooled OLS model. In this way, if a fixed-effects specification is favored by the Hausman(1978) test, an F-test is utilized to test the null hypothesis that all the bond-variant constant terms (α_i) introduced into a fixed-effects model, are equal to zero – i.e. versus a pooled OLS model. A separate F-test is conducted to test if a time fixed-effects specification - which can be estimated by introducing time dummies - is appropriate versus a pooled OLS one. The null hypothesis of the latter F-test is that all the introduced time dummies are equal to zero. In case a random-effects specification is favored by the Hausman (1978) test, the Breusch-Pagan(1980) LM test is utilized to test the null hypothesis that a pooled OLS specification is preferable instead of a random-effects model. When fixed-effects panel data specifications are favored, ML methods are used to estimate the models. When random-effects specifications are selected, GLS methods are used for estimation purposes (see for e.g. Wooldridge, 2002, for details). In addition, the F-statistics for the fixed-effects specifications and the Wald test statistics for the random-effects specifications are utilized to test the null hypothesis that all the estimated coefficients of each estimated model M1 - M6, are jointly equal to zero. The latter is strongly rejected for all the estimated models. The most parsimonious model M6, is based on the smallest Schwarz BIC (1978) value and the highest adjusted R^2 value. The bond and time clusters values reported correspond to the number of bond issues and weekly observations, respectively.

For all estimated models the reported estimated standard errors are unbiased cluster-adjusted standard errors, as suggested by Petersen (2009). For the fixed-effects specifications, two-way cluster-adjusted standard errors are estimated, whereas for the random-effects GLS specifications, bond cluster-adjusted standard errors are estimated. This is shown by Petersen(2009) to produce unbiased standard errors for panel data regressions. The corresponding t-statistics are reported below the estimated coefficients in the tables.

4.1 Main empirical results

Table 6 reports the estimated models M1-M6 for the whole period, January 2003 to June 2010. Hausman (1978) tests favor fixed-effects specifications (vs. random coefficient ones) in models M2, M3 and M6, while random coefficient specifications are selected for models M1, M4 and M5. Models M2, M3 and M6 are subsequently tested vs. a corresponding pooled OLS model through F-tests; as can be observed, in all cases bond and time fixed effects models are selected. In models M1, M4 and M5, the Breusch-Pagan (1980) LM test is performed to select between random-effects and pooled OLS models. The former is rejected in all cases. Thus, pooled OLS estimations are followed in M1, M4 and M5 specifications. In order to investigate for the possibility that the results are driven by an unidentified time-invariant country characteristic, we also include country of residence of the issuer fixed-effects in all M6 most parsimonious specifications for all the three periods examined. However, our results remain virtually the same. This further supports the argument of the paper that shipping bond markets should be viewed as a 'global' market rather than as one that is affected by country or regional differences.[30]

The estimated models are considered next. To start with models M1 to M5, these are estimated and presented in the paper with the sole purpose of assessing the impact of each group of factors in explaining shipping bond spreads and not to select one of these as the final model that determines spreads. It is only the first step to getting some idea of the variables that may be significant in the final most parsimonious M6 models. Care then should be taken, not to give too much weight to the interpretation of the coefficients in these models, as they possibly suffer from omitted variables' bias. In saying that, a brief comparison of these results is made next before moving to the well specified – final model M6, upon which inferences are based.

Model M1, which includes bond- and issuer-specific factors, exhibits the highest adjusted R^2 (18.20%) compared to models M2-M5. The coefficients found significant have the a priori anticipated signs, except Altman's z-score and the seniority dummy. They show that the change in the term to maturity, the change in the market value of the bond, the change in the rating and the change in the ratio of the stock market capitalization of the issuer over total

[30] We thank an anonymous referee for this suggestion.

assets are all significant in explaining the credit spread changes of shipping bond issues. Columns M2 and M3 report the estimated results from the set of the industry-specific and macroeconomic factors, as explanatory variables of shipping credit spread changes. Care is taken in these models not to include at the same time during the estimation variables which are collinear. Whether the ClarkSea index or the freight combined index is utilized, the results are qualitatively the same. That is, the estimated industry and macro-specific variables have the correct sign while the fourth lag of these freight indices is found significant. This dynamic model is discussed further later on. It seems that this group of factors alone can explain approximately 7% of the overall variation in weekly credit spread changes of shipping bonds. This is considerably lower, in comparison to the proportion of the variation explained by the bond and issuer specific variables of model M1. The next group of factors considered are interest rate specific variables, presented in column M4. All four factors are statistically significant and satisfy the a-priory expectations regarding their signs. They jointly account for 14.43% of the variation in weekly credit spread changes, as measured by the adjusted R^2 of the regression equation. Finally, in model M5, the FF factors (with no a priori expectations regarding their signs) seem to be less relevant in explaining shipping bond spreads; they display an explanatory power of only 2.82%, which is mainly due to the excess stock market return and the high minus low factors.

Model M6 is the most parsimonious specification, and includes variables from all groups that are significant in determining the shipping bonds' spreads. It has an adjusted R^2 value of 25.24%, attaining the highest value amongst models M1 to M6. The M6 model is obtained by maximizing the adjusted R^2, minimizing the Schwarz information criterion while avoiding using simultaneously during estimation pairs of variables which exhibit a linear correlation in excess of 60% or are judged to be carrying similar economic information. The estimated coefficients of the M6 most parsimonious specification are shown in column M6 of the table. Five main factors are found significant. Two of them are bond-related, namely the market value and the credit rating of the bond issue. The rest are industry and macro-specific variables: weekly lags 2, 3 and 4 of the ClarkSea index pick up the state of the freight market; the Cyclical GISC bond index and the equity volatility VIX index make up the rest of the factors found significant.

All coefficients have their correct a priori expected signs. The market value of the bond issue has a coefficient of -2.0253; that is, the higher the market value of a bond issue the lower is its liquidity risk, and thus the lower is the bond spread. The negative relationship between the market value of shipping bond issues and their spreads is also confirmed in Grammenos et. al. (2007). The change in the rating of the bond is also found significant, with an estimated coefficient of 0.0849. Its positive sign indicates that the lower the credit rating the higher is the spread of the bond issue, as expected a priori. Lagged values of the ClarkSea index of order two, three and four weeks are found significant in explaining the variation of shipping bonds' spreads. They capture in a dynamic way the industry specific component of shipping bond spreads. These are selected amongst potential lags 1-5 weeks, through the SBIC and adjusted R^2 criteria. The choice of introducing lags in freight rates indices stems from the possibility that events in the freight market are not immediately reflected in the cash flows and certainly not in the balance sheets of shipping companies. Additionally, there may be a gap of shipping expertise in bond markets participants. Moreover, there is a distinct possibility that, even experts in both shipping and bond markets, will expect that there will be a time lag between the time freight rates change and its realization into a positive or negative cash flow effect for companies. This is particularly the case, given that freight contracts would be at least of a few weeks duration in case the ship is operated in spot markets or longer for longer term contracts. The sum of the lagged coefficients is -0.1218; it represents the net effect on credit spreads of changes in freight rates, and has the correct, a priori expected, negative sign. Next, the change in the GISC index has an estimated coefficient of 1.1133, which suggests that this cyclical bond issuers' index is relevant and important in explaining shipping bond spreads as it captures the cyclical nature of the shipping industry. Finally, the VIX Index has an estimated coefficient of 0.0203, indicating that shipping bond spreads are in a positive relationship with money/capital market expected volatility conditions as measured through the market implied volatility index.

In order to assess the relative importance of the impact of each of the variables found significant in explaining shipping bond spreads, standardized coefficients are computed and reported in the last column of the table for each of the estimated coefficients of model M6.[31]

[31] In order to compare the relative impact of the estimated coefficients on the shipping credit spreads, standardized coefficients are also computed for each estimated coefficient in the model. These are obtained by first standardizing all variables to have a mean of 0 and a standard deviation of 1. That is, each variable is standardized by subtracting its mean from each of its values and then dividing these new values by the standard

As can be observed, the computed standardized coefficients are the following: For the market value of the bond issue it is -0.4453, for the change in the rating of the bond it is 0.0103, while that for the freight index the (net, over all lags) coefficient is -0.0853. For the change in the GISC index it is 0.1305, and finally for the VIX Index it is 0.1276. Thus, according to the magnitude of the standardized coefficients, it can be argued that, the market value of the bond is by far the most important factor in determining shipping bond spreads. Next comes the GISC cyclical bond index, with the equity volatility index VIX following closely behind. The shipping industry-specific variable - the ClarkSea freight rate index - reflecting freight market earnings, comes next. The lowest impact on spreads comes from changes in the rating of the shipping bond.

It seems that the market value of the issue, being a bond-specific factor indicating the liquidity of the bond, has a profound liquidity risk-related impact on shipping bond spreads. In comparison to the other bond-specific factor – the change in the rating of the bond, the market value of the bond has a standardized coefficient which is approximately 6.5 times higher, indicating that the shipping bond spreads are affected much more by this variable. Freight rate earnings also have a much higher impact on spreads than changes in the credit rating, albeit lower than the impact on spreads that the market value of the bond displays. Such an impact makes sense, as bond market prices reflect the freight rate risk entailed into shipping bonds, since the repayment schedule of a bond issue depends primarily on the cash flows generated by the freight rate.

Next, we consider whether the financial/economic crisis has an impact on the estimation results by estimating separately the corresponding models for the pre-crisis period, covering the years 2003 to July 2007 and for the period following the onset of the 2007 financial crisis, spanning the period August 2007 - June 2010.

---

deviation of the variable. The coefficients estimated with the use of the standardized variables are the standardized coefficients. Equivalently, the standardized coefficient of the i[th] explanatory variable can be computed through the following formula: $\beta_i^* = \beta_i \frac{s_{x_i}}{s_y}$, where, β_i^*, β_i and s_{xi} are the standardized coefficient, the estimated coefficient and the standard deviation of the i[th] explanatory variable, and s_y is the standard deviation of the dependent variable - that is, of the shipping bond spread. They refer to how many standard deviations the shipping bond spread will change for a one standard deviation change in a predictor variable, ceteris paribus. As a consequence, the importance of each variable can be inferred through them.

4.2 Pre-crisis results

Results for the pre-crisis period are presented in table 7. As can be observed, based on Hausman(1978) test statistics, random-effects specifications are favored in models M1, M3, M4 and M5, while fixed effects specifications are appropriate for models M2 and M6. When fixed effects specifications are favored the inclusion of bond and time fixed-effects versus pooled OLS models are tested, with respective F-statistics. When random effects models are favored by the Hausman(1978) test statistics, subsequent Breusch-Pagan(1980) test statistics reject the random-effects models and favor the pooled OLS ones, for models M1, M3, M4 and M5.

Estimation results for models M1 to M5 indicate that, the factors found significant in explaining shipping bond spreads are reduced when compared to those found significant for the whole period. The differences are that, in model M1 only the change in the market value of the bond issue and the change in the rating of the bond are statistically significant. The change in maturity, the change of the ratio 'Market value of equity over total assets', Altman's z-score and seniority are not. In addition, the explanatory power of these variables fall from 18.20% to 11.70%. The results for models M2 and M3 do not differ qualitatively from the all sample period, since all the variables included are significant and with the correct a priori expected signs. In model M4, only the 10-year Treasury rate and the slope of interest rates remain significant, while the 2-year treasury rate and the paperbill are insignificant. In model M5, from the three FF factors, the Excess stock market return remains significant but this time the SMB is significant and not the HML, which was found significant in the all sample estimation period. Regarding the adjusted R^2's of the estimated models, with the exception of model M4, they are lower overall in the before crisis period, in comparison to the whole sample period.

Focusing on the estimated coefficients of the most parsimonious model M6, there are two notable differences in comparison to the all sample estimation period results: the change in the credit rating is not significant in the before crisis period, while, out of the weekly ClarkSea freight index lags, only the fourth one is found significant now. It seems that in the pre-crisis period, expectations in the market were that things cannot go drastically wrong, and as a consequence not much attention is paid to changes in the rating of shipping bonds. Similarly, it was deemed sufficient to consider only the events in the freight market four weeks earlier. This is in contrast to the whole period analysis, where 2, 3 and 4 week lags in freight rates are significant in explaining spread changes.

As observed in the table, all the significant coefficients continue to have the a priori expected signs. The market value of the bond issue in M6 has a coefficient of -2.1569 and a standardized coefficient of -0.4112, displaying the highest impact among the significant variables. This indicates the important role of liquidity risk. The next most significant impact, based on the standardized coefficients, comes from the VIX Index which has an estimated coefficient of 0.0574 and a standardized coefficient of 0.1741, indicating a significant impact on spreads of the market-wide implied volatility and the expectations built in its values. The VIX Index is followed in importance by the GISC index. The latter has a coefficient of 1.2927 and a standardized coefficient of 0.1635. As expected, it indicates that in the cyclical shipping industry, this Merill Lunch-built bond cyclicality index can explain the variation of the shipping bond spreads. Last, investors consider important the industry effect, which is now captured by the 4th week lag of the freight earnings variable. This appears with a coefficient of -0.0994 and a standardized coefficient of -0.0681.

4.3 Crisis period results

The results for the period following the onset of the crisis are presented in table 8. As observed in model M1, the bond- and issuer-specific factors explain 24.50% of the observed variation in shipping bond spreads, which is more than double[32] the one observed for the pre-crisis period. This is expected, as during periods of financial crises investors are more likely to scrutinize the issuer and the bond specific characteristics of the bonds that they invest on. The change in the term to maturity variable remains insignificant, as in the before the crisis period. The change in the market value of the bond issue remains significant, indicating that investors are concerned about the liquidity of the bond issue. The change in the credit ratings

[32] Sixteen(16) bond issues are utilized for estimation here due to the limited data availability on seniority in the Datastream database. This explains the lower number of observations in comparison to the rest of the models.

of shipping bonds has become insignificant, whereas in the period before the crisis it is found significant. This is expected as market confidence in credit ratings deteriorated significantly following the default of the highly rated Lehman Brothers in September 2008, only a few months prior to this credit event. In model M2 macro factors explain 8.70% of the observed variation, which is close to the 7.32% of the pre-crisis period. The finding is similar in model M3, with the adjusted R^2 being 7.92% for the after the onset of the crisis period, which is higher than the 6.55% value for the before crisis period. Interest rates' variables in column M4 display an adjusted R^2 of 16.28%, which is slightly lower than the pre-crisis period value of 18.79%. Finally, the FF factors, in column M5, can explain 3.59% of the variation in credit spreads. The excess stock market return remains significant, but, in the crisis period, the HML variable becomes significant while the SMB factor becomes insignificant.

Focusing on the estimated most parsimonious M6 model, it can be observed that the variables found significant in explaining shipping bond spreads has changed between the two sub-periods. In the pre-crisis period, in order of importance, the change in the market value of the bond issue, the VIX implied volatility index, changes in the GISC cyclical bond index and the fourth lag of the freight earnings variable are the significant factors in explaining shipping bond spreads. In the period following the onset of the financial crisis, the change in the market value of the bond remains the most significant variable, the VIX Index remains significant and has more or less the same impact as the freight earnings variable. The latter is significant in lags 2, 3 and 4 and not only lag four as in the pre-crisis period. The ΔGISC bond index does not appear to be significant any more. It seems that the cyclicality of the shipping industry is captured now sufficiently by the lags of the freight earnings variable. Considering the ClarkSea index standardized coefficients, they indicate higher relative importance of the long-run negative effect (=-0.0822) in comparison to the pre-crisis period one of -0.0681. Relatively speaking, the freight earnings variable has gained importance in the after crisis period, in comparison to the pre-crisis period. It seems that the unprecedented uncertainty which dominated the markets after 2007, has led to greater monitoring of shipping freight markets and their cyclicality.

4.4 Comparing standard errors with and without clustering

As mentioned earlier, emphasis has been placed in the estimation results above to ensuring that inferences in the estimated models are robust. It is well known in the panel data literature – see Petersen (2009), that a major issue with panel data estimation is that unless the standard errors of the estimated coefficients are adjusted, they will be biased, leading in turn to incorrect inferences regarding the variables found significant in explaining the dependent variable in the panel data regression model. Care is taken then to use during estimation two-way clustered adjusted standard errors as proposed by Petersen (2009). Earlier studies in the literature on shipping bond spreads did not use two-way clustering of standard errors, and as a consequence their reported results are questionable.

To further evaluate the importance of this issue for the shipping bond spreads, this paper performs the following exercise: It estimates the final most parsimonious well specified M6 models for each period, upon which inferences are based regarding the significant factors explaining shipping bond spreads, with and without the two-way clustering of standard errors. The results for each period are presented in table 9. As can be observed, the t-statistics in the No-clustering columns are, falsely, several times higher than in the cluster-adjusted models. This is a consequence of the corresponding estimated standard errors being several times smaller (underestimated) than the 'correct' two-way adjusted ones. Therefore, when one attempts to specify a model for shipping bond spreads and uncover the factors that are important in explaining their variation, if using non-corrected standard errors, it is likely that factors will be falsely uncovered as significant – which would be a pure statistical fallacy.

In order to further evaluate this conjecture and assess the importance of this correction for shipping bond spreads, the equivalent of the M1 to M6 models is specified for each period without the two-way cluster adjustment of the standard errors proposed in Petersen (2009). The results about which factors are statistically significant are rather different in comparison to those reported in this paper. The complete results for all models are not reported here due to lack of space. However, in terms of the M6 models, upon which final inferences would be based, it is found that: For the whole period, Altman's z-score, the 5^{th} lag of the freight index, the ΔHW00(ML) Bond Index, the ΔSlope(10yr–2 yr) and the Paperbill are the five additional variables, which would have been falsely uncovered as significant for this period. Results are similar for the subperiods; in the before crisis period, six extra variables would have been falsely uncovered as significant, while for the period following the onset of the financial crisis eight additional variables would have been falsely reported as significant in explaining shipping bond spreads.[33] All the above further emphasize the contribution of this study in revealing the true factors that explain shipping bond spreads, and set it apart from other related studies in the literature.

5. Discussion

The findings in this paper are directly related with the general literature on corporate bond pricing. For example, Dick-Nielsen et al. (2012) suggest that bond liquidity and a set of company-level fundamentals are the main determinants of credit spread changes. They find that the effect of bond liquidity on bond spreads is much more profound during the period after the onset of the subprime crisis. This is mainly attributed to the adverse economic news for lead underwriters in the bond market, for e.g. during the period of the take-over of Bear Sterns, and to the increasing information asymmetry regarding the impact of the crisis in the bond market. The authors show that illiquidity is the major cause of the general rise of bond spreads after the onset of the financial crisis. Acharya et al. (2013) show that when a decline in liquidity happens as a result of a "stress" regime, investment grade bonds' prices rise, while high-yield bond prices fall. This is associated with a flight to liquidity happening during adverse economic conditions, i.e. securities with higher prior liquidity become more valuable. Thus, the prices of investment grade bonds, which typically exhibit higher liquidity during crises periods, rise as a result of an unexpected decrease of liquidity. The results of the aforementioned studies are similar to the results presented in this paper. Specifically, bond liquidity is shown to be the most important variable in explaining shipping bond spreads in both periods, before and after the onset of the crisis. Results show the magnitude of the liquidity coefficients to be less than half their values during the pre-crisis period. However, the importance of bond liquidity, revealed by the reported standardized coefficients, is relatively similar between the two periods.

Other studies in bond spread determinants, including Campbell and Taksler (2003) and Gemmill and Keswani (2011), show that market-wide volatility can also explain a high

[33] Full results are available from the authors upon request.

proportion of the observed variation in corporate bond spreads. This paper confirms the relevance of market-wide volatility, represented by the VIX Index, in explaining shipping bond spreads both in the pre-crisis and the after the onset of crisis period.

In addition to the above, this paper reveals for the first time new determinants of credit spreads both in the general finance and in the shipping finance literature. One of these is the cyclical bond issuers' index (GISC index), which, to the best of our knowledge, has not been used previously in the literature. This variable is shown in the current paper to be important in explaining shipping bond spreads. Cyclicality is well known to be a major issue in the shipping industry (see Stopford, 2009, and Kavussanos and Alizadeh, 2001), and such cyclicality is shown here to transmitting itself to shipping bond spreads' determinants. Additionally, it is revealed that the GISC bond index is prevalent during the pre-crisis period but not significant during the crisis period; this indicates that under the "normal" market conditions, prevailing before the start of the financial crisis, market participants paid attention to the cyclical variables prevailing in shipping, which however do not seem to be playing a significant role during crises periods, as other variables are deemed to be more important.

Another industry-specific variable, freight earnings, is found relevant in explaining shipping bond spreads in this paper. In line with Grammenos et al. (2007), it is found that previous rather than current values of the freight earnings are significant in explaining shipping bond spreads. However, the use of weekly data in this study allows the estimation of more precise dynamic effects in the model; thus, it is shown here that for the whole period sample and for the crisis period, 2, 3 and 4 weekly lags of freight earnings are significant, rather than the one month lag revealed in the aforementioned study. In contrast, in the pre-crisis period, only the fourth lag of freight earnings is significant. Such evidence enables portfolio managers, investors and other market participants to make more sophisticated short-term decisions regarding buy and sell positions in the shipping bonds market; specifically, the model allows predictions of how spreads will move according to how freight earnings changed a number of weeks before they actually do, thereby enabling market participants to act on this information.

As highlighted in previous sections of this paper identifying the major determinants of shipping bond spreads is of paramount importance to investors, practitioners and academics involved in the practice and research of the industry. It has been shown that the findings depend critically on the appropriate “technical” treatment of panel data estimations. Specifically, the two-way clustered adjusted standard errors utilized in this paper produce robust results, in comparison to extant studies in the literature. It is believed that this is the major reason behind the differences in the results of this study. Specifically, while variables such as those found significant in previous studies in the shipping literature (see for e.g. Leggate, 2000, Grammenos et al, 2002 and Grammenos et. al. 2007) have been examined in this paper also from the outset as potential determinants of shipping bond spreads, most of them are not found significant. That is, variables such as credit rating, changes in the term to maturity of the bond and changes in yields of 10-year treasury bonds that are found significant in the above studies are not revealed as truly significant here. Instead it seems that the liquidity of the bond issue, cyclical bond factors, the shipping specific-earnings variable and the volatility of the stock market are the major factors driving shipping bond spreads.

Additional factors which are important in explaining the results of this paper include: the wider sample of observations used, which covers global shipping bonds instead of only US ones; the longer time period, covering an entire shipping business cycle, thereby picking up the various conditions of the freight market; the sample of the shipping bonds utilized being carefully selected so as to include only cargo carrying issuers. The latter is important so as to ensure that the freight earnings variable, which is used as an explanatory variable in the equations, represents/matches truly the income of the shipping bond issuer.

The findings of this paper have important implications regarding both private and institutional investors interested in asset allocation as well as other market players in the shipping industry. Specifically, optimal asset allocation is of primary interest to finance professionals and in particular to bond portfolio managers, who take positions in specific sectors or industries of the bond market such as shipping, and require a thorough analysis of the determinants of bond spreads changes in the sector. Thus, professional bond portfolio managers can take into account the results in this study when deciding to execute buy/sell orders on their bond portfolios for better decision making.

6. Conclusions

The contributions of this paper to the literature are the following: First, it investigates the determinants of shipping bond spread changes for a shipping bonds issued in several geographical regions of the world (and not only the USA) and for a long enough period to cover an entire shipping business cycle. Second, panel data estimation results in the paper are robust to biasedness of t-statistics, by using two-way cluster-adjusted standard errors. These features are important and set the paper apart from others both in the finance and in the shipping literature on bond spreads. Third, a new set of variables with respect to the literature are introduced, some of which are found significant, as explanatory factors of shipping bond spreads. The latter include: the market-wide volatility, as measured by the VIX Index; and the GISC cyclical bond issuers' index, that reflects the cyclicality of the shipping industry. Additionally, changes in the market value of the bond – reflecting liquidity; changes in the bond rating – reflecting changes in the riskiness of the bond; and lagged values of the shipping industry-specific freight earnings variable, are also found significant. Finally, the long run effect of standardized coefficients presented earlier shows that: especially after the start of the crisis, shipping bondholders seem to ask for a higher freight earnings risk premium and thus drive shipping bond spreads to higher levels.

Acknowledgements: This paper has benefited from the comments of four anonymous referees, and also from those of participants in the following, where earlier versions of it have been presented: The International Association of Maritime Economists (IAME) Conference, Lisbon, Portugal; The Hellenic Finance and Accounting Association (HFAA) Conference, Limassol, Cyprus; and Shanghai Maritime University, China. The authors gratefully acknowledge financial support for previous versions of this paper, titled "Determinants of Bond Spreads in the US Transportation Sector", by the Research Centre of the Athens University of Economics and Business through the Basic Research Funding Program (BRFP). The BRFP has had no influence in the design, implementation and writing of this paper. Any remaining errors or omissions are the responsibility of the authors.

REFERENCES

- ABN, AMRO, 2011. Shipping Finance and Investment: Current Trends in Ship Finance.
- Acharya, V.V., Amihud, Y., Bharath, S.T., 2013. Liquidity risk of corporate bond returns: conditional approach. Journal of Financial Economics 110, 358–386.
- Albertijn, S., Bessler, W., Drobetz, W., 2011. Financing Shipping Companies and Shipping

Operations: A Risk-Management Perspective. Journal of Applied Corporate Finance 23, 70–82.

- Altman, E.I., 1968. Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. The Journal of Finance 23, 589–609.
- Asness, C.S., Moskowitz, T.J., Pedersen, L.H., 2013. Value and Momentum Everywhere. The Journal of Finance 68, 929–985.
- Breusch, T.S., Pagan, A.R., 1980. The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. The Review of Economic Studies 47, 239.
- Campbell, J.Y., Taksler, G.B., 2003. Equity Volatility and Corporate Bond Yields. The Journal of Finance 58, 2321–2350.
- Chen, L., Lesmond, D.A., Wei, J., 2007. Corporate Yield Spreads and Bond Liquidity. The Journal of Finance 62, 119–149.
- Collin-Dufresne, P., Goldstein, R.S., Martin, J.S., 2001. The Determinants of Credit Spread Changes. The Journal of Finance 56, 2177–2207.
- Dickey, D.A., Fuller, W.A., 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica: Journal of the Econometric Society 1057–1072.
- 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.
- Drobetz, W., Schilling, D., Tegtmeier, L., 2010. Common risk factors in the returns of shipping stocks. Maritime Policy & Management 37, 93–120.
- Eichengreen, B., Mody, A., Nedeljkovic, M., Sarno, L., 2012. How the Subprime Crisis went global: Evidence from bank credit default swap spreads. Journal of International Money and Finance 31, 1299–1318.
- Ericsson, J., Renault, O., 2006. Liquidity and credit risk. The Journal of Finance 61, 2219–2250.
- Fabozzi, F.J., 2007. Bond markets, analysis and strategies. Pearson Education India.
- Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.
- Fridson, M.S., Garman, M.C., 1998. Determinants of spreads on new high-yield bonds. Financial Analysts Journal 28–39.
- 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.
- Gemmill, G., Keswani, A., 2011. Downside rik and the size of credit spreads. Journal of Banking & Finance 35, 2021-2036
- Grammenos, C.T., Alizadeh, A.H., Papapostolou, N.C., 2007. Factors affecting the dynamics of yield premia on shipping seasoned high yield bonds. Transportation Research Part E: Logistics and Transportation Review 43, 549–564.
- Grammenos, C.T., Arkoulis, A.G., 2003. Determinants of spreads on new high yield bonds of shipping companies. Transportation Research Part E: Logistics and Transportation Review 39, 459–471.
- Gujarati, D., Porter, D., 2008. Basic Econometrics. McGraw-Hill/Irwin, New York.
- Hausman, J.A., 1978. Specification Tests in Econometrics. Econometrica 46, 1251.
- Helwege, J., Huang, J.-Z., Wang, Y., 2014. Liquidity effects in corporate bond spreads. Journal of Banking & Finance. Forthcoming.
- 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.
- Kavussanos, M.G., 2003. Time Varying Risks Among Segments of the Tanker Freight Markets. Maritime Economics and Logistics 5, 227–250.
- Kavussanos, M.G., 2010. Business risk measurement and management in the cargo carrying sector of the shipping industry – an update, Chapter 25 in Eds. The Handbook of Maritime

Economics and Business, Lloyd’s List Publications, London.
- Kavussanos, M.G., Alizadeh-M, A.H., 2001. Seasonality patterns in dry bulk shipping spot and time charter freight rates. Transportation Research Part E: The Logistics and Transportation Review 37, 443–467.
- Kavussanos, M.G., Visvikis, I.D., 2006. Derivatives and risk management in shipping, WitherbySeamanship, London, UK.
- Leggate, H.K., 2000. A European perspective on bond finance for the maritime industry. Maritime Policy & Management 27, 353–362.
- Lin, H., Wang, J., Wu, C., Liquidity risk and expected corporate bond returns, Journal of Financial Economics 99, 2011, 628–650.
- Longstaff, F.A., 2010. The subprime credit crisis and contagion in financial markets. Journal of Financial Economics 97, 436–450.
- 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.
- Petersen, M.A., 2009. Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies 22, 435–480.
- Schwarz, G., 1978. Estimating the Dimension of a Model. Annals of Statistics 6, 461–464.
- Stopford, M., 2009. Maritime Economics 3e. Routledge.
- Thompson, S.B., 2011. Simple formulas for standard errors that cluster by both firm and time. Journal of Financial Economics 99, 1–10.
- Wooldridge, J.M. 2002. Econometric Analysis Cross Section Panel. MIT Press.

Table 1: Risk factors used as explanatory variables of bond spreads in Eq. (1)

Group of Explanatory Variables	Description	Expected Sign
Dependent Variable	*Bond Spread:* The difference between the yield to maturity of a shipping bond issue minus the yield to maruity of a, corresponding in maturity, US treasury bond, considered as the risk free asset. If the maturity of the shipping bond cannot be matched exactly, the US bond with the closest possible maturity is chosen.	
Bond-specific factors	*Term to maturity:* The remaining life of each bond issue until final settlement, expressed in years.	+/-
	Market Value of the Bond: This is the current market value of the issue, which equals the current market price multiplied by the amount currently on issue.	-
	Rating: The average credit rating assigned to each bond issue by at least two of the three dominant Credit Rating Agencies, where AAA=1 to D=22.	+
	Seniority: The seniority of bond issues reflects a hierarchy of priority, when paying the debt back, in case a company faces default. The different types of seniority are represented by a dummy variable, where 1="First Mortgage" to 6="Senior Subordinated Debt".	+
Issuer-specific factors	*Market Value of Equity of the Issuer / Total Assets:* The market capitalization for each bond issuer, which equals the current market price multiplied by the number of shares outstanding, over the total assets.	-
	Altman's z-score: An indication of the default likelihood for the company with a specific bond issue.	-
Industry-specific factors	*ClarkSea Index:* An index constructed as a weighted average of earnings in all shipping subsectors, with the weights used reflecting the number of vessels in each fleet sector.	-
	Freight rate Combined Index: A freight earnings index constructed to reflect the vessel profile of the bond issuer, and thus the freight market conditions of the main subsector of shipping that the earnings of the shipping company come from. It aims to capture potential differences in market conditions between subsegments of shipping.	-
	GISC (ML) Bond index: Merrill Lynch's Global Services Cyclical bond index.	+
Macroeconomic factors	*MSCI World Index:* Morgan Stanley Capital Intenational world stock market index. An index constructed to be representative of the stock market's sentiment at a global level.	-
	HW00 (ML) Bond Index: Merrill Lynch's Global High Yield bond market index.	+
	Moody's Baa Yield: An index constructed by Moody's, which represents the median yield on Baa rated bond issues.	+
	VIX Index: A measure of the implied volatility of S&P 500 index options, which indicates the market's expectation of stock market volatility over the next 30 day period.	+
Interest rates	*The US 10-year Treasury rate.*	-
	The US 2-year Treasury rate.	-
	Slope (10yr – 2yr): The difference between the yield observed at the long (10-year) and the short (2-year) end of the yield curve.	+
	Paperbill: The difference between the 3-month non-financial commercial paper rate and the 3-month T-bill secondary market rate.	+
Fama and French (FF) three factors	*Excess stock market return:* It refers to the value-weighted return of all the Center for Research in Security Prices (CRSP) firms incorporated in the US, minus the one-month Treasury bill rate.	+/-
	Small-minus-Big (SMB): Stands for small minus big market capitalization.	
	High-minus-Low (HML): Stands for high minus low book-to-market ratio.	

Notes: This table lists the risk factors examined in this paper as potential determinants of changes of shipping bond spreads. These factors can be classified into six broad categories: Bond-specific, issuer-specific, industry-specific, macroeconomic factors, interest rates and Fama French three factors. The column "Expected Sign" refers to the a priori theoretical sign of the risk factor.

Table 2: Merrill Lynch Rating scale for calculating composite ratings and correspondence to the numeric value used in the analysis

Numeric	Merrill Lynch Composite	Moody's	S&P	Fitch	
1	AAA	Aaa	AAA	AAA	
2	AA1	Aa1	AA+	AA+	
3	AA2	Aa2	AA	AA	
4	AA3	Aa3	AA-	AA-	**Investment Grade**
5	A1	A1	A+	A+	
6	A2	A2	A	A	
7	A3	A3	A-	A-	
8	BBB1	Baa1	BBB+	BBB+	
9	BBB2	Baa2	BBB	BBB	
10	BBB3	Baa3	BBB-	BBB-	
11	BB1	Ba1	BB+	BB+	
12	BB2	Ba2	BB	BB	
13	BB3	Ba3	BB-	BB-	
14	B1	B1	B+	B+	
15	B2	B2	B	B	
16	B3	B3	B-	B-	**Speculative Grade**
17	CCC1	Caa1	CCC+	CCC+	
18	CCC2	Caa2	CCC	CCC	
19	CCC3	Caa3	CCC-	CCC-	
20	CC	Ca	CC	CC	
21	C	C	C	C	
22	D		D	DDD-D	

Notes: This table presents the rating correspondence between the numeric value used in our model estimation and three rating scales: The constructed Merrill Lynch Composite ratings and the credit ratings assigned by the three dominant Credit Rating Agencies Moody's, Standard and Poor's (S&P) and Fitch. Credit ratings for each bond issue are reported by Merrill Lynch and are constructed as the average of their numeric equivalents. For example, a bond which is rated by Moody's as Ba1 = 11 (11 is the numeric value for Ba1), by S&P as B+ = 14 and by Fitch as B- = 16, has an average numeric equivalent of (11+14+16)/3 = 13.66, which corresponds to B1 (the closest numeric value is 14) in the composite rating. Credit ratings with numeric values below 10 are considered to be Investment Grade, with low probabilities of default. Credit ratings with numeric values between 11 to 21 are considered risky, with high probabilities of a default event occuring during their lifetime. Numeric value 22 refers to default. **Source:** Merrill Lynch Global Bond Indices; Bloomberg.

Table 3: Number of shipping bond issues by: Country of residence, Stock exchange, Vessel profile of the issuer, Median rating of the bond issue and Seniority

Panel A: Number of bonds issued by country of residence of the issuer	
Country of Residence of the issuer	**Number of Bonds**
Bermuda (BM)	4
Bahamas (BS)	1
Greece (GR)	1
Marshall Islands (MH)	2
United States (US)	42
International	4
Total	**54**
Panel B: Number of bonds listed in different stock exchanges	
Stock Exchange of Issuer (Listed)	**Number of Bonds**
Bursa Malaysia	1
NASDAQ	6
NYSE	42
Oslo Stock Exchange	5
Total	**54**
Panel C: Number of bonds according to the vessel profile of the issuer	
Vessel Profile of issuer	**Number of Bonds**
Bulk	4
Container	5
Diversified	30
Tanker	15
Total	**54**

Panel D: Number of bonds and average coupon, according to the credit rating assigned when issued			
Composite Credit Rating	**Number of Bonds**	**Average Coupon**	
A2	4		
A3	2		
BBB1	1		
BBB2	-	5.91%	**Investment Grade**
BBB3	2		
BB1	8		
BB2	2		
BB3	8		
B1	7		
B2	7		
B3	1		
CCC1	5	8.28%	**Speculative Grade**
CCC2	-		
CCC3	1		
CC	4		
Unrated	2		
Total	**54**	7.98%	**Overall**

Panel E: Number of bonds according to the seniority of the issue	
Seniority	**Number of Bonds**
First Mortgage	3
Company Guarantee	17
Notes	2
Senior Notes	16
Senior Secured	2
Senior Unsecured	13
Subordinated	1
Total	**54**

Notes: "International" country of residence in panel A refers to bond issuers which have dual residence. The vessel profile of the bond issuer in panel C is defined as diversified if the majority of the vessels (>60% of the total fleet) of a shipping bond issuer are operating in more than one shipping sub-segments. For details regarding seniority, presented in panel E of the table, see footnote 19.

Table 4: Shipping bond characteristics by year of issuance

Year	Number of Active Bond issues	Number of New Bond issues	Average Spread of Active bonds (bps)	Standard Deviation of Spreads of Active bonds (bps)	Total Market Value ($ millions) of Active Bonds	Average Market Value ($ millions) of Active Bonds	Average Coupon (%) of Active Bonds	Average Maturity of Active issues (years)	Median Composite Rating
2003	13	-	795.88	605.26	2,116.43	109.92	9.45	6.16	B1 (14)
2004	38	25	393.92	251.88	8,987.64	187.26	8.23	8.09	BB3 (13)
2005	42	5	351.65	294.66	9,952.21	241.99	7.75	7.84	BB3 (13)
2006	46	4	425.93	691.09	10,604.11	235.50	7.86	6.85	BB3 (13)
2007	50	5	466.48	808.20	11,037.22	238.10	7.89	6.24	BB3 (13)
2008	47	2	631.44	649.31	10,125.43	250.71	7.95	6.13	BB3 (13)
2009	44	0	882.13	900.54	9,598.41	233.59	7.97	5.42	BB2 (12)
2010	41	0	753.74	927.05	9,471.64	236.16	8.02	4.83	BB2 (12)

Notes: This table presents the characteristics of the shipping bonds sample over time. Bond spreads are winsorized at the 1^{st} and 99^{th} percentiles. The number of active bonds refers to the number of shipping bonds which were available in the bond market during a specific year. The number of new bonds refers to the number of issues which are first issued each year. Average spread of active bonds refers to the arithmetic average of the spread of the active bonds during each year, while the next column refers to their corresponding standard deviations. Total market value refers to the sum of the market values of all active shipping bonds at the end of each year. The average market value refers to the average amount outstanding for all the active bonds during the specific year. The same principle holds for the average coupon and the average maturity of the bond issues which were active during the specific year. Last, the median composite rating refers to the median average composite rating, as defined in table 2, for all the active bonds on a yearly basis. The numbers in parentheses refer to the numerical values of the ratings.

Table 5: Descriptive statistics of the variables in Eq. (1) – Sample period 2003:01-2010:06

	Mean [p-value]	Median	Min	Max	Standard Deviation	Skewness	Kurtosis	J-B [p-value]	Fisher-Type ADF [p-value] Levels of variables	Fisher-Type ADF [p-value] 1st Differences of variables (Δ)
Spread (bps)	557.07 [1.000]	374.21	51	5,620	715.96	4.79	30.88	20,456 [0.0000]	56.16 [1.0000]	2,940.95 [0.0000]
Term to Maturity (years)	6.51 [1.000]	5.45	0.01	25.01	5.01	1.92	6.58	16,186 [0.0000]	4.64 [1.0000]	233.91 [0.0000]
Market Value of Bond (millions US $)	231.37 [1.000]	177.12	0.02	1,052	201.58	1.90	6.59	16,080 [0.0000]	301.42 [0.0512]	3,155.16 [0.0000]
Rating	12.18 [0.988]	13.00	6.00	21.00	3.57	-0.11	2.46	103.03 [0.0000]	340.44 [0.0765]	1,198.34 [0.0000]
Market Value of Equity of Issuer / Total Assets	0.53 [1.000]	0.45	0.00	3.29	0.41	2.04	9.92	34,501 [0.0000]	101.01 [1.0000]	3,069.09 [0.0000]
Altman's z-score	2.38 [0.6048]	1.99	0.05	16.53	1.71	3.44	23.17	266,762 [0.0000]	227.02 [0.0020]	3,381.63 [0.0000]
Seniority	3.08 [0.9863]	4	1	7	1.16	0.19	2.44	101.76 [0.0000]	189.32 [0.0034]	3,157.98 [0.0000]
Freight rate Combined index ($/Day)	26,807 [1.000]	26,055	3,056	78,127	12,475	0.77	3.81	1,716 [0.0000]	217.55 [0.1714]	2,293.13 [0.0000]
ClarkSea index ($/Day)	25,209 [0.9921]	25,912	7,350	49,742	9,577	0.29	-0.30	165.25 [0.0000]	101.70 [1.0000]	4,524.21 [0.0000]
GISC (ML) Bond Index	205.85 [0.999]	196.40	150.77	255.40	25.40	0.37	-0.34	40.46 [0.0000]	32.12 [1.0000]	3,467.82 [0.0000]
HW00 (ML) Bond Index	163.83 [0.9898]	154.84	101.46	220.54	26.82	0.23	-0.39	54.75 [0.0000]	40.41 [1.0000]	1,963.41 [0.0000]
MSCI World Index	511.15 [1.000]	484.44	286.15	686.25	100.79	0.09	-0.97	29.40 [0.0000]	116.02 [0.9996]	5,316.22 [0.0000]
Moody's Baa (%)	6.68 [1.000]	6.49	5.71	9.49	0.67	1.86	3.73	39.96 [0.0000]	109.28 [0.9999]	5,521.18 [0.0000]
VIX Index	20.89 [0.9418]	17.75	10.02	79.13	10.89	2.23	6.43	1515.41 [0.0000]	517.07 [0.0000]	5,997.63 [0.0000]
US 10-year Treasury rates (%)	4.12 [1.000]	4.18	2.08	5.23	0.59	-0.58	0.41	1.98 [0.3713]	172.72 [0.4701]	5,882.25 [0.0000]
US 2-year Treasury rates (%)	2.93 [0.7332]	2.5	0.67	5.23	1.46	0.23	-1.40	39.91 [0.0000]	78.52 [1.0000]	5,471.23 [0.0000]
Slope (10yr-2yr) (%)	1.18 [0.9911]	1.51	-0.19	2.89	1.01	-0.18	-1.52	65.83 [0.0000]	106.96 [1.0000]	5,523.56 [0.0000]
PaperBill (%)	0.36 [1.000]	0.17	-0.21	1.82	0.38	2.14	4.03	608.52 [0.0000]	678.75 [0.0000]	5,932.84 [0.0000]
Excess Market Return	0.05 [1.000]	0.17	-18.41	13.03	2.84	-0.64	10.76	53,679 [0.0000]	5,942.77 [0.0000]	-
SMB	0.04 [1.000]	0.04	-3.40	3.68	1.16	0.07	3.38	146.50 [0.0000]	5,962.98 [0.0000]	-
HML	0.07 [1.000]	0.07	-6.85	7.64	1.45	0.22	9.63	38,253 [0.0000]	5,890.07 [0.0000]	-

Notes: See table 1 for definitions of variables. Min and max are the minimum and maximum values of the sample data, respectively**.** Skewness and kurtosis are the estimated centralized third and fourth moments of the data. J-B is the Jarque and Bera (1980) test for normality; the statistic is $\chi^2(2)$ distributed. ADF is the Augmented Dickey and Fuller (1981) test. The ADF regressions include an intercept term. The lag length of the ADF test is determined by minimizing Schwarz's Bayesian Information Criterion (SBIC). For the variable market value of bond which is marginally I(1) according to the Fisher-type ADF test, we also perform the Im et al. (2003) panel data unit root test. The latter results in a value of -0.1877 and a p-value of 0.4256 in levels and a value of -14.94 and a p-value of 0.0000 in first differences, respectively. Thus, the variable 'Market value of bond' is I(1). Numbers in square brackets [.] indicate p-values.

Table 6: Panel data regressions for shipping credit spread changes on risk factors 2003:01 – 2010:06

		M1	M2	M3	M4	M5	M6	M6 Standardized coefficients
Bond and issuer specific variables	**Constant**	0.0041	-0.0235*	-0.0255**	0.0019	-0.0022	-0.0612***	-
		(1.50)	(-1.93)	(-2.04)	(1.34)	(1.34)	(-4.48)	
	ΔTerm to Maturity	-0.2202***	-	-	-	-	-	-
		(-7.04)						
	ΔMarket Value of Bond	-1.9604***	-	-	-	-	-2.0253***	-0.4453
		(-9.87)					(-12.41)	
	ΔRating	0.1151*	-	-	-	-	0.0849**	0.0103
		(1.89)					(2.09)	
	ΔMarket Value of Equity / TA	-0.0045**	-	-	-	-	-	-
		(-2.52)						
	Altman z-score	0.0022	-	-	-	-	-	-
		(1.28)						
	Seniority	-0.0011*	-	-	-	-	-	-
		(-1.74)						
Industry and macro specific variables	**ΔClarkSeaIndex$_{t-2}$**	-	-	-	-	-	-0.0947**	-0.0682
							(-2.37)	
	ΔClarkSeaIndex$_{t-3}$	-	-	-	-	-	0.0959**	0.0728
							(2.19)	
	ΔClarkSeaIndex$_{t-4}$	-	-0.0794***	-	-	-	-0.1230***	-0.0899
			(-2.69)				(-3.20)	
	ΔFreight Combined Index$_{t-4}$	-	-	-0.0458**	-	-	-	-
				(-2.49)				
	ΔGISC (ML) Bond Index	-	0.8458***	0.8691***	-	-	1.1133***	0.1305
			(3.472)	(3.75)			(4.80)	
	ΔHW00 (ML) Bond Index	-	-	-	-	-	-	-
	ΔMSCI World Index	-	-0.5557***	-0.5460***	-	-	-	-
			(-5.28)	(-5.31)				
	VIX Index	-	0.0106**	0.0112**	-	-	0.0203***	0.1276
			(2.38)	(2.48)			(4.57)	
Interest rate specific variables	**ΔUS 10-year Treasury rate**	-	-	-	-0.3533***	-	-	-
					(-4.39)			
	ΔUS 2-year Treasury rate	-	-	-	-0.1301***	-	-	-
					(-3.74)			
	ΔSlope (10yr-2yr)	-	-	-	0.0221***	-	-	-
					(2.95)			
	PaperBill	-	-	-	0.0058**	-	-	-
					(1.96)			
Fama and French factors	**Excess Stock Market return**	-	-	-	-	-0.0041***	-	-
						(-4.48)		
	Small-minus-Big (SMB)	-	-	-	-	-0.0013	-	-
						(-0.80)		
	High-minus-Low (HML)	-	-	-	-	0.0031*	-	-
						(1.84)		
	Observations (bond-week)	4,686	13,811	13,811	13,811	14,081	7,295	
	Bond clusters	37	54	54	54	54	54	
	Time clusters	390	386	386	386	390	370	
	R^2 overall / Adj. R^2	18.20%	7.37%	7.29%	14.43%	2.82%	25.24%	
	F-stat	96.36	14.59	14.50	307.44	76.95	19.92	
	[p-value]	0.0000	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	Hausman test (fe vs. re)	8.02	10.71	11.43	2.83	0.29	14.19	
	[p-value]	[0.1551]	[0.0301]	[0.0221]	[0.5871]	[0.9615]	[0.0479]	
	F-stat (bond fe vs. pooled ols)	3.08	1.81	1.92	2.23	2.05	2.31	
	[p-value]	[0.0000]	[0.0002]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	
	F-stat (time fe vs. pooled ols)	2.29	2.45	2.65	1.15	3.86	3.90	
	[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.2393]	[0.0000]	[0.0000]	
	BP test (re vs. pooled ols)	0.00	-	-	0.00	0.00	-	
	[p-value]	[1.0000]			[1.0000]	[1.0000]		
	Schwarz BIC criterion	-12,669	-37,486	-36,239	-30,557	-37,502	-38,812	
	Bond Fixed Effects	No	Yes	Yes	No	No	Yes	
	Time Fixed Effects	No	Yes	Yes	No	No	Yes	
	Random Effects	No	No	No	No	No	No	
	Mean VIF	1.18	1.06	1.05	1.63	1.33	1.16	

Notes: This table presents the results of the estimated panel data regressions between the logarithmic first differences of shipping bond spreads and different specifications of the econometric model described in eq. (1). The coefficients of bond and time dummies are supressed where they are used. F-stat, tests the joint significance of the estimated coefficients. The Hausman(1978) test statistic is utilized in models M1 to M6 to select between the fixed and random-effects specifications. Once selected, the fixed-effects or random-effects specifications are tested versus pooled OLS models based on the F-stat (H_0: $\alpha_i=0$, for i=1,2,…,n, where i is the number of shipping bonds) and the Breusch-Pagan(BP) LM (1980) test, respectively. If a fixed-effects specification is favoured both by Hausman and the F-stat, then another F-stat is utilized to investigate the joint statistical significance of time-dummies in the models which leads to the estimation of a time fixed-effects. Letter Δ stands for the log first differences. t-statistics are reported in parentheses below the estimated coefficients. Statistical significance of the estimated coefficients is denoted with *, ** and *** for 10%, 5% and 1% significance levels, respectively. All M1-M6 specifications are estimated with two-way clustered adjusted standard errors (Petersen, 2009). Columns M1-M5 report estimates for specifications which test the explanatory power of individual groups of risk factors (i.e. bond- and issuer-specific, industry- and macro-specific, interest rates and FF factors). In columns M2 and M3 the ClarkSea index is replaced with the Freight rate combined index in order to examine how strong is the shipping "segmentation" effect. Column M6 reports a fixed-effects specification for the most parsimonious model, favored by the Hausman(1978) test and estimated with the maximum likelihood principle. Therefore, the Schwarz BIC (1978) information criterion and the Adj. R^2 are utilized to select among different specifications of model M6. Mean Variance Inflation Factors (VIF's) are presented as diagnostic tests for the presence of multicollinearity in the estimation of M1-M6 specifications. For each of the specifications M1-M6, a separate VIF estimate is obtained for each variable included. However, only the Mean (over all coefficients) VIF value for each model is reported here due to lack of space. As a rule of thumb, VIF values below 10 indicate the absence of multicollinearity. Thus, there seems to be no multicollinearity issues in the estimated models overall and for each individual coefficient – analytical coefficient values are available from the authors on request. Standardized coefficients are computed as: $\beta_i^* = \beta_i \frac{s_{x_i}}{s_y}$, where, β_i^* and β_i are respectively the standardized and the estimated coefficients, s_{x_i} and s_y are respectively the standard deviations of the ith explanatory variable and of the shipping bond spread. The standardized coefficients show by how many standard deviations the dependent variable will change, per standard deviation chnage in each of the independent variables.

Table 7: Panel data regressions for shipping credit spread changes on risk factors before the onset of the crisis, 2003:01 – 2007:07

		M1	M2	M3	M4	M5	M6	M6 Standardized coefficients
Bond and issuer specific variables	Constant	0.0003	-0.0858**	-0.0694**	0.0006	0.0002	-0.1464***	-
		(-0.09)	(-2.30)	(-2.00)	(0.37)	(0.10)	(-3.21)	
	ΔTerm to Maturity	0.2268	-	-	-	-	-	-
		(0.70)						
	ΔMarket Value of Bond	-1.6611***	-	-	-	-	-2.1569***	-0.4112
		(-7.31)					(-5.82)	
	ΔRating	0.1007*	-	-	-	-	-	-
		(1.66)						
	ΔMarket Value of Equity / TA	-0.0013	-	-	-	-	-	-
		(-0.83)						
	Altman z-score	-0.0003	-	-	-	-	-	-
		(-0.15)						
	Seniority	0.0001						
		(0.22)						
	ΔClarkSea Index$_{t-4}$	-	-0.1124**	-	-	-	-0.0994**	-0.0681
			(-2.47)				(-2.26)	
	ΔFreight Combined Index$_{t-4}$	-	-	-0.0597**	-	-	-	-
				(-2.07)				
	ΔGISC (ML) Bond Index	-	1.1545***	1.1921***	-	-	1.2927***	0.1635
			(4.18)	(4.19)			(5.17)	
	ΔMSCI World Index	-	-0.6777***	-0.7021***	-	-	-	-
			(-3.59)	(-3.60)				
	VIX Index	-	0.0345**	0.0269**	-	-	0.0574***	0.1741
			(2.29)	(2.00)			(3.11)	
Interest rate specific variables	ΔUS 10-year Treasury rate	-	-	-	-0.9014***	-	-	-
					(-5.61)			
	ΔUS 2-year Treasury rate	-	-	-	-0.1001	-	-	-
					(-1.36)			
	ΔSlope (10yr-2yr)	-	-	-	0.0137***	-	-	-
					(2.75)			
	PaperBill	-	-	-	0.0025	-	-	-
					(0.66)			
Fama and French factors	Excess Stock Market return	-	-	-	-	-0.0041*	-	-
						(-1.83)		
	Small-minus-Big (SMB)	-	-	-	-	-0.0037*	-	-
						(-1.71)		
	High-minus-Low (HML)	-	-	-	-	-0.0021	-	-
						(-0.62)		
	Observations (bond-week)	3,240	7,252	7,252	7,252	7,449	7,252	
	Bond clusters	35	47	47	47	47	47	
	Time clusters	238	234	234	234	238	234	
	R^2 overall / Adj. R^2	11.70%	7.32%	6.55%	18.79%	2.28%	22.27%	
	F-stat	34.58	13.54	109.14	207.07	37.19	16.15	
	[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	Hausman test (fe vs. re)	4.99	9.72	7.70	3.21	0.92	9.60	
	[p-value]	[0.4170]	[0.0454]	[0.1031]	[0.5237]	[0.8206]	[0.0477]	
	F-stat (bond fe vs. pooled ols)	3.29	1.41	1.38	1.41	1.36	1.77	
	[p-value]	[0.0000]	[0.0421]	[0.0431]	[0.0351]	[0.0504]	[0.0011]	
	F-stat (time fe vs. pooled ols)	2.49	3.15	3.11	2.56	2.24	3.02	
	[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	BP test (re vs. pooled ols)	0.00	-	0.00	0.00	0.00	-	
	[p-value]	[1.0000]		[1.0000]	[1.0000]	[1.0000]		
	Schwarz BIC criterion	-9,942	-21,135	-20,283	-13,866	-21,377	-22,419	
	Bond Fixed Effects	No	Yes	No	No	No	Yes	
	Time Fixed Effects	No	Yes	No	No	No	Yes	
	Random Effects	No	No	No	No	No	No	
	Mean VIF	1.21	1.13	1.11	2.17	1.29	1.02	

See notes in table 6.

Table 8: Panel data regressions for shipping credit spread changes on risk factors after the onset of the crisis 2007:08 – 2010:06

		M1	M2	M3	M4	M5	M6	M6 Standardized coefficients
Bond and issuer specific variables	**Constant**	-0.0006 (-0.06)	-0.0461* (-1.72)	-0.0560** (-2.01)	0.0011 (0.66)	0.0051* (1.86)	-0.0605*** (2.65)	-
	ΔTerm to Maturity	0.0707 (-0.23)	-	-	-	-	-	-
	ΔMarket Value of Bond	-2.1222*** (-7.11)	-	-	-	-	-0.8638* (-1.84)	-0.3466
	ΔRating	0.0521 (0.27)	-	-	-	-	-	-
	ΔMarket Value of Equity / TA	-0.0075 (-0.53)	-	-	-	-	-	-
	Altman z-score	0.0191* (1.95)	-	-	-	-	-	-
	Seniority	0.0051 (1.25)	-	-	-	-	-	-
Industry and macro specific variables	**ΔClarkSea Index$_{t-2}$**	-	-	-	-	-	-0.0938** (-2.10)	-0.0891
	ΔClarkSea Index$_{t-3}$	-	-	-	-	-	0.1168** (2.46)	0.1108
	ΔClarkSea Index$_{t-4}$	-	-0.0658* (-1.91)	-	-	-	-0.0991** (-2.39)	-0.0939
	ΔFreight Combined Index$_{t-4}$	-	-	-0.0386* (-1.79)	-	-	-	-
	ΔGISC (ML) Bond Index	-	0.6415** (2.14)	0.6615** (2.16)	-	-	-	-
	ΔMSCI World Index	-	-0.4914*** (-4.42)	-0.4819*** (-4.42)	-	-	-	-
	VIX Index	-	0.0177** (2.08)	0.0181** (2.08)	-	-	0.0215*** (2.98)	0.1078
Interest rate specific variables	**ΔUS 10-year Treasury rate**	-	-	-	-0.4281*** (-4.62)	-	-	-
	ΔUS 2-year Treasury rate	-	-	-	-0.0655 (-1.60)	-	-	-
	ΔSlope (10yr-2yr)	-	-	-	0.1184*** (2.91)	-	-	-
	PaperBill	-	-	-	0.0036 (1.18)	-	-	-
Fama and French factors	**Excess Stock Market return**	-	-	-	-	-0.0043*** (-3.95)	-	-
	Small-minus-Big (SMB)	-	-	-	-	-0.0006 (-0.26)	-	-
	High-minus-Low (HML)	-	-	-	-	0.0039* (1.92)	-	-
	Observations (bond-week)	1,432	6,515	6,515	6,515	6,541	6,515	
	Bond clusters	16	51	51	51	51	51	
	Time clusters	151	146	146	146	151	151	
	Adj. R^2	24.50%	8.70%	7.92%	16.28%	3.59%	16.91%	
	F-stat	17.92	6.83	70.57	223.35	49.08	5.25	
	[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	Hausman test (fe vs. re)	11.32	16.83	8.34	1.59	7.23	15.92	
	[p-value]	[0.0455]	[0.0021]	[0.0845]	[0.8103]	[0.0650]	[0.0071]	
	F-stat (bond fe vs. pooled ols)	1.23	2.42	2.56	1.97	2.18	2.42	
	[p-value]	[0.2024]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	F-stat (time fe vs. pooled ols)	4.81	3.53	3.67	3.35	13.18	3.42	
	[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	
	BP test (re vs. pooled ols)	-	-	0.00	0.00	0.00	-	
	[p-value]			[1.0000]	[1.0000]	[1.0000]		
	Schwarz BIC criterion	-3,126	-16,616	-16,072	-17,075	-16,333	-17,177	
	Bond Fixed Effects	Yes	Yes	No	No	No	Yes	
	Time Fixed Effects	Yes	Yes	No	No	No	Yes	
	Random Effects	No	No	No	No	No	No	
	Mean VIF	1.10	1.11	1.08	2.17	1.48	1.25	

See notes in table 6.

Table 9: M6 specifications of the three periods with and without clustering of s.e.'s

	M6 All Sample No clustering	M6 All Sample Clustering	M6 Before Crisis No clustering	M6 Before Crisis clustering	M6 Crisis No clustering	M6 Crisis clustering
Constant	-0.0612***	-0.0612***	-0.1464***	-0.1464***	-0.0605***	-0.0605***
	(-5.98)	(-4.48)	(-11.61)	(-3.21)	(-6.10)	(-2.65)
ΔMarketValue	-2.0253***	-2.0253***	-2.1569***	-2.1569***	-0.8638***	-0.8638*
	(-27.42)	(-12.41)	(-15.72)	(-5.82)	(-4.15)	(-1.84)
ΔGISC	1.1133***	1.1133***	1.2927***	1.2927***	-	-
	(12.02)	(4.80)	(16.19)	(5.17)		
ΔRating	0.0849*	0.0849**	-	-	-	-
	(1.92)	(2.09)				
VIX	0.0203***	0.0203***	0.0574***	0.0574***	0.0215***	0.0215***
	(9.26)	(4.57)	(12.04)	(3.11)	(7.65)	(2.98)
ΔClarkSea$_{t-2}$	-0.0947***	-0.0947**	-	-	-0.0938***	-0.0938**
	(-5.66)	(-2.37)			(-6.89)	(-2.10)
ΔClarkSea$_{t-3}$	0.0959***	0.0959**	-	-	0.1168***	0.1168**
	(4.87)	(2.19)			(7.22)	(2.46)
ΔClarkSea$_{t-4}$	-0.1230***	-0.1230***	-0.0994***	-0.0994**	-0.0991***	-0.0991**
	(-7.65)	(-3.20)	(-6.70)	(-2.26)	(-7.33)	(-2.39)
Observations	7,295	7,295	7,252	7,252	6,515	6,515
Adjusted R^2	25.24%	25.24%	22.27%	22.27%	16.91%	16.91%
Schwarz BIC	-38,812	-38,812	-22,419	-22,419	-17,177	-17,177
F-stat	19.92	19.92	16.15	16.15	5.25	5.25
[p-value]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]

Notes: This table presents the most parsimonious M6 specifications for the three periods without and with the two-way clustering of standard errors as described in Petersen (2009). t-statistics are reported in parentheses below the estimated coefficients. Statistical significance of the estimated coefficients is denoted with *, ** and *** for 10%, 5% and 1% significance levels, respectively.