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Capital structure decisions of globally-listed shipping companies

Wolfgang Drobetz [a], Dimitrios Gounopoulos [b], Andreas Merikas [c], Henning Schröder [a,*]

[a] Institute of Finance, University of Hamburg, Von-Melle-Park 5, 20146 Hamburg, Germany
[b] University of Surrey, Surrey Business School Guildford, Surrey GU2 7XH, United Kingdom
[c] University of Piraeus, Department of Maritime Studies, Piraeus, Greece

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ABSTRACT

Debt capital has traditionally been the most important source of external finance in the shipping industry. The access that shipping companies nowadays have to the capital markets provides them with a broader range of financing instruments. As such, this study investigates the determinants of capital structure decisions using a sample of 115 exchange-listed shipping companies. We test whether listed shipping companies follow a target capital structure, and we analyze their adjustment dynamics after deviations from this target leverage ratio. When compared with industrial firms from the G7 countries, shipping companies exhibit higher leverage ratios and higher financial risk. Standard capital structure variables exert a significant impact on the cross-sectional variation of leverage ratios in the shipping industry. Asset tangibility is positively related to corporate leverage, and its economic impact is more pronounced than in other industries. Profitability, asset risk, and operating leverage are all inversely related to leverage. There is only weak evidence for market-timing behavior of shipping companies. Because demand and supply in the maritime industry are closely related to the macroeconomic environment, leverage behaves counter-cyclically. Using different dynamic panel estimators, we further document that the speed of adjustment after deviations from the target leverage ratio is lower during economic recessions. On average, however, the capital structure adjustment speed in the maritime industry is higher compared with the G7 benchmark sample. These findings indicate that there are substantial costs of deviation from the target leverage ratio due to high expected costs of financial distress. Our results have implications for shipping companies' risk management activities.

1. Introduction

The shipping industry is of eminent importance for the international economy. Commercial ships are involved in the carriage of roughly 90% of global trade,[1] and the availability, low cost, and efficiency of maritime transport has helped to facilitate the global division of labor as well as the shift of industrial production to emerging countries. From a corporate finance perspective, it is notable that shipping is a highly leveraged industry. According to estimates by ABN AMRO (2011), more than 80% of all external funding needs in the shipping industry have traditionally been covered by debt finance. As financing choices affect a firm's valuation in the presence of market frictions (such as taxes, distress costs, and information asymmetry), the access

* Corresponding author.
E-mail addresses: wolfgang.drobetz@wiso.uni-hamburg.de (W. Drobetz), d.gounopoulos@surrey.ac.uk (D. Gounopoulos), merikas@unipi.gr (A. Merikas), henning.schroeder@wiso.uni-hamburg.de (H. Schröder).

[1] See International Maritime Organization, 2006; http://www.marisec.org/worldtradeflyer.pdf.

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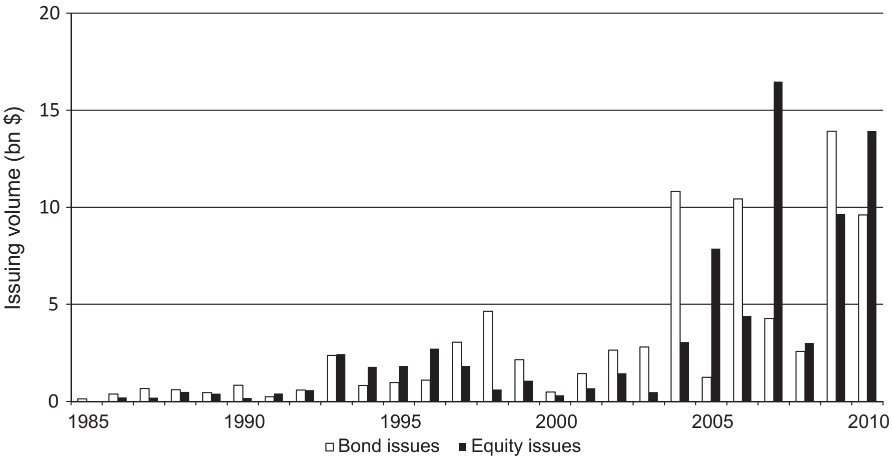

Fig. 1. *Annual bond and equity issuing volumes in the shipping industry*. The data for bond and equity issuances are obtained from ThomsonOne. The sample period is from 1985 to 2010. Issuing volumes are denominated in billions USD. Equity issues include initial public offerings and seasoned equity offerings.

shipping companies nowadays have to the global capital markets raises novel research questions with regard to their capital structure decisions. However, only in the last decade ship owners have begun to tap the global capital markets (Grammenos et al., 2007; Merikas et al., 2009). Small firms have no access to the capital markets, and thus debt has mainly been provided in the form of bank loans, while most equity financing in the shipping industry has come from private equity and retained earnings in the past. Fig. 1 exhibits the annual bond and equity (including initial public offerings and seasoned equity offerings) issuing volumes of shipping companies. The cyclical behavior of equity issuances in the shipping industry is consistent with prior results for the broader equity capital markets (Lowry, 2003). A caveat is that the shipping industry is fragmented and consists of a large number of smaller firms with concentrated ownership (Stopford, 2009; Tsionas et al., 2012) and limited access to the capital markets. Accordingly, any analysis of capital structure decisions in the shipping industry requires a focus on a specific market segment. This study analyzes the capital structure decisions of globally-listed shipping companies. In contrast to a single-vessel company, a shipping company owns, leases, charters, and operates its vessels and has a consolidated balance sheet (Grammenos, 2010). Given this financial structure, they are able to borrow as a corporation and use their balance sheet as collateral (with covenants relating to leverage, interest ratio, and asset cover).

As illustrated in Fig. 2, the leverage ratio (defined as the ratio of interest-bearing debt to total assets) of our sample of globally-listed shipping companies is almost twice as high compared to a sample of firms from the G7 countries. While our sample of listed shipping companies exhibits a mean leverage ratio of 41% (based on the book values of debt and equity) during the sample period from 1992 to 2010, the mean leverage ratio of all industrial firms (excluding financial and utility firms) from the G7 countries covered in the Compustat Global database is only 25%. Given that most shipping companies enjoy industry-specific tax incentives and rarely benefit from a tax shield (PricewaterhouseCoopers, 2009), it is interesting to observe that shipping companies nevertheless use comparatively high levels of leverage. Another observation is that book leverage falls below market leverage in some sample years, implying that the average shipping company's equity capital is valued by investors below its book value. These peculiarities of the shipping industry make it interesting to analyze the cross-sectional drivers of the level of leverage as well as the dynamics of leverage over time.

DeAngelo et al. (2011) conjecture that the optimal capital structure from the traditional static point of view – where financial managers trade off the tax benefits of debt against the distress costs of excessive debt – may not be optimal. The costs of leverage include the opportunity cost of its consequent future inability to borrow and therefore vary with firms' financial conditions and investment needs in the future. Given that many shipping companies are a tax conduit, the tax benefits of debt are often negligible. However, considering the riskiness and the cyclical nature of the maritime industry, avoiding financial distress and maintaining financial flexibility are main concerns for shipping companies. Equity capital provides a cushion against all types of risk; equity helps to preserve a company's financial flexibility, and thus it becomes a conceivable option although it is the most expensive financing alternative (Bolton and Freixas, 2000).[2]

While virtually all existing studies in the area of maritime financial management analyze the shipping industry from the product market and/or the asset market side, our approach is novel as it concentrates on the liability side and the financing decisions of shipping companies. As surveyed in Albertijn et al. (2011), both freight rates and vessel values are highly volatile and dependent on the business cycle. Recognizing that shipping companies operate in a risky environment, prior studies put

[2] Further advantages that arise for shipping companies from going public include: access to global capital markets, which provides a number of options for future refinancing; liquidity, which is assumed to lead to higher valuations and lower costs of capital if the company's fundamentals are compelling and attract sufficient new investors; the use of stock options as a means to attract key personnel; and the possibility to use their stock as an acquisition currency (Syriopoulos, 2010).

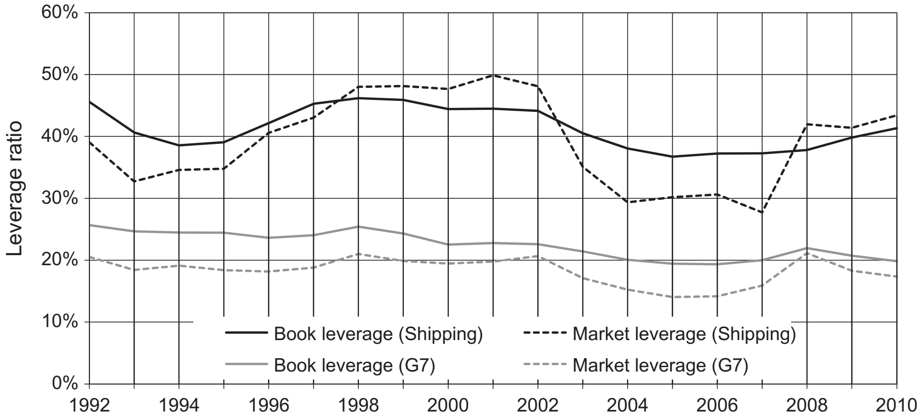

Fig. 2. *Mean leverage ratios over the sample period*. The shipping sample consists of 115 listed shipping companies. The G7 sample contains 14,523 companies, and the sample period is from 1992 to 2010. All data are annual and obtained from the Compustat Global database (excluding financial firms and utilities). Book leverage is defined as the ratio of interest bearing debt (short- and long-term debt) to book value of assets. Market leverage is defined as the ratio of interest bearing debt to the quasi-market value of assets (see Table A1).

their focus on risk management strategies using freight rate derivatives.[3] To the best of our knowledge, no study addresses the question how this cyclicality on the asset side of a shipping company's balance sheet translates to its liability side and how it affects financing and capital structure decisions. Capital structure theory suggests that both sides are not independent in the presence of market frictions. The question whether financing decisions are able to create firm value is at the center of modern corporate finance, and given their industry-specific characteristics, it is of particular importance for shipping companies. For example, similar to the airline industry (Jayasekera, 2010) and the Real Estate Investment Trust (REIT) industry (Harrison et al., 2011), they exhibit high asset tangibility. Tangible assets are easier for outsiders to value than intangible ones, and as such, a firm's expected distress costs are lower. Moreover, tangibility makes it difficult for shareholders to substitute high-risk assets for low-risk ones. The lower expected costs of financial distress and the reduced debt-related agency problems support the high leverage ratios in the shipping industry.

Tangibility does not necessarily imply redeployability of assets. Tangible assets drive corporate leverage only to the extent that they are saleable (Campello and Giambona, 2012). The values of commercial vessels respond to the supply and demand forces in the secondary markets, which makes them likely to be redeployable in normal times. However, as the ongoing financial crisis has forcefully demonstrated, redeployability of assets in shipping companies may be limited in bad times and is intricately linked to the cyclicality of asset (vessel) prices. There is only a small number of healthy industry participants as buyers who put assets into "best use" and value them more than industry outsiders or financial buyers (Shleifer and Vishny, 1992). Because of these strong interdependencies between product market conditions and financing choices, capital structure decisions are therefore strategic choices of top priority in maritime financial management. Most important, these interdependencies cast doubt on the optimality of the shipping industry's excessive leverage ratios in the past and lend support to recent demands from the banking side for higher equity requirements of shipping companies as a response to the current shipping crisis and the more stringent Basel III regulatory standards (Albertijn et al., 2011).

Based on a sample of 115 exchange-listed shipping companies, we test whether they follow a target capital structure and analyze the dynamics of their capital structure adjustments. Listed shipping companies exhibit comparatively high leverage ratios and thus higher financial risk. Our results reveal that the standard capital structure variables exert a significant impact on the cross-sectional variation of leverage ratios in the maritime industry. Asset tangibility is positively related to leverage, and its economic impact is more pronounced compared with other industries. Profitability, asset risk, and operating leverage are all inversely related to leverage, but there is only weak evidence for market-timing behavior in our sample of shipping companies. Leverage behaves counter-cyclically over the business cycle. Using different dynamic panel estimators, we further document that the speed of adjustment after deviations from the target is significantly lower during economic recessions. On average, however, the speed of adjustment in the maritime industry is higher than for other industrial firms. Taken together, these findings indicate that there are substantial costs of deviation from the target leverage ratio in the shipping industry due to high expected costs of financial distress. Country-level variables do not affect the capital structure decisions of shipping companies; this observation supports the conjecture that shipping is a truly global business with limited local influences. We compare our results with other industries and suggest that they have implications for corporate risk management activities of shipping companies.

[3] See Kavussanos and Visvikis (2006) and Alizadeh and Nomikos (2009) for textbook presentations of freight derivatives (such as forward freight contracts, freight options, and vessel price options). Moreover, it is important to recognize that capital structure choices together with decisions regarding a firm's operational flexibility and the use of financial derivatives are all elements of its broader corporate risk management strategy (Stulz, 1996; see Section 4.3).

The remainder of this study is structured as follows: Section 2 provides the theoretical framework. Section 3 contains a detailed data description. The results of standard leverage regressions are reported and discussed in Section 4; those of dynamic panel regressions to estimate the speed of adjustment after target deviations in Section 5. Finally, Section 6 offers concluding statements and provides an outlook for further research.

2. Theoretical issues and determinants of capital structure

2.1. Capital structure theories

The main theories of capital structure which attempt to explain firms' financing decisions are the trade-off theory, the pecking order theory, and the market timing theory. According to the trade-off theory, capital structure choices are determined by a trade-off between the benefits and costs of debt (Kraus and Litzenberger, 1973). The benefits and the costs of debt can come in different forms. On the one hand, the tax benefits of debt have to be balanced against the deadweight costs of bankruptcy and financial distress (the tax-bankruptcy perspective). On the other hand, from an agency perspective, firms need to evaluate the agency costs of debt, which arise from underinvestment (Myers, 1977) and asset substitution (Jensen and Meckling, 1976), against the agency costs of equity from the free cash flow problem (Jensen, 1986). As a result, although increased leverage mitigates the agency costs of equity, it exacerbates bondholder–shareholder conflicts.

While the trade-off theory assumes the existence of an optimal leverage ratio based on market imperfections such as taxes, financial distress costs, and agency costs in the model, the pecking order theory is based on asymmetric information between firm insiders and outsiders and the resulting adverse selection problems in raising capital (Myers and Majluf, 1984; Myers, 1984). This theory cannot provide predictions concerning an optimal leverage ratio, but rather, it posits that a firm's capital structure is the result of its financing requirements over time and its attempt to minimize adverse selection costs. The pecking order theory ranks financing sources according to the degree they are affected by information asymmetry. As a result, firms use internal funds in the first place. If they need external funds, they prefer to issue debt over equity.

In a third strand of the literature, Baker and Wurgler (2002) document that market timing efforts – issuing equity when the stock market is perceived to be more favorable and market-to-book ratios are relatively high – have a persistent impact on corporate capital structures. They argue that neither the trade-off theory nor the pecking order theory is consistent with the persistent negative effect of the weighted average of a firm's past market-to-book ratios on its leverage. Instead, Baker and Wurgler (2002) suggest that firms time their equity issues to stock market conditions. Firms do not generally care whether they finance with debt or equity, but rather, choose the form of financing which seems most valued by financial markets at the time. Any capital structure changes induced by equity issues persist because firms do not readjust their debt ratios towards the target afterwards. As a result, the observed capital structure is not the result of a dynamic optimization strategy but reflects the cumulative outcome of past attempts to time the equity market.

The empirical evidence documents that there exists no comprehensive theory which is capable of explaining all time-series and cross-sectional patterns of observed leverage ratios (Parson and Titman, 2009; Graham and Leary, 2011). However, several studies identify observable firm-level factors which can reliably explain the variation in corporate leverage (Lemmon et al., 2008; Frank and Goyal, 2009). Any observable leverage factors should be related to capital structure theories by serving as a proxy for the underlying forces that drive these theories, such as the costs of financial distress and information asymmetry. Nevertheless, the expected sign of the relationship is not always unambiguous, and it is therefore important to sort out those factors which are reliably signed and economically relevant for explaining corporate leverage.

2.2. Capital structure factors

Based on the existing empirical literature, we extract a list of factors that have been used to explain firms' financing decisions.[4] For the sake of clarity, we discuss these factors in two groups. We start in Section 2.2.1 with a "standard factors" group, which includes the four factors used by Rajan and Zingales (1995). We proceed in Section 2.2.2 with an "additional factors" group. These additional factors are inspired by Frank and Goyal (2009), among others, and potentially exert an influence on the capital structure of shipping companies.

We omit a tax factor for three reasons. First, taxes are not part of Frank and Goyal's (2009) "core model" of reliable capital structure factors. Second, most countries offer special tax incentives for shipping companies (PricewaterhouseCoopers, 2009). Most important, many countries have introduced a tonnage tax regime, where the payable tax is based on the tonnage of the vessel instead of actual accounting profits from the exploitation of the vessel. In this case, the effective tax rate is negligible as long as the shipping business is generally doing well. Alternatively, shipping incentive regimes in several countries reduce the tax burden for shipping companies by either narrowing the tax base, lowering the tax rate, or providing complete tax redemption. Finally, shipping companies often choose to locate their activities in countries that offer tax efficient regimes (but without incentives specifically targeted at the shipping industry).

[4] Prior studies which analyze factors that are important for capital structure decisions of listed companies include Rajan and Zingales (1995), Lemmon et al. (2008), and Frank and Goyal (2009).

2.2.1. Standard factors

Tangibility: Asset tangibility is a measure for the level of a firm's collateralizable value. From a trade-off perspective, one expects that firms with a higher ratio of fixed-to-total assets are subject to lower costs of financial distress, as tangible assets suffer from a smaller loss of value in case of bankruptcy. In addition, tangible assets are easier to value for outsiders, resulting in lower information asymmetry, less pronounced agency costs of debt, and a higher debt capacity. Therefore, the trade-off theory predicts a positive relationship between tangibility and leverage. Based on the pecking order theory, Harris and Raviv (1991) argue that a tangibility-induced reduction in information asymmetry makes an equity issuance less costly, implying lower leverage ratios for firms with more tangible assets. The positive relationship between tangibility and leverage in most empirical studies supports the trade-off theory.

Market-to-book ratio: The market-to-book ratio is a measure for a firm's growth opportunities. Growth firms are expected to suffer from higher costs of financial distress and face higher debt-related agency costs due to a potential underinvestment problem (Myers, 1977). This conjecture suggests an inverse relationship between market-to-book and leverage under the trade-off theory. In contrast, holding profitability constant, the pecking order theory implies higher leverage ratios for firms with more growth opportunities; debt is expected to increase when investment exceeds retained earnings, and vice versa. In line with the trade-off theory, most empirical studies report a robust negative relationship between growth opportunities and leverage ratios. However, this finding is further compatible with a market timing perspective. In fact, if market timing drives capital structure decisions, a higher market-to-book ratio will reduce leverage as firms exploit security mispricing through equity issuances.

Profitability: Given lower costs of financial distress and a higher income to shield for more profitable firms, the static trade-off approach predicts a positive relationship between profitability and leverage. The agency models of Jensen and Meckling (1976), Easterbrook (1984), and Jensen (1986) refer to the disciplining role of leverage. They suggest that more profitable firms hold higher levels of leverage in order to reduce agency conflicts. In contrast, the pecking order theory posits that higher profitability implies lower levels of leverage as internal funds are preferred over (external) debt financing. This latter conjecture is reliably supported by most empirical studies (Rajan and Zingales, 1995; Frank and Goyal, 2009).

Firm size: The effect of size on leverage is also ambiguous. From the trade-off perspective, large firms tend to be more diversified and exhibit a lower probability of default, implying an inverse relationship between size and the expected bankruptcy costs and, thus, a positive relationship between size and leverage. Alternatively, under the pecking order theory, size can be regarded as a proxy for information asymmetry between firm insiders and capital markets. Specifically, the larger the firm, the more information is provided to outside investors, and as such, adverse selection costs when issuing equity are lower. This notion suggests an inverse relationship between size and leverage. Empirical tests generally document a robust positive empirical relationship between size and leverage, which supports the trade-off theory (Rajan and Zingales, 1995; Frank and Goyal, 2009).

2.2.2. Additional factors

Asset risk: Financial distress costs are commonly considered to be a positive function of the volatility of asset values; firms with more volatile assets tend to have a lower collateralizable value. This conjecture particularly applies to temporary illiquid tangible assets that are hardly redeployable in bad macroeconomic states (Shleifer and Vishny, 1992; Campello and Giambona, 2012). Therefore, the trade-off theory predicts an inverse relationship between asset volatility and leverage due to a lower collateralizable value and higher expected bankruptcy costs for firms with riskier asset values. In contrast, from a pecking order perspective, firms with more volatile assets suffer from higher adverse selection costs, and thus they choose to hold more debt. Despite the important role of risk in capital structure theory, there is only scarce empirical evidence. Exceptions are Lemmon et al. (2008) and Gropp and Heider (2010), who document that risk is a reliable factor for explaining corporate leverage.[5]

Operating leverage: The degree of a firm's operating leverage is a positive function of the firm's fixed production costs. The higher a firm's operating leverage, the higher are its operating risks, and therefore, operating leverage and asset risk can be viewed as complementary measures of a firm's business risks. Under the trade-off theory, one would expect lower levels of financial leverage for firms with high levels of operating leverage, and vice versa. In addition, integrated risk management involves simultaneous decisions about a firm's operations, its use of financial derivatives, and its capital structure choices (Meulbroek, 2002). All else equal, risk management through operations can increase a firm's debt capacity and will favor the use of debt, implying a negative relationship between operating and financial leverage. Similar to asset risk, operating leverage has not been extensively investigated in the empirical literature. Using a large US sample of industrial firms, Kahl et al. (2011) show that high fixed cost firms face higher cash flow risks and choose lower financial leverage (as well as higher cash holdings). Harrison et al. (2011) investigate the capital-intensive REIT industry and similarly document that operating leverage is negatively related to financial leverage.

Dividend paying status: A firm's dividend paying status is another frequently used leverage factor. According to Lintner (1956) and Brav et al. (2005), firms attempt to maintain constant dividend payouts relative to earnings in the long-run. In the short-run, they attempt to smooth their dividends from year to year in order to avoid sharp changes (and decreases

[5] While both studies define their risk measure using the volatility of cash flows (the risk on a firms' revenue side), we put our focus on the volatility of a firm's assets (the balance sheet risk).

in particular). A higher level of dividend payouts leads to lower retained earnings, requiring firms to tap the markets for external finance. The resulting predictions of the pecking order theory are ambiguous. On the one hand, given that debt is preferred to equity, this financing hierarchy predicts a positive relationship between dividends and corporate leverage. On the other hand, paying dividends implies that firms are subject to market monitoring, and the resulting reduced information asymmetry may lead to a negative relationship between dividends and leverage (through more frequent equity issuances). In fact, evidence by Frank and Goyal (2009) reveals that dividend-paying firms tend to carry lower leverage.

Rating probability: An implicit assumption so far has been that a firm's leverage is completely a function of a firm's demand for debt. However, firms are sometimes rationed by lenders (Stiglitz and Weiss, 1981). Based on surveys, Graham and Harvey (2001) report that an important goal of chief financial officers (CFOs) is to maintain financial flexibility. In fact, one of their major concerns is being shut out of the capital markets during market downturns. Faulkender and Petersen (2006) emphasize that when estimating a firm's target leverage, empirical analyses should not only include the determinants of a firm's preferred leverage (the demand side) but also those factors that measure the constraints on its ability to increase leverage (the supply side). They argue that a company's ability to issue public (rated) debt can be interpreted as an indicator of large debt capacity. Firms with a credit rating have easier access to the debt markets than those without a rating, and thus rated firms will choose more leverage. This result can occur either directly through a quantity channel (lenders are willing to lend more) or a price channel (firms with access to a cheaper source of capital will borrow more). Either way, Faulkender and Petersen (2006) document that opening up a new supply of debt capital increases a firm's leverage.

Possessing a credit rating involves information collection and processing through the rating agency, and thus firms with a public rating suffer from less pronounced information asymmetry. Accordingly, from a pecking order perspective, firms that have a rating may use less debt and more equity. As emphasized by Frank and Goyal (2009), however, this effect is ambiguous because lower adverse selection costs increase the frequency with which firms tap the external capital market, potentially resulting in more debt.

Lemmon and Zender (2010) criticize the use of the actual presence or absence of a debt rating as a measure of debt capacity. Firms without a rating might have deliberately chosen to rely on equity financing for reasons other than being excluded from the debt markets. In order to minimize biases that result from firms which have the debt capacity to issue rated debt but choose not to do so, they propose estimating the rating probability for each firm in a given year by using a logistic regression-based predictive model based on a number of firm-specific variables as rating predictors (see Section 3.3). These estimated probabilities are assumed to proxy for a firm's debt capacity. Lemmon and Zender (2010) document that in the absence of debt capacity concerns the need for external financing is covered by debt rather than equity, which they interpret as evidence for the pecking order theory.

3. Data

3.1. Sample of listed shipping companies

Our sample consists of 115 (84 active and 31 inactive) listed shipping companies covered in the Compustat Global database during the period between 1992 and 2010. The data are on an annual basis and converted into US dollars. Companies included in our analysis are chosen upon the condition that they own and/or operate commercial ships.[6] In order to account for a company's total liabilities, we only consider firms with fully consolidated balance sheet data (i.e., classified as consolidation level "F" in Compustat Global). Furthermore, we drop firm-years with values of total book assets below one million US dollars and require that all firm-year observations have non-missing data for total book assets. In the most basic specification, our sample consists of 1442 firm-year observations. Table 1 reports the number of shipping companies including firm-year observations according to their country of incorporation.

3.2. Measuring leverage

There are many different forms of debt, equity, and hybrid securities, and hence the appropriate definition of the debt-to-equity ratio for empirical research is not obvious (Welch, 2011). Following Frank and Goyal (2009), we use the ratio of the sum of short- and long-term debt to total assets (based both on book and market values). This measure of leverage covers debt in a narrower sense (i.e., interest-bearing debt).[7] In robustness tests, we repeat our main regression analyses using the alternative definitions of leverage suggested by Rajan and Zingales (1995); they provide a detailed discussion of the pros and cons of each single measure. The results are shown in Table A3 in the Appendix. As our findings are largely robust against alternative definitions of leverage, we omit a detailed discussion of these robustness checks.

[6] This approach implies that we exclude shipyards as well as shipping companies involved in passenger shipping and operate drilling ships, supply vessels, or inland vessels.

[7] This choice is also consistent with the leverage measures used in previous studies, such as Rajan and Zingales (1995), Titman and Wessels (1988), and Lemmon et al. (2008).

Table 1
Shipping companies and firm-year observations by country.

Country	Companies	Firm-years
United Arab Emirates	1	7
Belgium	3	36
Bermuda	10	110
Canada	1	19
Chile	1	19
China	7	82
Cayman Islands	1	12
Denmark	6	75
Finland	1	8
Greece	1	8
Hong Kong	3	40
Indonesia	2	31
India	6	53
Ireland	1	15
Italy	1	14
Jersey	1	5
Japan	9	159
South Korea	5	65
Luxembourg	1	7
Latvia	1	11
Marshall Islands	6	54
Malaysia	6	76
Norway	8	99
Philippines	1	14
Russia	1	12
Singapore	7	69
Sweden	3	43
Thailand	4	68
Taiwan	9	101
United States of America	7	115
South Africa	1	15

The table shows the distribution of firms and firm-year observations in our sample with respect to the firms' country of incorporation. The sample consists of 115 listed shipping companies. Data are annual and obtained from the Compustat Global database. The sample period is from 1992 to 2010. Country classifications are based on Compustat item *CINC* that indicates the country in which a company is legally registered.

3.3. Definitions of variables

Table A1 in the Appendix describes the construction principles of our leverage measures (both in book and market terms) and all explanatory variables. The standard capital structure variables are defined as follows: Tangibility is the ratio of property, plants, and equipment to total assets; profitability is the operating income before depreciation to total asset; firm size is the natural logarithm of total assets; and market-to-book is the ratio of the market value to book value of assets.

Following Novy-Marx (2011), we measure operating leverage as the ratio of operating expenses to total assets. This measure of operating leverage is particularly suitable for shipping companies. Their operating costs include manning, repairs and maintenance, stores and lubes, marine insurance, and administration, and thus they represent the fixed costs for the vessel to be seaworthy.[8] In the past, they were assumed to be relatively constant and to rise with inflation (Kavussanos and Visvikis, 2006). While operating risk refers to the volatility of a company's cash flows and profitability, asset risk measures the volatility of the value of its assets. As in Frank and Goyal (2009), asset risk is defined as the unleveraged annual standard deviation of a company's daily stock returns. Daily return data is obtained from Thomson Datastream. A company's dividend paying status is modeled using a dummy variable, which is set equal to one if the firm pays dividends in a given year, and zero otherwise.

In order to estimate a company's probability to obtain a public rating, we adapt the logistic regression approach from Faulkender and Petersen (2006) and Lemmon and Zender (2010).[9] Specifically, we estimate a logistic regression model for the full Compustat Global sample of industrial firms from the G7 countries, where the dependent binary variable is set equal to one if firm *i* in year *t* has a long-term (public) credit rating, and zero otherwise. As rating predictors we apply company size, profitability, asset tangibility, market-to-book ratio, firm age, R&D expenses, stock return volatility, and industry dummy

[8] The alternative ΔEBIT/ΔSales ratio (Kavussanos and Visvikis, 2006) is only a blurry measure of operating leverage because it could include variable cost elements and thus does not measure a shipping company's riskiness based on its fixed cost commitment. Variable costs include bunker and canal as well as port dues. These costs show up in a shipping company's financial statements only if the vessel is being operated in the spot market rather than the time-charter market.

[9] Grammenos et al. (2007, 2008) provide an analysis of the characteristics of rated shipping bonds. Most shipping companies in our sample do not possess a public rating.

Table 2
Descriptive Statistics.

	Obs.	Mean	SD	Median	Percentiles 25th	Percentiles 75th	Min	Max
Book leverage	1430	0.407	0.206	0.401	0.259	0.559	0.000	0.867
Market leverage	1249	0.386	0.212	0.376	0.222	0.550	0.000	0.820
Book assets (m$)	1434	2429.529	6750.061	575.169	229.422	1932.788	15.307	55500.000
Tangibility	1429	0.630	0.204	0.668	0.510	0.792	0.097	0.951
Market-to-book	1252	1.165	0.451	1.052	0.892	1.314	0.545	3.400
Profitability	1355	0.113	0.070	0.104	0.068	0.150	-0.035	0.366
Size	1434	6.483	1.562	6.355	5.436	7.567	2.728	10.924
Operating leverage	1411	0.500	0.410	0.394	0.187	0.691	0.014	2.094
Asset risk	1096	0.199	0.145	0.166	0.107	0.249	0.007	1.904
Rating probability	1041	0.184	0.217	0.089	0.033	0.250	0.001	0.921
Price run-up	1117	0.196	0.761	0.021	-0.226	0.389	-0.793	4.000
Dividend payer	1442	0.778	0.416	1.000	1.000	1.000	0.000	1.000
Age	1442	6.660	4.805	6.000	3.000	10.000	1.000	18.000

The descriptive statistics show the number of firm-year observations (Obs.), the mean, the standard deviation (SD), the median, the 25th and 75th percentile, as well as the minimum (Min) and the maximum (Max) value of each variable. The sample consists of 115 listed shipping companies. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. Data are annual and obtained from the Compustat Global database. All variables apart from rating probability, age, and the dividend payer dummy are winsorized at the upper and lower one percentile. See Appendix Table A1 for definitions of variables.

variables for all 2-digit SIC codes in the sample.[10] In order to arrive at firm-year rating probabilities, we reinsert the estimated coefficients into the logistic regression model and compute the firm-level probabilities using annual company characteristics. We use this probability as a proxy for a shipping company's supply-side constraints and its ability to increase leverage (debt capacity).

3.4. Descriptive statistics

Table 2 provides descriptive statistics of all variables. They are winsorized at the upper and lower one percentile to mitigate the impact of outliers and to eradicate errors in the data. In order to put our findings for shipping companies into a broader perspective, we compare them with those in Frank and Goyal (2009) for US data, in Bessler et al. (2012) for a sample of firms from the G7 countries, and in Harrison et al. (2011) for the U.S. Real Estate Investment Trust (REIT) industry (not tabulated).

On average, both book and market leverage ratios are substantially higher in the shipping industry than for the average industrial company from the US or any other G7 country; in Table 2 the mean book leverage ratio is 40.7%, and the mean market leverage ratio is 38.6% (see also Fig. 2).[11] There is substantial heterogeneity in the cross-section of leverage ratios. Table 3 shows the mean values of quartile portfolios, which are sorted based on the different firm characteristics.[12] In fact, shipping companies exhibit a large spread in their use of leverage, ranging from a mean book (market) leverage ratio of 20.6% (16.5%) in the first quartile (Q1) to 62.2% (58.5%) in the fourth quartile (Q4). Their high leverage ratios are comparable to those for the REIT industry. Presumably, this similarity in leverage ratios is attributable to the observation that both the shipping industry and the REIT industry are characterized by a high intensity of fixed assets. In line with this conjecture, shipping companies exhibit high tangibility ratios. On average, tangible assets account for 63% of firms' total assets, and even in the first quartile (Q1), the mean tangibility ratio is as high as 39.6%. In contrast, the average US and G7 firm exhibits a lower mean tangibility ratio of 34.0% and 28.9%, respectively.

While the mean value of total book assets is $2.43 billion, the median value is only $0.58 billion. Table 3 confirms that there is substantial heterogeneity in size across quartile portfolios. In addition, market-to-book ratios in the shipping industry are substantially lower compared with the G7 benchmark. In general, shipping companies' valuation levels are relatively low, and there are even short periods of time when the average shipping company was rated below its book value during our sample period (see also Fig. 2). While the mean market-to-book ratio is as low as 1.17, there is also cross-sectional variation in market-to-book ratios (Table 3); they range from 0.88 in the first quartile portfolio (Q1) to 1.54 in the fourth quartile portfolio (Q4). As a comparison, the mean market-to-book ratio in the G7 sample is 1.71, indicating substantial valuation dis-

[10] The sample of G7 firms is taken from Bessler et al. (2012); they provide a detailed data description. The sample contains 233,146 firm-year observations, and the estimation period is from 1989 to 2010. We use the RatingXpress historical rating files from S&P to determine whether a firm has a long-term (public) credit rating. These files contain all historical ratings for all rating levels (entities, maturities, and issues) and rating types (long- and short-term, local, and foreign currency).

[11] A caveat is that shipping companies are different from other industrial firms in many respects, and these differences might explain the differences in leverage. Therefore, one has to be careful when simply comparing mean leverage ratios across heterogeneous samples. Although outside the scope of our analysis, a remedy would be to compare mean leverage ratios for the shipping industry to a matched sample of firms from other industries.

[12] For any variable, firms are sorted according to their mean value over the entire sample period. Based on these mean values, firms are grouped into quartile portfolios. Table 3 reports the mean values for firms in each quartile portfolio.

Table 3
Quartile means.

	Q1	Q2	Q3	Q4	Total
Book leverage	0.206	0.353	0.486	0.622	0.407
Market leverage	0.165	0.357	0.470	0.585	0.386
Tangibility	0.396	0.603	0.725	0.826	0.630
Market-to-book	0.877	1.049	1.215	1.538	1.165
Profitability	0.064	0.097	0.123	0.174	0.113
Size	4.805	5.932	6.862	8.265	6.483
Operating leverage	0.108	0.265	0.517	1.007	0.500
Asset risk	0.109	0.171	0.224	0.377	0.199

The table reports quartile means for the firm-specific variables. For each variable, sample firms are sorted into quartile portfolios (Q1–Q4) according to their individual variable mean. Quartile means are calculated from these portfolios. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. Data are annual and obtained from the Compustat Global database. All variables are winsorized at the upper and lower one percentile. See Appendix Table A1 for definitions of variables.

counts in the shipping industry. In terms of profitability, however, shipping companies are similar to other industrial firms. The median shipping company exhibits a ratio of operating income before depreciation to total assets of 10.4%, which is slightly higher than the median ratio of 9.71% in the sample of firms from the G7 countries.[13] As expected, profitability varies strongly across quartile portfolios, potentially indicating that different business models (e.g., with respect to the level of activism in timing freight rates and/or vessel prices) offer different return potentials.

As expected, the higher financial leverage in the shipping industry is accompanied by distinctly lower operating leverage ratios. Our mean measure for operating leverage is only 0.50 for the sample of shipping companies in Table 2, while it is as high as 1.07 in the sample of G7 industrial firms. The median operating leverage measure is even lower with 0.39. These observations contradict the conventional wisdom that the shipping industry exhibits high operating leverage in addition to high financial leverage (Kavussanos and Visvikis, 2006). In contrast, with a mean standard deviation of 19.9% (across quartiles in Table 3), the asset values of shipping companies are substantially more volatile than those of non-shipping firms (with standard deviations of 13.0% in the US sample and 11.3% in the G7 sample). This observation is consistent with the conjecture that shipping companies suffer from pronounced vessel price risks. Asset volatility in combination with fair value accounting standards directly affects the balance sheets of listed shipping companies (Albertijn et al., 2011).[14]

The estimated rating probabilities indicate that the average shipping company is unlikely to have a high debt capacity and easy access to the public debt markets. Only 22% of our shipping companies possess a higher rating probability than the median G7 firm and thus may be classified as unconstrained in their debt capacity. This result that most shipping companies suffer from supply-side constraints in their debt capacity does not contradict the observation that shipping companies carry high leverage compared with other industries. As emphasized by Faulkender and Petersen (2006), the availability of a debt rating indicates a firm's access to the public debt market. However, shipping companies' debt mainly comes in the form of bank debt. According to ABN AMRO (2011), bank loans traditionally have satisfied approximately 75% of all external funding needs. Financial intermediaries, who specialize in collecting information about borrowers and interact with them over time and across different products (Leland and Pyle, 1977), may be able to alleviate the information asymmetries that cause the public debt market's failure and use their privileged information in the credit approval decision.[15]

As many as 77.8% of the shipping companies in our sample pay out dividends, but their payout ratios (not tabulated) are similar to those for other industrial firms. To the extent that payouts are related to financial constraints (Fazzari et al., 1988; Denis and Sibilkov, 2010), these payout patterns of shipping companies do not support the conjecture that they face financial constraints.[16] However, they may be consistent with Bolton and Freixas' (2000) extended pecking order hierarchy. In their model, the safest firms use the public debt market for financing; these firms have the greatest capacity to borrow and a very low probability of distress, and therefore it is cost effective for them to avoid the intermediation costs incurred with bank debt. More risky firms with a lower capacity to borrow use the more flexible but nominally more expensive bank debt. Bank debt provides the cheapest form of flexible financing (in the sense of being more efficient in restructuring distressed firms). The riskiest firms are constrained to use equity (or are unable to obtain any outside funding).[17] These firms may deliberately pay dividends and accept monitoring through capital markets in order to obtain equity at reasonable costs. An alternative explanation is that

[13] This result is robust when we use other definitions of profitability, such as the ratio of EBIT to total assets or the ratio of EBIT to sales.

[14] The current shipping crisis and the sharp decrease in the market prices of vessels have forced many listed shipping companies to deal with impairment losses (which are recognized when the carrying amount of the long-lived asset is not recoverable and exceeds its fair value).

[15] In the past, the shipping industry has been characterized by relationship-lending, and as such, the monitoring and additional information collection performed by shipping banks has eliminated to a large extent the information asymmetry and credit rationings. However, shipping banks' lending capacity may be restricted in the future due to the new Basel III regulations (Albertijn et al., 2011).

[16] The finding that most shipping companies in our sample are classified as being financially constrained according to the Faulkender and Petersen (2006) logistic regression model is mostly attributable to their small size, low market-to-book ratio, and high asset risk.

[17] In Bolton and Freixas' (2000) framework, a firm's ability to issue public debt indicates a large debt capacity (and high financial flexibility). Conversely, the use of bank (monitored) debt indicates a lower debt capacity (and low financial flexibility). Rather than relying solely on bank debt, only shipping companies with the best reputation will choose to issue shipping bonds. This notion is consistent with the predominance of bank debt in the shipping industry.

Table 4
Correlations.

	Book leverage	Market leverage	Tangibility	Market-to-book	Profitability	Size	Operating leverage	Asset risk	Dividend payer	Rating probability
Book leverage	1.000									
Market leverage	0.878	1.000								
	0.000									
Tangibility	0.487	0.485	1.000							
	0.000	*0.000*								
Market-to-book	−0.154	−0.484	−0.094	1.000						
	0.000	*0.000*	*0.003*							
Profitability	−0.094	−0.213	0.206	0.327	1.000					
	0.003	*0.000*	*0.000*	*0.000*						
Size	−0.001	−0.074	−0.142	0.061	−0.067	1.000				
	0.974	*0.018*	*0.000*	*0.053*	*0.035*					
Operating leverage	−0.304	−0.265	−0.469	−0.081	−0.085	0.111	1.000			
	0.000	*0.000*	*0.000*	*0.010*	*0.007*	*0.000*				
Asset risk	−0.388	−0.500	−0.135	0.446	0.302	−0.246	−0.128	1.000		
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*			
Dividend payer	−0.138	−0.154	−0.139	0.035	0.053	0.244	0.035	−0.016	1.000	
	0.000	*0.000*	*0.000*	*0.268*	*0.094*	*0.000*	*0.269*	*0.612*		
Rating probability	0.020	−0.050	−0.162	0.066	−0.100	0.918	0.111	−0.070	0.212	1.000
	0.526	*0.112*	*0.000*	*0.037*	*0.002*	*0.000*	*0.000*	*0.027*	*0.000*	

The table reports pairwise correlation coefficients for book and market leverage as well as for the firm-specific determinants of leverage. The sample period is from 1992 to 2010. All variables are winsorized at the upper and lower one percentile. Numbers in italics below the coefficients indicate *p*-values. See Appendix Table A1 for definitions of variables.

shipping companies usually enjoy tax exemption, and investors may benefit from favorable tax treatment and exhibit a preference for dividends.

Finally, Table 4 shows the pairwise correlation coefficients of all firm-level characteristics. Tangibility is positively correlated with leverage. More profitable companies and those with higher market-to-book ratios tend to carry lower leverage. Consistent with the conjecture in Merikas et al. (2011), shipping companies' operating leverage is negatively correlated with financial leverage. Dividend paying companies and those with more volatile assets also tend to use less debt. Finally, rating probability and firm size exhibit weak univariate correlations with leverage. All correlation patterns are similar for book and market leverage definitions. In results not tabulated, we reject the presence of multicollinearity in our set of variables using a test based on variance inflation factors (VIF-test).

4. Corporate finance style regressions

4.1. Standard capital structure regressions

In order to evaluate the relative importance of our set of capital structure factors, we test different model specifications. While Model 1 (M1) is a standard pooled OLS regression, Model 2 (M2) is a fixed effect panel regression:

$$L_{it} = \alpha + \beta X_{it} + \varepsilon_{it}, \tag{M1}$$
$$L_{it} = \alpha + \beta X_{it} + c_f + c_t + \varepsilon_{it}, \tag{M2}$$

where L_{it} denotes the leverage measure of firm i at time t; X_{it} is a vector of firm characteristics; β is a vector of regression coefficients; α is the intercept; and ε is an error term. Model 2 involves three sub-specifications, which include either firm fixed effects (c_f), calendar year fixed effects (c_t), or both in order to account for unobserved heterogeneity at the firm level and across time. Based on Petersen (2009), standard errors are clustered at the firm level to account for heteroscedasticity and autocorrelation of errors. Results for both the OLS and the different fixed effect specifications are shown in Table 5. We report the results for the standard Rajan and Zingales (1995) specification and for an extended model, including the full set of capital structure variables.

The OLS results in Column 1 indicate that the estimated coefficients on all standard capital structure variables (for both book and market leverage) exhibit the same signs as in prior studies (Rajan and Zingales, 1995; Frank and Goyal, 2009). Tangibility is positively related to leverage, which is in line with the conjecture that fixed assets provide collateral for loans and thus increase debt capacity. In the market leverage regression, the estimated coefficient on the market-to-book ratio is significantly negative. As firms with higher growth options suffer from higher costs of financial distress, this finding is consistent with the trade-off theory. In contrast, the coefficient on profitability suggests that higher profitability is accompanied by lower leverage. This result supports the pecking order theory, where firms prefer internal funds to external funds and debt to equity. The positive coefficient on firm size is lost in measurement error.

Column 2 presents the results for the model with the full set of variables. Again, the signs of the estimated coefficients are the same for both book and market leverage. Comparable to the results in Welch (2004) and Lemmon et al. (2008), asset risk exerts a negative effect on leverage. Given the costs of financial distress associated with higher asset risk, the negative relationship between leverage and asset risk supports the trade-off theory. In line with the results for REITs (Harrison et al., 2011), operating leverage is negatively related to financial leverage. Presumably, the observation that high fixed costs firms pursue more conservative financial policies is attributable to financial flexibility (Kahl et al., 2011) and corporate risk management considerations. These findings will be discussed in more detail in Section 4.3.

Dividend payers tend to carry lower leverage, as indicated by the negative coefficient on the dividend dummy variable (Frank and Goyal, 2009). Moreover, when firms have restricted access to debt markets, all else equal, financing will take place through equity markets (Faulkender and Petersen, 2006; Lemmon and Zender, 2010). The positive coefficient on our rating probability variable is consistent with the conjecture that less debt will be issued if access to the public debt markets is restricted and if there are constraints on a firm's ability to increase its leverage (supply-side limitations). Although shipping banks eliminate information asymmetry to a large extent through their long-term lending relationships and are able to provide large amounts of debt to the shipping sector, monitoring is always imperfect and costly. These costs will be passed onto the borrower in the form of higher interest rates, causing constrained shipping companies to reduce their use of debt.

As in prior studies, the adjusted R-square in Column 2 is substantially higher for market leverage compared with book leverage. Most important, Lemmon et al. (2008) show that adding firm fixed effects to the standard OLS leverage regression substantially improves its explanatory power. This observation implies that corporate capital structure is to a significant extent driven by an unobserved time-invariant component. As a result, the standard capital structure factors become largely irrelevant once the regression accounts for time-invariant firm effects. Consistent with the findings in Lemmon et al. (2008), we observe a large increase in adjusted R-squares in Columns 3 and 4 when firm fixed effects are included into the model. Further adding year fixed effects only marginally improves the model's explanatory power, as shown in Columns 7 and 8. As expected, not all capital structure variables pass the "fixed effects stress test". The coefficients still have the same sign, but in several instances both their magnitude and significance level decreases.

Table 5
Standard leverage regressions.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dependent variable: Book leverage								
Tangibility	0.511***	0.362***	0.374***	0.309***	0.510***	0.361***	0.325***	0.274***
	(0.068)	(0.071)	(0.060)	(0.062)	(0.071)	(0.072)	(0.060)	(0.062)
Market-to-book	−0.022	0.024	−0.027	0.004	−0.021	0.031	−0.003	0.030
	(0.023)	(0.030)	(0.019)	(0.023)	(0.028)	(0.036)	(0.025)	(0.030)
Profitability	−0.526***	−0.215	−0.394***	−0.247**	−0.515***	−0.203	−0.397***	−0.246*
	(0.143)	(0.142)	(0.115)	(0.117)	(0.166)	(0.167)	(0.135)	(0.134)
Size	0.008	−0.028	−0.003	−0.016	0.010	−0.029	0.039	0.010
	(0.009)	(0.019)	(0.019)	(0.029)	(0.009)	(0.018)	(0.024)	(0.031)
Operating leverage		−0.085***		−0.043		−0.086***		−0.028
		(0.027)		(0.028)		(0.027)		(0.030)
Dividend payer		−0.044*		−0.023		−0.046*		−0.020
		(0.026)		(0.017)		(0.026)		(0.016)
Asset risk		−0.518***		−0.282***		−0.541***		−0.291***
		(0.097)		(0.099)		(0.108)		(0.105)
Rating probability		0.253**		0.140		0.262**		0.241
		(0.122)		(0.201)		(0.121)		(0.184)
Firm fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Observations	1007	1007	1007	1007	1007	1007	1007	1007
Adj. R^2	0.280	0.393	0.725	0.745	0.282	0.395	0.743	0.762
Dependent variable: Market leverage								
Tangibility	0.506***	0.356***	0.400***	0.322***	0.502***	0.353***	0.348***	0.283***
	(0.067)	(0.068)	(0.059)	(0.060)	(0.069)	(0.068)	(0.058)	(0.059)
Market-to-book	−0.181***	−0.137***	−0.197***	−0.161***	−0.161***	−0.109***	−0.147***	−0.107
	(0.022)	(0.020)	(0.017)	(0.016)	(0.020)	(0.020)	(0.017)	(0.018)
Profitability	−0.586***	−0.279**	−0.508***	−0.349***	−0.535***	−0.219*	−0.446***	−0.272**
	(0.118)	(0.115)	(0.116)	(0.115)	(0.129)	(0.131)	(0.130)	(0.125)
Size	0.001	−0.036**	−0.019	−0.004	0.001	−0.040***	0.017	0.006
	(0.008)	(0.015)	(0.014)	(0.025)	(0.008)	(0.015)	(0.019)	(0.025)
Operating leverage		−0.088***		−0.062**		−0.087***		−0.049
		(0.025)		(0.029)		(0.024)		(0.033)
Dividend payer		−0.044*		−0.022		−0.044*		−0.017
		(0.024)		(0.015)		(0.024)		(0.015)
Asset risk		−0.503***		−0.327***		−0.545***		−0.375***
		(0.104)		(0.110)		(0.115)		(0.120)
Rating probability		0.257**		−0.088		0.279***		0.044
		(0.101)		(0.150)		(0.099)		(0.145)
Firm fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Observations	1007	1007	1007	1007	1007	1007	1007	1007
Adj. R^2	0.457	0.553	0.750	0.776	0.474	0.575	0.779	0.806

The table shows the results of standard leverage regressions using a sample of 115 listed shipping companies during the period from 1992 to 2010. All variables are winsorized at the upper and lower one percentile. Standard errors clustered at the firm level are given in parentheses. Firm fixed effects and year fixed effects indicate whether entity fixed effects and calendar year are included in the specification.
* Statistical significance at 10% level.
** Statistical significance at 5% level.
*** Statistical significance at 1% level.

4.2. Determinants of changes in leverage

So far, our analysis has employed aggregate (book and market) leverage measures, which are the product of historical changes in shipping companies' debt and equity levels. In this section, we provide additional insight into the determinants of marginal capital structure decisions by examining security issuance decisions and annual changes in firm leverage. In order to evaluate the relative importance of our firm-specific leverage factors for debt and equity issuances, we use a logistic regression model (Chang et al., 2006; Bessler et al., 2011). The dependent variables are dummy variables that indicate changes in the level of debt and equity. The debt issuance dummy is set equal to one if a firm increases its level of debt by more than 10% in a given year, and zero otherwise. Similarly, the equity dummy is set equal to one if there is an increase in shares outstanding of more than 10% during a fiscal year, and zero otherwise.[18] These proxy variables for the actual issuance decisions are regressed against year-to-year changes in the values of all continuous variables used in Table 5 as well as the

[18] The choice of a 10% threshold for the dependent binary variables follows Harrison et al. (2011). As in Chang et al. (2006), we also use a 1% and a 5% threshold as a robustness test. Although the significance levels of the estimated coefficients slightly increase, we report the results in Table 6 based on the 10% threshold in order to avoid potential effects from executive stock options.

Table 6
Determinants of changes in leverage.

	[1] Debt issuer	[2] Equity issuer	[3] Book leverage	[4] Market leverage
Δ Tangibility	3.115***	−0.149	0.463*	0.535**
	(0.723)	(0.505)	(0.238)	(0.211)
Δ Market-to-book	0.937	−0.241	0.222	−0.789***
	(0.604)	(0.476)	(0.184)	(0.163)
Δ Profitability	−0.116	−0.251***	−0.016	−0.015
	(0.093)	(0.081)	(0.019)	(0.017)
Δ Size	71.906***	11.614***	1.820**	2.129***
	(8.358)	(2.731)	(0.720)	(0.748)
Δ Operating leverage	−0.831**	−0.078	−0.067	−0.012
	(0.325)	(0.320)	(0.076)	(0.073)
Dividend payer	0.189	−0.793**	0.079	0.099
	(0.262)	(0.360)	(0.086)	(0.089)
Δ Asset risk	−0.357**	0.512***	−0.099***	−0.078**
	(0.177)	(0.186)	(0.034)	(0.034)
Rating probability	0.228	0.120	0.175	0.404
	(0.288)	(0.488)	(0.364)	(0.362)
Price run-up	−0.503*	−0.065	−0.021	−0.001
	(0.258)	(0.161)	(0.027)	(0.027)
Observations	920	920	902	902
Adj. R^2	0.345	0.068	0.058	0.301

The table reports regression coefficients for factors affecting the companies' security issuance decisions and changes in leverage ratios. Column 1 presents results from a logistic regression explaining firm decisions to issue additional debt. Column 2 shows results from a logistic regression explaining firm decisions to issue additional equity. The dependent variables are dummy variables that indicate changes in the level of debt and equity. The debt issuance dummy is set equal to one if a firm increases its level of debt by more than 10% in a given year, and zero otherwise. Similarly, the equity dummy is set equal to one if there is an increase in shares outstanding of more than 10% during a fiscal year, and zero otherwise. Columns 3 and 4 report regression results using annual changes in book and market leverage ratios as the dependent variable. All specifications include year-to-year changes in the continuous firm-specific variables, as well as appropriate values for all indicator variables. Standard errors clustered at the firm level are given in parentheses. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.

** Statistical significance at 5% level.

*** Statistical significance at 1% level.

dividend payer and rating probability dummy variables. Furthermore, in order to test for market timing behavior (Korajczyk et al., 1992; Baker and Wurgler, 2002), we add the stock return (price run-up) over the previous 12 months. The time-varying adverse selection explanation suggests that equity issuances occur when information asymmetry is temporarily low. A price run-up will be associated with lower information asymmetry because it may be the gradual resolution of information asymmetry that has triggered the price run-up (Lucas and McDonald, 1990). Results are reported in Column 1 and Column 2 of Table 6.

Analyzing Column 1, we observe similar patterns for the determinants of changes in debt as for the level regressions. Tangibility is positively related to the probability of an increase in debt, while operating leverage and asset risk show an inverse relationship with debt changes. The equity issuance model in Column 2 exhibits distinctly less explanatory power than the debt issuance model. Again, profitability is negatively related to the probability of an increase in equity. In contrast, the likelihood of an equity issuance seems to be a positive function of asset risk. This is consistent with Bolton and Freixas' (2000) prediction that firms with riskier assets are more likely to issue equity. The estimated coefficient on the size measure indicates that growing shipping companies cover their capital requirement by issuing both debt and equity. Against expectations, the coefficients on both the market-to-book ratio and the price-run up are lost in estimation error. Either the financial managers of shipping companies were unable to time the market, or the pronounced information asymmetries (as a result of high asset risk) and the correspondingly low market-to-book ratios during the entire sample period did not offer a "window of opportunity" for market timing.[19] At least, firms with positive stock returns during the prior 12 months are less likely to issue debt, and thus the corresponding negative coefficient on the price run-up variable provides indirect support for the market timing hypothesis. Finally, the results of regressions with year-to-year changes in financial leverage as the dependent variable in Columns 3 and 4 are broadly consistent with our findings for leverage levels (albeit less pronounced).

4.3. Is shipping a peculiar industry?

The standard leverage regressions in Tables 5 and 6 reveal that the signs of the estimated coefficients for the shipping industry do not strongly differ from those in earlier studies for non-shipping companies. While one would not expect to find

[19] The time-varying adverse selection explanation of financing choices is the dynamic analog of the static pecking order theory, which suggests that firms issue equity when stock prices are high and coincide with low adverse selection, e.g., after firms' information releases or during business cycle expansions (Korajczyk et al., 1991; Choe et al., 1993; Bayless and Chaplinsky, 1996).

completely different drivers of corporate leverage in the shipping industry, it seems nevertheless important to analyze potential differences in the degree of impact the various standard capital structure factors have on leverage ratios. In order to compare our results with broader industry benchmarks and other important industrial sectors, we refer to earlier findings in Rajan and Zingales (1995), Frank and Goyal (2009), and Lemmon et al. (2008) for broad US samples of industrial firms, Gropp and Heider (2010) for the banking industry, and Harrison et al. (2011) for REIT companies. Moreover, we estimate Model 2 using a comprehensive sample of industrial firms from the G7 countries (Bessler et al., 2012) and report it as our benchmark. For the sake of comparability, we also compute coefficient elasticities at the mean of each regression coefficient.[20] Table 7 summarizes the results for market leverage (using the specification with both firm and year fixed effects from Column 8 in Table 5 as the "shipping model").

There are several interesting peculiarities in the capital structure dynamics of shipping companies. A first observation is that tangibility is the most important driver of shipping companies' capital structure. The corresponding elasticity indicates that a 1% increase in the proportion of fixed to total assets leads to an increase in the leverage measure by 0.46%; this is the highest value across all studies reported in Table 7. This observation supports the conjecture that assets which are more tangible are more desirable from the perspective of creditors because they are easier to repossess in bankruptcy states ("verifiable by the courts").[21] However, a caveat is that tangible assets often lose value when they are liquidated (Pulvino, 1998; Benmelech and Bergman, 2011). Campello and Giambona (2012) emphasize that tangible assets drive capital structure only to the extent that they are redeployable. Only those tangible assets that can be easily redeployed (sold in secondary markets) support higher leverage, and thus leverage is ultimately driven by "market tangibility".

Although the values of commercial vessels respond to the supply and demand forces in their secondary markets, which makes them more likely to be redeployable, their degree of redeployability is intricately linked to their very high vessel price risk. In fact, a second major observation in Table 7 is that their high asset risk compared with other industries exerts a strong negative impact on shipping companies' leverage, as indicated by the high coefficient elasticity; a 1% increase in asset risk leads to a decrease in the leverage measure by 0.19%. Again, this is the highest elasticity across all studies summarized in Table 7. High vessel price volatility has a negative impact on collateral values, potentially leading to financial distress (or even bankruptcy) and "fire-sale" externalities during industry downturns (Pulvino, 1998). As a result, high asset price risk supports lower levels of leverage. Furthermore, vessel price risk does not merely affect a single shipping company; it can lead to a downward spiral and magnify shocks to the overall economy. Benmelech and Bergman (2011) document this "collateral channel" for the airline industry by using data of secured debt tranches issued by US airlines. One firm's bankruptcy reduces the collateral values of other industry participants, particularly when the market for assets is relatively illiquid. This reduction in collateral values increases the cost and reduces the availability of external debt finance across the entire industry. Applying this argument to the shipping industry, a company's bankruptcy increases the likelihood of vessel sales, and the increasing supply exerts downward pressure on the value of similar vessels. Bankruptcy and financial distress also reduce the demand for vessels from experienced industry buyers who put vessels into "best-use", placing downward pressure on collateral values.[22] Due to both increased supply and reduced vessel demand, bankruptcies increase the likelihood of vessel fire-sales and reduce collateral values. These effects further raise the industry-wide cost of debt capital and limit the opportunities to raise debt.

A third observation in Table 7 is that shipping companies tend to mitigate their higher asset and financial risks by keeping operating leverage low. Although the estimated coefficient on operating risk is not statistically significant in the reported specification, the comparatively high elasticity indicates that higher operating risk is accompanied by lower levels of leverage. According to Meulbroek (2002), a company has three ways of implementing its corporate risk management objectives: modifying its operations, employing financial derivatives, and adjusting its capital structure. Consequently, integrated risk management involves simultaneous decisions about shipping operations, the use of financial derivatives, and capital structure (including financing) choices. All else equal, the more a shipping company hedges its operating risk exposure, the less equity it requires to support its business, which minimizes the risk of bankruptcy. Put differently, risk management can usually increase a shipping company's debt capacity and will favor the use of debt. Accordingly, our results support the conjecture in Merikas et al. (2011) that a shipping company's operating exposure, measured as the fraction of spot- and time-charter employments of a portfolio of vessels, is not independent from its capital structure. Based on a small sample of listed

[20] Following Pindyck and Rubinfeld (1998), we compute coefficient elasticities at the mean as:

$$\varepsilon_{y,x_k} = \frac{\frac{\delta y}{\bar{y}}}{\frac{\delta x_k}{\bar{x}_k}} = \frac{\delta y}{\delta x_k} \cdot \frac{\bar{x}_k}{\bar{y}} = b_k \cdot \frac{\bar{x}_k}{\bar{y}}$$

where $\bar{x}_k$ and $\bar{y}$ are the means of the independent and the dependent variable, and b_k is the regression coefficient of variable k. When comparing our results with prior findings, we bear in mind that model specifications, sample sizes, and leverage measures differ to some extent across the studies mentioned in Table 7. While Rajan and Zingales (1995) and Frank and Goyal (2009) do not include fixed effects into their analysis, the regression design by Lemmon et al. (2008), Gropp and Heider (2010), and Harrison et al. (2011) is very similar to ours. In the case a study does not provide coefficient elasticities, we calculate them using the reported variable means. Due to potential differences between the reported sample means and those in the final regression sample, all calculated elasticities should be regarded as close approximations.

[21] At the other extreme, tangibility is lowest in the financial sector, and it is thus estimated insignificantly in Gropp and Heider's (2010) banking study. The strong impact of tangibility may further explain why size (interpreted as a proxy for default risk) is not a reliable capital structure factor in the shipping industry.

[22] The collateral channel also explains why shipping banks have been reluctant to liquidate their collaterals from non-performing loans during the shipping crisis although most loan-to-value covenants were broken, and some banks were even forced to allocate additional equity capital due to the Basel II regulations.

Table 7
Comparing the impact of capital structure determinants.

	[1] Table 5, Column 8	[2] G7 Companies	[3] Rajan and Zingales (1995), Table 9, Panel B	[4] Frank and Goyal (2009), Table 5, Column 9	[5] Lemmon et al. (2008), Table 2, Column 6	[6] Gropp and Heider (2010), Table X, Column 1	[7] Harrison et al. (2011), Table 3, Column 4
Tangibility	0.283***	0.147***	0.33***	0.105***	0.03***	0.006	0.064***
	(0.059)	(0.010)	(0.030)	(0.006)	(0.002)	(0.013)	(0.012)
	[0.457]	[0.228]		[0.128]	[0.037]	[0.002]	[0.109]
Market-to-book	−0.107***	−0.019***	−0.08***	−0.023***	−0.04***	−0.118***	−0.037***
	(0.018)	(0.001)	(0.010)	(0.001)	(0.002)	(0.039)	(0.004)
	[−0.318]	[−0.178]		[−0.145]	[−0.154]	[−0.144]	[−0.094]
Profitability	−0.272**	−0.124***	−0.60***	−0.114***	−0.05***	−0.392***	−0.956***
	(0.125)	(0.006)	(0.070)	(0.003)	(0.002)	(0.079)	(0.079)
	[−0.077]	[−0.018]		[−0.008]	[−0.019]	[−0.023]	[−0.109]
Size	0.006	0.024***	0.03***	0.023***	0.03***	0.013**	0.120*
	(0.025)	(0.002)	(0.000)	(0.001)	(0.002)	(0.006)	(0.067)
	[0.099]	[0.740]		[0.376]	[0.515]	[0.165]	[0.469]
Operating leverage	−0.049	−0.012***			−0.01***		−0.068
	(0.033)	(0.002)			(0.003)		(0.060)
	[−0.063]	[−0.069]			[−0.002]		[−0.186]
Dividend payer	−0.017	−0.030***		−0.102***	−0.04***	−0.010	
	(0.015)	(0.002)		(0.003)	(0.002)	(0.007)	
	[−0.034]	[−0.091]			[−0.079]	[−0.011]	
Asset risk	−0.375***	−0.028***				−0.016***	
	(0.120)	(0.006)				(0.003)	
	[−0.192]	[−0.040]				[−0.001]	
Rating probability	0.044	0.065***					
	(0.145)	(0.012)					
	[0.021]	[0.049]					
Observations	1007	135,995	2207	180,552	68,224	2415	2409
Adj. R^2	0.806	0.726	0.190	0.292	0.450	0.880	0.820

The table presents regression results for various samples and relates the results from this study to prior research. The dependent variable is market leverage. Column 1 shows the results for the "shipping model" from Table 5 (Column 8). Comparable results for G7 countries are obtained by estimating the model for a comprehensive sample of 14,523 companies. The data are taken from Bessler et al. (2012). Benchmark results based on US data are from Rajan and Zingales (1995), Frank and Goyal (2009), Lemmon et al. (2008). Results for banks and REITs are from Gropp and Heider (2010) and Harrison et al. (2011), respectively. The definition of leverage differs across these studies. Furthermore, Frank and Goyal (2009) as well as Rajan and Zingales (1995) do not use country or time fixed effects in their analysis. Standard errors are given in parentheses. Coefficients elasticities are reported in square brackets. Where not reported in the original study, elasticities have been calculated based on reported coefficients and variable means as follows:

$$\varepsilon_{y,x_k} = \frac{\frac{\delta y}{\bar{y}}}{\frac{\delta x_k}{\bar{x}_k}} = \frac{\delta y}{\delta x_k} \cdot \frac{\bar{x}_k}{\bar{y}} = b_k \cdot \frac{\bar{x}_k}{\bar{y}}$$

where $\bar{x}_k$ and $\bar{y}$ are the means of the independent and the dependent variable, and b_k is the regression coefficient of variable k. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.

** Statistical significance at 5% level.

*** Statistical significance at 1% level.

shipping companies, they report a negative correlation coefficient between operating cash flow risk (i.e., a high degree of spot employment rather than long-term employment) and financial risk.[23]

The total risk exposure of a shipping company, which results from its operating business and from changes in its asset values, can be adjusted on a firm-level basis either through operational decisions, such as long-term charter contracts and leasing of ships, or by using derivative instruments to achieve a specific net exposure. The remaining exposure must be covered by sufficient equity capital. In fact, there exists an interaction between operations, risk management, and capital structure. Shipping companies need to trade off the risks from changes in operating cash flows and asset values with the scope of their risk management activities through adjustments in their operations and the use of derivative instruments. All else equal, shipping companies with higher business risks should be more likely to engage in risk management, and vice versa. This conjecture is supported by a negative correlation between asset risk and operating leverage in Table 4. In addition to these risk management choices on the asset side of a shipping company's balance sheet, its capital structure constitutes another layer of risk management (Stulz, 1996). Our analysis cannot solve the issue of causality. However, if shipping companies conduct risk management only to the extent that their cost of equity capital is higher than their cost of debt capital plus the costs of hedging, their capital structure choices suggest that it pays for them to engage in risk management.

4.4. Robustness tests

In this section, we provide robustness checks for our results with respect to different model specifications, alternative leverage measures, and institutional differences across countries. Several prior empirical studies suggest estimating standard leverage regressions using lagged values of the independent variables (Frank and Goyal, 2009). Table A2 in the Appendix shows the results for OLS and fixed effect specifications with lagged independent variables. Our results remain unchanged under this alternative specification. In order to check whether our results are dependent on our definition of leverage, we estimate Model 1 and Model 2 using the three alternative leverage measures suggested by Rajan and Zingales (1995). Table A3 in the Appendix confirms that tangibility, profitability, and asset risk are main drivers of corporate leverage in the shipping industry.

Finally, we check our results for biases that may arise from country-level effects and/or differences in the institutional regimes. According to La Porta et al. (1998), a country's legal origin determines the extent to which external finance is available.[24] It is commonly believed that capital markets in common law countries provide better opportunities to manage their capital structure (Drobetz et al., 2013; Halling et al., 2012). Specifically, firms in countries with a bank-oriented financial system tend to suffer from less liquid capital markets, making it more difficult for firms to issue new or to retire outstanding securities and to rebalance after a leverage shock (see Section 5). These institutional differences in financing choices have an impact on corporate capital structures. For example, Fan et al. (2012) document that the legal regime explains a large proportion of the cross-sectional variation in corporate leverage, with common law systems being associated with lower debt ratios than civil law systems. In order to analyze the importance of firm-level determinants of corporate leverage across countries, we follow Alves and Ferreira (2011) and include cross-product terms between our standard capital structure variables and the dummy variable that marks firm-year observations from a country with a common law regime. Results for these extended level regressions are reported in Table A4 in the Appendix. Similar to Alves and Ferreira (2011), there is some weak evidence for reduced influence of profitability on leverage in common law countries. Overall, however, the coefficients on the cross-product terms are largely insignificant, and the non-cross terms remain unchanged. The observation that capital structure choices of shipping companies and the major drivers of leverage are independent from institutional characteristics supports the conjecture that shipping is a uniformly global business that is largely independent of country-level influences. In a broader context, it is further consistent with Tsionas et al. (2012), who document that concentrated ownership structures in shipping companies and their impact on firm valuation are similar across countries irrespective of the different corporate governance settings.

4.5. The impact of macroeconomic factors

As documented in Section 4.1, the capital structure in the shipping industry is driven by time-invariant factors and extant determinants which influence financing decisions over time. A remaining question is whether this time component is driven by underlying time-variant factors, e.g., macroeconomic conditions which influence firms' capital raising and induce them to choose different levels of leverage at different points in time (Erel et al., 2012). The conjecture that macroeconomic conditions affect firms' ability to raise capital seems particularly important for the shipping industry given that the demand for shipping services is derived from the need of exporters and importers to transport freight to destinations around the world.

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[23] Similarly, Hankins (2011) shows that US bank holding corporations manage aggregate cash flow volatility and that operational and financial hedging are substitutes. Kim et al. (2006) also find that operational and financial hedging are substitutes. In contrast, Carter et al. (2011) document that airlines which use operational hedges are also more likely to manage their risks using financial hedges. They explain their finding by the high costs of changing the operations of a firm. Bartram et al. (2009) document that derivatives hedging is determined endogenously with other financial and operating decisions, such as leverage, debt maturity, holding of liquid assets, dividend policy, and operational hedges (e.g., foreign assets).

[24] In a companion study, Porta et al. (2002) document that investor protection is superior under the common law regime, resulting in higher security values compared to the civil law system.

Table 8
Macroeconomic determinants of leverage.

	[1]	[2]	[3]	[4]	[5]
Dependent variable: Book leverage					
Tangibility	0.309***	0.309***	0.305***	0.303***	0.303***
	(0.062)	(0.063)	(0.062)	(0.062)	(0.063)
Market-to-book	0.004	0.006	0.010	0.010	0.013
	(0.023)	(0.026)	(0.025)	(0.028)	(0.027)
Profitability	−0.247**	−0.242**	−0.188	−0.194	−0.205
	(0.117)	(0.117)	(0.124)	(0.132)	(0.135)
Size	−0.016	−0.017	−0.016	−0.013	−0.017
	(0.029)	(0.030)	(0.029)	(0.030)	(0.029)
Operating leverage	−0.043	−0.044	−0.037	−0.036	−0.042
	(0.028)	(0.027)	(0.028)	(0.028)	(0.029)
Dividend payer	−0.023	−0.023	−0.020	−0.020	−0.023
	(0.017)	(0.017)	(0.016)	(0.016)	(0.017)
Asset risk	−0.282***	−0.287***	−0.282***	−0.280***	−0.294***
	(0.099)	(0.104)	(0.098)	(0.102)	(0.102)
Rating probability	0.140	0.143	0.152	0.155	0.159
	(0.201)	(0.203)	(0.204)	(0.206)	(0.204)
Recession (US)		0.006			
		(0.010)			
Recession (shipping)			0.020*		
			(0.010)		
Inflation				−0.027**	
				(0.011)	
Term spread$_{t-1}$				−0.008*	
				(0.004)	
GDP growth				0.005*	
				(0.003)	
Oil price				−0.015**	
				(0.008)	
Stock market returns				0.000	
				(0.000)	
Freight rates					0.027***
					(0.009)
FX USD					0.067
					(0.047)
Secondhand ship prices					−0.088**
					(0.042)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1007	1007	1007	1003	1007
Adj. R^2	0.745	0.745	0.747	0.746	0.747
Dependent variable: Market leverage					
Tangibility	0.322***	0.321***	0.311***	0.305***	0.308***
	(0.060)	(0.061)	(0.059)	(0.059)	(0.061)
Market-to-book	−0.161***	−0.146***	−0.146***	−0.133***	−0.133***
	(0.016)	(0.017)	(0.015)	(0.017)	(0.016)
Profitability	−0.349***	−0.315***	−0.199*	−0.245*	−0.223*
	(0.115)	(0.113)	(0.119)	(0.124)	(0.127)
Size	−0.004	−0.013	−0.005	−0.005	−0.011
	(0.025)	(0.024)	(0.024)	(0.024)	(0.024)
Operating leverage	−0.062**	−0.069**	−0.048	−0.053*	−0.062**
	(0.029)	(0.028)	(0.031)	(0.030)	(0.031)
Dividend payer	−0.022	−0.023	−0.015	−0.020	−0.024
	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)
Asset risk	−0.327***	−0.366***	−0.326***	−0.360***	−0.357***
	(0.110)	(0.118)	(0.107)	(0.112)	(0.115)
Rating probability	−0.088	−0.062	−0.057	−0.056	−0.019
	(0.150)	(0.146)	(0.147)	(0.149)	(0.147)
Recession (US)		0.041***			
		(0.009)			
Recession (shipping)			0.051***		
			(0.010)		
Inflation				−0.050***	
				(0.012)	
Term spread$_{t-1}$				−0.013***	
				(0.005)	
GDP growth				0.004	

(*continued on next page*)

Table 8 (*continued*)

	[1]	[2]	[3]	[4]	[5]
				(0.003)	
Oil price				−0.020***	
				(0.007)	
Stock market returns				−0.001***	
				(0.000)	
Freight rates					0.037***
					(0.009)
FX USD					0.196***
					(0.040)
Secondhand ship prices					−0.206***
					(0.037)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1007	1007	1007	1003	1007
Adj. R^2	0.776	0.782	0.787	0.794	0.791

The table reports the results from standard leverage regressions. The model is augmented by a comprehensive set of macroeconomic factors. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. All firm-level variables are winsorized at the upper and lower one percentile. Standard errors clustered at the firm level are given in parentheses. All specifications include firm fixed effects. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.

** Statistical significance at 5% level.

*** Statistical significance at 1% level.

Obviously, this "derived" demand is mainly affected by the broader macroeconomic environment (Stopford, 2009; Drobetz et al., 2012). As capital requirements in the maritime industry are a positive function of the demand for shipping services, we control for aggregate influences by including macroeconomic determinants into our leverage regressions. The results are shown in Table 8, where Column 1 repeats the result of the benchmark model from Column 4 in Table 5 (with firm-fixed effects but excluding time-fixed effects) for easier comparison.

In a first step, we analyze the cyclicality of leverage. The business cycle can affect financing choices and leverage ratios through two channels. On the one hand, the demand-for-capital mechanism is based on changes in information asymmetry between firms and investors over the business cycle. If the adverse selection costs associated with information asymmetry are negatively related to the business cycle, poor macroeconomic conditions will induce firms to issue less information-sensitive securities. Therefore, they tend to use less equity and more debt (Choe et al., 1993; Bayless and Chaplinsky, 1996). On the other hand, macroeconomic conditions may affect the supply of capital, as documented by phenomena such as "credit crunches" (Holmstrom and Tirole, 1997) and "flight-to-quality" (Vayanos, 2004). We incorporate two business cycle dummy variables into the leverage regression model, and as such, our analysis cannot disentangle these two channels (see Table A1). The first dummy variable is set equal to one if the US economy hits a recession, and zero otherwise. Alternatively, the second dummy variable is set equal to one if the shipping industry enters into a bad state, and zero otherwise.[25] For market leverage, Columns 2 and 3 in Table 8 show that both recession dummy variables are estimated significantly positive when they are added to the benchmark regression model, indicating that shipping companies' leverage is counter-cyclical. As measured by the magnitude of the coefficients, the economic impact on market leverage is large for the shipping recession dummy (leverage is higher by five percentage points in a recession) and slightly smaller for the US recession dummy variable. The counter-cyclical nature of leverage is consistent with the theoretical predictions in Hackbarth et al. (2006). In their contingent claims model, the additional debt capacity associated with a lower default risk is outweighed by the higher present value of future cash flows (and thus higher asset values) in boom regimes, thereby creating counter-cyclicality in leverage. Similarly, based on a large international sample of industrial firms, Halling et al. (2012) document that target leverage ratios behave counter-cyclically. They argue that this finding is attributable to firms' market timing activities (the demand-for-capital mechanism). Even according to the trade-off theory, a firm's target leverage is lower when equity market valuation levels are generally high and/or after a stock price run-up. More debt would be issued when equity valuations are low and/or interest rates are low.[26] Furthermore, counter-cyclical leverage ratios are in line with the predictions of the pecking order theory. With higher free cash flows, firms will use internal funds rather than debt financing during expansion regimes (and vice versa).

[25] The US business cycle data is obtained from the National Bureau of Economic Research (see www.nber.org). We assign a given year a value of one if there are at least six months in that year which are defined as a recession; these are the sample years 2001, 2008, and 2009. Implicitly, we assume that the US business cycle has a leading function for the state of the economy in all other sample countries. There are two depressed periods in the shipping industry during our sample period, one ranging from 1998 to 2002 and the other from 2009 onward.

[26] Erel et al. (2012) show evidence for capital-raising patterns over the business cycle that are related to supply-side effects. They document that constrained firms' equity and bond issuances are pro-cyclical, thus the likelihood that these firms raise capital decreases as they are shut out of the capital markets during a recession. In contrast, unconstrained firms take advantage of the increased demand for their higher-rated securities and increase their capital raising (and buffer the cash) during macroeconomic downturns. While their equity issues are not strongly sensitive to the business cycle, their bond issues are counter-cyclical ("flight-to-quality" hypotheses).

In a second step, we add a set of standard macroeconomic variables. Similar to Ferson and Harvey (1994), we use the GDP-weighted inflation rate in the G7 countries, the lagged term spread between the 10-year interest rate series and the 1-year interest rate series of US Treasuries, the aggregate GDP growth rate in the G7 countries, the annual change in the Brent crude oil price, and the annual stock market return of the MSCI World Index (see Table A1). All data are taken from Thomson Financial Datastream. Column 4 in Table 8 shows the results when these variables are added to the standard leverage regression.[27] Inflation has a negative effect on leverage. Intuitively, in periods with higher inflation, firms use currently weak dollars to repay debt and lower their leverage ratios. Given that a low term spread (or even a downward sloping yield curve) predicts recessions (Dahlquist and Harvey, 2001), the negative coefficient on the lagged term spread is consistent with the counter-cyclicality of leverage ratios. Similarly, higher oil prices are an indicator of a booming economy, and thus the crude oil price exerts a negative impact on leverage. In contrast, however, the negative coefficient for GDP growth is at odds with the notion of counter-cyclicality of leverage ratios, but it is only significant at the 10% level in the book leverage model and insignificant in the market leverage model.

In a third step, we add a set of variables that are specifically related to the shipping industry. As shown in Column 5 of Table 8, we use the annual change in the real trade-weighted US dollar index "Major Currencies" (published by the Federal Reserve and defined as foreign currency/US dollar), the change in the Clarksea Index (aggregate freight rates denominated in US dollar), and the change in the Clarkson All Ships Second Hand Price Index.[28] All shipping-related data is taken from Clarkson's Shipping Intelligence Network. Our results suggest that higher freight rates lead to higher cash flows and, therefore, to higher target leverage due to an increasing debt capacity. As the US dollar is the leading currency in the maritime industry, an appreciation (i.e., an increase in the ratio of foreign currency/US dollar) implies lower cash flows from operations for non-US companies in their home currency, higher external capital requirements, and higher leverage ratios (if they follow a pecking order). Furthermore, an increase in the second-hand ship prices is negatively related to leverage. This result seems at odds with the argument that vessels serve as collaterals and higher vessel values increase debt capacity. However, many shipping companies in our sample are active asset players. If ship owners are able to sell vessels at high valuation levels, the difference between market value and book value adds to the equity position, thereby reducing the leverage ratio. Finally, a general observation is that the additional explanatory power of the macroeconomic variables (as measured by the incremental R-squares) is very low.

5. Speed of adjustment analysis

Our findings so far suggest that the leverage choices of shipping companies are reliably related to a set of firm-specific and macroeconomic variables, and thus they seem to pursue a target capital structure. In a next step, we analyze the dynamics of capital structure choices by estimating these shipping companies' speed of adjustment back to the target capital ratio. This kind of dynamic analysis has gained importance in the recent literature, and Huang and Ritter (2009) even call it "the most important issue in capital structure research."

5.1. Prior empirical evidence

Flannery and Rangan (2006) estimate a partial adjustment model and document a high speed of adjustment of 30% per year in their US sample. Kayhan and Titman (2007) apply an OLS methodology and report a slower 10% speed of adjustment for book leverage and 8.3% for market leverage per year. Using the GMM methodology, Lemmon et al. (2008) report a 25% speed of adjustment for book leverage. Huang and Ritter (2009) use a long-difference panel estimator and report a lower adjustment speed for US data between 11% and 23% per year. Antoniou et al. (2008) show heterogeneity of adjustment speed across the G5 countries, ranging from 11% in Japan to 40% in France. Most recently, Öztekin and Flannery (2011) use a sample with firms from 37 countries and document that firms from countries with strong legal institutions, financial structures based on the effectiveness of capital markets instead of intermediaries, and better functioning financial systems adjust to their leverage targets as much as 50% more rapidly. In countries with weaker institutions (restricted access to capital markets, higher information asymmetries, and low financial flexibility), issuing debt or equity is more difficult and costly, and as such, adjustment speeds are lower.

The contingent claims model of Hackbarth et al. (2006) predicts that the pace and the size of the adjustment is positively correlated with current macroeconomic conditions because the default (restructuring) threshold selected by shareholders is reduced in bad states, which leads to decreased bankruptcy costs. Accordingly, their model predicts that the speed of adjustment is faster in a booming macroeconomic environment than in a recession. Based on US data, Cook and Tang (2010) relate the speed of adjustment to macroeconomic conditions, confirming a slower speed of adjustment during poor macroeconomic periods. Halling et al. (2012) study the adjustment speed over the course of the business cycle using a large sample of international firms. They also report a slower speed of adjustment during recession periods, and the effect is even more pronounced for financially constrained firms.

[27] Standard VIF-tests reject the null hypothesis of multicollinearity problems among the extended set of variables.

[28] Second-hand prices are more appropriate than newbuilding prices for our analysis because they are available for immediate delivery within the prevailing market conditions.

Faulkender et al. (2012) investigate firm-level (rather than country-level) heterogeneity in the speed of adjustment. For example, they document that firms with large (positive or negative) operating cash flows make more aggressive changes in their leverage ratios because adjustment costs are "shared" with market transactions related to operating cash flows. This cash flow effect is more pronounced for over-leveraged firms compared with under-leverage firms. Similarly, Elsas and Florysiak (2011) document heterogeneity in the speed of adjustment depending on firm size, growth opportunities, and industry classification.

5.2. Econometric issues

Almost all prior empirical studies on adjustment speed rely on dynamic panel models, where today's leverage is dependent on lagged leverage. The econometric specification of the speed of capital structure adjustment in the most stylized manner is:[29]

$$L_{i,t} - L_{i,t-1} = \lambda(L^*_{i,t} - L_{i,t-1}) + \varepsilon_{i,t} \tag{1}$$

where the change in leverage depends on the speed of adjustment λ and the distance between lagged leverage $L_{i,t-1}$ and the target leverage $L^*_{i,t}$. While an estimate of $\lambda = 0$ implies no adjustment, $\lambda = 1$ indicates immediate (full) readjustment to the target leverage subsequent to a shock. The target leverage again depends linearly on a set of firm characteristics, labeled X, that are related to the costs and benefits of debt and equity in different capital structures theories. Rearranging and substituting $\beta X_{i,t}$ for the target leverage results in:

$$L_{i,t} = (1 - \lambda)L_{i,t-1} + \lambda\beta X_{i,t} + \varepsilon_{i,t} \tag{2}$$

where X is a vector with firm-specific leverage factors (as used in our analysis in Section 4), and β is a coefficient vector. Nickell (1981) shows that standard OLS estimation is biased upward because it omits fixed effects. Dividing the error term $\varepsilon_{i,t}$ into a firm fixed effect μ_i and Gaussian white noise $\delta_{i,t}$, we have:

$$L_{i,t} = (1 - \lambda)L_{i,t-1} + \lambda\beta X_{i,t} + \mu_i + \delta_{i,t} \tag{3}$$

Baltagi (2005) shows that introducing a dummy variable for the fixed effects (FE-estimator) controls for the unobserved heterogeneity but does not remove the bias either. Since leverage is a function of the fixed effects, lagged leverage $L_{i,t-1}$ is correlated with the portion of the regression residual associated with the firms' fixed effects μ_i and is also correlated with the error term $\delta_{i,t}$. One way to remove the bias is to instrument the variables. Arellano and Bond (1991) develop a GMM-estimator with valid instruments, known as the "difference GMM-estimator" (AB-estimator). By differentiating Eq. (4), we can remove the time-invariant fixed effect:

$$\Delta L_{i,t} = (1 - \lambda)\Delta L_{i,t-1} + \lambda\beta\Delta X_t + \Delta\delta_{i,1} \tag{4}$$

All lagged right-hand side variables can be used to instrument the first-differenced lagged dependent variable ($\Delta L_{i,t-1}$). This estimator is not subject to any biases in the absence of second-order serial correlation in the residuals. However, it can become problematic if there is little information in the instruments, i.e., when the lagged variables contain little information about the changes in leverage. The problem is particularly pronounced when the coefficient on the lagged dependent variable is close to unity, as is expected for the persistent leverage time series (Blundell and Bond, 1998; Huang and Ritter, 2009). Therefore, Blundell and Bond (1998) extend the AB-estimator to a "system GMM-estimator" (BB-estimator). In addition to the equation in first differences, their system also includes the level equation:

$$L_{i,t} = (1 - \lambda)L_{i,t-1} + \lambda\beta X_{i,t} + \mu_i + \varepsilon_{i,t} \tag{5}$$

$$\Delta L_{i,t} = (1 - \lambda)\Delta L_{i,t-1} + \lambda\beta\Delta X_t + \Delta\delta_{i,1} \tag{6}$$

In Eq. (6) in first differences, the lagged levels of all right-hand side variables (such as $L_{i,t-2}, \ldots, L_{i,0}$) are valid instruments. In contrast, in Eq. (5) in levels, the lagged first differences (such as $\Delta L_{i,t-2}, \ldots, \Delta L_{i,t-1}$) are proper instruments. Nevertheless, the BB-estimator is still biased when the coefficient on the lagged dependent variable is close to unity (Huang and Ritter, 2009) or when there is second-order correlation in the errors (Flannery and Hankins, 2012).

Another source for biases in the estimated speed of adjustment is that all estimators ignore that leverage is a fractional variable between zero and one. Chang and Dasgupta (2009) emphasize that most econometric estimators are inappropriate in this case because they erroneously attribute the fact that debt ratios are bounded in the [0, 1] interval to be due to mean reversion. The estimate for adjustment speed can be positive even if financing decisions are purely random. Similarly, Iliev and Welch (2010) document that the standard dynamic panel specification is a poor process for leverage ratios because of the boundedness property. They claim that adjustment speed estimates will be biased upward (predictability bias).[30]

Elsas and Florysiak (2010) also address the problem of mechanical mean reversion and suggest a doubly-censored Tobit estimator (with censoring the leverage ratio at zero and one), relying on a latent variable approach to account for the

[29] Flannery and Hankins (2012) provide an overview of different dynamic panel models.

[30] Iliev and Welch (2010) provide a numerical bias adjustment under their embedded leverage process (which they call a "placebo" leverage ratio).

fractional nature of the dependent leverage variable. Based on Baltagi (2005) and Loudermilk (2007), the dynamic panel specification with a fractional dependent variable (DPF-estimator) is based on a doubly-censored dependent variable:

$$L_{i,t} = \begin{cases} 0 & L^{+}_{i,t} \leqslant 0 \\ L^{+}_{i,t} & 0 < L_{i,t} < 1 \\ 1 & L^{+}_{i,t} \geqslant 1 \end{cases} \tag{7}$$

where $L^{+}_{i,t}$ is the observed leverage ratio, which is set equal to zero when it is below zero, and to one when it is higher than one. Presumably, the replacement primarily corrects data errors because leverage ratios below zero and above one are unusual. The specification of the fixed effects term captures corner solutions as well as unobserved heterogeneity:

$$L_{i,t} = (1-\lambda)L_{i,t-1} + \lambda\beta X_{i,t} + \mu_i + \varepsilon_{i,t} \tag{8}$$

with

$$\mu_i = \alpha_0 + \alpha_1 L_{i,0} + E(X_i)\alpha_2 + \alpha_i \tag{9}$$

for the unobserved firm fixed effect μ_i, which depends on the mean of the firm specific variables $E(X_i)$ and on the leverage ratio in the initial period $L_{i,0}$. Tobit estimation is carried out by maximum likelihood. Using simulation analysis, Elsas and Florysiak (2010) document that their DPF-estimator is unbiased, even under misspecification of the underlying distribution regarding the fixed effect. Most important, when comparing the different dynamic panel estimators, the DPF-estimator exhibits the lowest bias in their US sample.

5.3. Adjustment speed estimates

In order to get a comprehensive picture of the speed of adjustment in the shipping industry, we use all estimators introduced in Section 5.2 (the OLS estimator, the FE-estimator, the AB-estimator, the BB-estimator, and the DPF-estimator).[31] Based on our results in Section 4, we use the standard capital structure variables to model the target leverage ratio. Furthermore, as we are particularly interested in evaluating the speed of adjustment during recessions, we include a cross-product term between the one-period lagged leverage measure and the US recession dummy variable (see Section 4.5) in the model.

The results of the estimated partial adjustment models are shown in Table 9.[32] Subtracting the coefficients on the lagged leverage ratio from one yields an estimate of the speed of adjustment. These estimates can be translated into half-lives of the influence of a shock on the leverage ratio. The half-life of a leverage shock is given as $\log(0.5)/\log(1-\lambda)$, where λ corresponds to the adjustment speed estimate. Incorporating an additional interaction term between leverage and the US recession dummy variable into the model allows us to examine the difference in the speed of adjustment across the different business cycle states.

Confirming the findings in Drobetz et al. (2013), who use data for industrial firms from the G7 countries, the estimated adjustment speed coefficients vary distinctly across the different estimators, explaining the controversial results in many earlier US studies. Based on book leverage, Table 9 shows that adjustment speed estimates range from 22% for the OLS-estimator to 59% for the AB-estimator. Rather than focusing on the interpretation of single estimates, we provide a general picture of the speed of adjustment in the shipping industry. The mean of all estimates is 40.0%, which corresponds to a half-life of only 1.35 years. For market leverage, we even obtain higher adjustment speed estimates with a mean of 58.9% and a corresponding half-life of only 0.78 years.[33] As a comparison, Huang and Ritter (2009) report adjustment speed estimates between 11% and 23% for US data, and Drobetz et al. (2013) document a mean adjustment speed of 20% for their G7 sample. Our results thus indicate that shipping companies implement leverage adjustments subsequent to target deviations much faster than do companies in broad samples of industrial firms.

The speed of adjustment depends on two concepts: (i) the cost of deviating from the target and (ii) the cost of adjustment back to the target capital structure. Financial managers must assess the trade-off between the cost of being off the target leverage ratio and the cost of adjustment. On the one hand, as many shipping companies are financially constrained (see Section 3.4), one expects that shipping companies face comparatively high costs of adjustment and are slow in adjusting their leverage ratios back to the target subsequent to a shock. On the other hand, shipping firms are already highly leveraged, and being off the target (and above it, in particular) leads to detrimental costs of financial distress. Therefore, they are forced to revert to the target quickly. Although we do not explicitly test for asymmetric effects, our findings seem to suggest that

[31] The reported specifications for the AB- estimator and BB-estimator treat the firm-specific explanatory variables as exogenous. The lagged dependent leverage is modeled to be predetermined. As a robustness check, one can also assume that the firm-specific explanatory variables are predetermined or endogenous for the AB- and BB-estimator. In results not tabulated, we find that the speed of adjustment is still high but becomes slightly smaller using these alternative model specifications.

[32] All analyses from the pooled ordinary least squares and fixed effects regressions in Section 4 could also be implemented in the dynamic partial adjustment framework. The signs of the estimated coefficients on the capital structure variables in Table 9 are largely the same as in Table 5. However, due to the econometric issues related to the dynamic panel estimators and the large number of different estimators, our analyses treats the impact of firm-specific and macroeconomic factors on leverage (Section 4) and the speed of adjustment dynamics (Section 5) separately.

[33] The ordering of the magnitude of the estimators across the different dynamic panel models is in line with theoretical expectations (Flannery and Hankins, 2012; Drobetz et al., 2013). Moreover, the prior literature does not offer clear findings whether adjustment speed is higher or lower for market leverage ratios compared with book leverage ratios. Therefore, the different half-lives for book and market leverage should be interpreted with caution.

Table 9
Partial adjustment regressions

	[1] OLS	[2] FE	[3] AB	[4] BB	[5] DPF
Dependent variable: Book leverage					
Book leverage$_{t-1}$	0.780***	0.580***	0.410***	0.533***	0.693***
	(0.016)	(0.022)	(0.034)	(0.003)	(0.025)
Book leverage$_{t-1}$ ∗ Recession (US)	0.042***	0.017	0.016	0.015***	0.026*
	(0.014)	(0.014)	(0.012)	(0.002)	(0.014)
SOA (%)	22.0	42.0	59.0	46.7	30.7
SOA-Recession (%)	17.8	40.3	57.4	45.2	28.1
Tangibility	0.113***	0.176***	0.278***	0.235***	0.151***
	(0.016)	(0.025)	(0.032)	(0.010)	(0.026)
Market-to-book	0.013*	0.014*	0.009	0.013***	0.017**
	(0.007)	(0.008)	(0.009)	(0.003)	(0.008)
Profitability	−0.331***	−0.342***	−0.305***	−0.396***	−0.361***
	(0.043)	(0.051)	(0.054)	(0.016)	(0.050)
Size	0.002	0.007	0.000	0.010***	0.017**
	(0.004)	(0.009)	(0.014)	(0.004)	(0.008)
Operating leverage	−0.013*	−0.004	−0.066***	−0.047***	0.004
	(0.007)	(0.014)	(0.020)	(0.004)	(0.014)
Dividend payer	0.000	0.006	0.003	−0.005***	0.011
	(0.007)	(0.009)	(0.010)	(0.001)	(0.009)
Asset risk	−0.163***	−0.192***	−0.188***	−0.179***	−0.181***
	(0.023)	(0.027)	(0.027)	(0.007)	(0.029)
Rating probability	0.007	0.025	−0.080	−0.121***	−0.023
	(0.031)	(0.062)	(0.103)	(0.032)	(0.057)
Observations	1003	1003	884	1003	967
Dependent variable: Market leverage					
Market leverage$_{t-1}$	0.602***	0.388***	0.292***	0.319***	0.453***
	(0.019)	(0.022)	(0.028)	(0.008)	(0.023)
Market leverage$_{t-1}$ ∗ Recession (US)	0.117***	0.085***	0.086***	0.086***	0.092***
	(0.016)	(0.015)	(0.013)	(0.001)	(0.015)
SOA (%)	39.8	61.2	70.8	68.1	54.7
SOA-Recession (%)	28.1	52.7	62.2	59.5	45.5
Tangibility	0.130***	0.177***	0.256***	0.197***	0.162***
	(0.019)	(0.029)	(0.035)	(0.008)	(0.029)
Market-to-book	−0.076***	−0.112***	−0.133***	−0.136***	−0.108***
	(0.008)	(0.009)	(0.010)	(0.002)	(0.009)
Profitability	−0.088*	−0.124**	−0.073	−0.081***	−0.093*
	(0.050)	(0.056)	(0.060)	(0.013)	(0.056)
Size	−0.007	0.015	−0.010	−0.027***	0.019**
	(0.005)	(0.010)	(0.014)	(0.004)	(0.009)
Operating leverage	−0.037***	−0.024	−0.074***	−0.065***	−0.020
	(0.009)	(0.015)	(0.021)	(0.003)	(0.015)
Dividend payer	−0.007	0.006	0.003	−0.002**	0.008
	(0.008)	(0.010)	(0.011)	(0.001)	(0.010)
Asset risk	−0.327***	−0.386***	−0.406***	−0.401***	−0.384***
	(0.029)	(0.033)	(0.033)	(0.006)	(0.033)
Rating probability	0.064*	−0.140**	0.018	0.077***	−0.119*
	(0.036)	(0.068)	(0.099)	(0.029)	(0.066)
Observations	951	951	836	951	951

The table presents results from dynamic partial adjustment models with book and market leverage as the dependent variable. Besides lagged leverage, the model specifications include the cross-product term between lagged leverage and the recession dummy variable to evaluate the speed of adjustment during economic downturns. In order to control for firm-specific influences, the model further incorporates the set of firm-level factors. Column 1 reports results obtained by estimating the model using standard ordinary least squares (OLS), Column 2 shows results for the fixed effect estimator (FE), Column 3 for the Arellano and Bond (1991) difference GMM-estimator (AB), Column 4 for the Blundell and Bond (1998) system GMM-estimator, and Column 5 for the Elsas and Florysiak (2010) DPF-estimator. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. All models include firm and year fixed effects where appropriate. Percentage values for the estimated speed of adjustment (SOA) and the speed of adjustment during recessions (SOA-Recession) are shown in rows 3 and 4, respectively. Standard errors are given in parentheses below the coefficients. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.
** Statistical significance at 5% level.
*** Statistical significance at 1% level.

bankruptcy costs from excessive leveraging are more expensive than the costs of having too little debt (such as free cash flow problems). This conjecture is consistent with the evidence in Faulkender et al. (2012), where firms tend to deleverage quickly after positive shocks to their capital structure but do not releverage after negative shocks with the same speed. Furthermore,

Table A1
Definitions of variables.

	Definition	Source	Database codes
Firm-level variables			
Book leverage	Ratio of long- and short-term debt to total book assets	Compustat	(dltt+dlc)/at
Market leverage	Ratio of long- and short-term debt to the market value of assets	Compustat	(dltt+dlc)/(at−ceq+mkval)
Tangibility	Ratio of fixed to total book assets	Compustat	ppent/at
Market-to-book	Ratio of the market value of assets to book value of assets	Compustat	(at−ceq+mkval)/at
Profitability	Ratio of operating income before depreciation to total book assets	Compustat	oibdp/at
Size	Natural logarithm of total book assets	Compustat	log (at)
Operating leverage	Ratio of operating expense to total book assets	Compustat	xopr/at
Dividend payer	Indicator dummy variable equal to one if a firm pays dividends in a given year	Compustat	=1 if dv > 0
Asset risk	Unleveraged annualized standard deviation of a firm's daily stock price returns	Datastream	$SD(r_t) \times$ (mkval/(at−ceq+mkval))
Rating probability	Estimated rating probability of a firm in a given year (see Section 3.3)	Compustat	–
Price run-up	Stock return over the 12 months immediately preceding the leverage observation	Datastream	–
Macroeconomic variables			
Recession (US)	Indicator dummy variable equal to one if at least six months in given year are classified as recession months in the USA by the National Bureau of Economic Research	NBER	–
Recession (shipping)	Indicator dummy variable equal to one during depressed periods in the shipping industry (the years 1998 to 2002 and 2009 onward).	–	–
Term spread	One period lagged term spread between the 10-year interest series and the one-year interest series of US treasuries	Federal Reserve	–
GDP growth	Aggregated growth rate in the G7 countries	Datastream	G7OCFGDR
Oil price	Annual change in the brent crude oil price	Clarksons	19710
Stock market returns	Annual stock market return of the MSCI World Index	Datastream	MSWRLD$
Freight rates	Annual change in the Clarksea Index (aggregated freight rates denominated in US dollar)	Clarksons	60378
FX USD	Annual change in the real-trade weighted US dollar index "Major Currencies"	Federal Reserve	–
Secondhand ship prices	Annual change in the Clarkson All Ships Second Hand Price Index	Clarksons	41413
Alternative leverage measures and additional variables (robustness checks)			
Book leverage (2)	Ratio of total (non-equity) liabilities to total book assets	Compustat	(at−ceq)/at
Book leverage (3)	Ratio of debt to net book assets	Compustat	(dlc+dltt)/(at−lct+dlc
Book leverage (4)	Ratio of total debt to book capital	Compustat	(dlc+dltt)/(ceq+dlc+dltt)
Market leverage (2)	Ratio of total (non-equity) liabilities to market value of assets	Compustat	(at−ceq)/(at−ceq+mkval)
Market leverage (3)	Ratio of debt to the net market value of assets	Compustat	(dlc+dltt)/(at−ceq+mkval−lct+dlc)
Market leverage (4)	Ratio of total debt to market value of capital	Compustat	(dlc+dltt)/(mkval+dlc+dltt)
Law	Indicator dummy variable equal to one in countries with a common law regime	World Factbook	–

they document that constrained firms adjust more slowly when they are underleveraged, but more quickly when they are overleveraged. A closely related argument refers to the observation that shipping is a very cyclical industry with long-lasting down markets and high asset risk. The high leverage that results from high tangibility under a "normal" environment imposes a problem in recession states because the collateral values decline and distress costs increase (see Section 4.3). As a result, shipping companies are put under pressure by their banks to rapidly bring the leverage ratio back to the target.

Finally, given that these adjustment activities are easier to implement during good macroeconomic times, one expects the speed of adjustment to exhibit business cycle dependencies. By incorporating a cross-product term of the one-period lagged leverage measure and the US recession dummy variable into a dynamic panel model, we are able to examine the state dependence of adjustment speed. Consistent with theoretical predictions (Hackbarth et al., 2006) and prior empirical findings (Cook and Tang, 2010; Halling et al., 2012; Drobetz et al., 2013), we observe significantly lower adjustment speed estimates during recession environments than during booming periods. As indicated by the interaction term between lagged leverage

Table A2
Standard leverage regressions with lagged independent variables.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dependent variable: Book leverage								
Tangibility	0.471***	0.331***	0.199***	0.161***	0.474***	0.335***	0.158***	0.131**
	(0.072)	(0.074)	(0.052)	(0.051)	(0.074)	(0.075)	(0.053)	(0.054)
Market-to-book	−0.032	0.003	−0.044**	−0.027	−0.032	0.005	−0.024	−0.006
	(0.023)	(0.030)	(0.020)	(0.022)	(0.028)	(0.037)	(0.027)	(0.029)
Profitability	−0.581***	−0.307**	−0.441***	−0.361***	−0.576***	−0.249	−0.464***	−0.37**
	(0.152)	(0.149)	(0.128)	(0.129)	(0.171)	(0.172)	(0.147)	(0.145)
Size	0.008	−0.029	−0.004	−0.024	0.008	−0.038**	0.031	−0.003
	(0.010)	(0.020)	(0.018)	(0.030)	(0.010)	(0.019)	(0.023)	(0.032)
Operating leverage		−0.086***		−0.033		−0.086***		−0.017
		(0.027)		(0.034)		(0.028)		(0.036)
Dividend payer		−0.038		0.001		−0.036		0.001
		(0.027)		(0.021)		(0.027)		(0.020)
Asset risk		−0.429***		−0.168**		−0.472***		−0.157*
		(0.078)		(0.073)		(0.091)		(0.081)
Rating probability		0.266**		0.188				0.282
		(0.133)		(0.192)				(0.187)
Firm fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Observations	903	903	903	903	903	895	903	903
Adj. R^2	0.248	0.338	0.731	0.737	0.251	0.349	0.746	0.752
Dependent variable: Market leverage								
Tangibility	0.454***	0.327***	0.200***	0.145***	0.461***	0.331***	0.165***	0.127**
	(0.073)	(0.076)	(0.058)	(0.054)	(0.073)	(0.073)	(0.057)	(0.055)
Market-to-book	−0.126***	−0.097***	−0.107***	−0.096***	−0.133***	−0.091***	−0.094***	−0.076***
	(0.017)	(0.020)	(0.020)	(0.020)	(0.019)	(0.024)	(0.023)	(0.026)
Profitability	−0.607***	−0.370***	−0.516***	−0.437***	−0.557***	−0.278*	−0.466***	−0.370***
	(0.130)	(0.126)	(0.120)	(0.123)	(0.143)	(0.143)	(0.132)	(0.133)
Size	0.000	−0.033*	0.010	0.018	−0.001	−0.044***	0.037*	0.022
	(0.008)	(0.017)	(0.015)	(0.023)	(0.008)	(0.016)	(0.019)	(0.024)
Operating leverage		−0.08***		−0.075*		−0.077***		−0.041
		(0.025)		(0.042)		(0.024)		(0.043)
Dividend payer		−0.034		−0.004		−0.037		−0.006
		(0.028)		(0.022)		(0.028)		(0.018)
Asset risk		−0.371***		−0.134*		−0.452***		−0.181**
		(0.083)		(0.075)		(0.102)		(0.090)
Rating probability		0.243**		−0.046		0.288***		0.099
		(0.113)		(0.133)		(0.104)		(0.137)
Firm fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Observations	895	895	895	895	895	895	895	895
Adj. R^2	0.316	0.376	0.660	0.666	0.400	0.475	0.752	0.758

The table shows the results from standard leverage regressions, where all explanatory variables are lagged by one period. The sample consists of 115 listed shipping companies during the period from 1992 to 2010. All variables are winsorized at the upper and lower one percentile. Standard errors clustered at the firm level are given in parentheses. Firm fixed effects and year fixed effects indicate whether calendar year and entity fixed effects are included in the specification. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.

** Statistical significance at 5% level.

*** Statistical significance at 1% level.

and the US business cycle dummy variable, the speed of adjustment is 2.3 percentage points lower during recessions for book leverage and 9.3 percentage points for market leverage (again taking the average values over all five models).[34] Except for the FE-estimator and the AB-estimator in the book leverage specification, all interaction terms are estimated statistically significant. Given that shipping companies must cope with strong business cycle influences, one expects that their speed of adjustment exhibits strong business cycle dependencies. For example, during recessions default risk and the cost of raising debt capital will likely increase. More generally, if financial market liquidity is low and banks tighten their loan activities, firms face higher cost of adjustment and will not find it optimal to make frequent and large adjustments. These arguments support our finding that shipping companies' speed of adjustment is lower in bad macroeconomic states (recessions) than in good states (boom).

[34] Our results (not shown) remain qualitatively unchanged when we use the shipping recession dummy variable (see Section 4.5) in the interaction term with the lagged leverage measure.

Table A3
Standard leverage regressions with alternative leverage measures.

	Book leverage (2)	Book leverage (3)	Book leverage (4)	Market leverage (2)	Market leverage (3)	Market leverage (4)
Dependent variable: Alternative leverage measures						
Tangibility	0.211***	0.286***	0.284***	0.229***	0.294***	0.288***
	(0.064)	(0.072)	(0.078)	(0.063)	(0.066)	(0.073)
Market-to-book	0.077***	0.041	0.056*	−0.148***	−0.125***	−0.124***
	(0.022)	(0.032)	(0.033)	(0.021)	(0.021)	(0.023)
Profitability	−0.124	−0.257*	−0.224	−0.184*	−0.308**	−0.258*
	(0.116)	(0.151)	(0.151)	(0.106)	(0.134)	(0.131)
Size	0.014	0.002	0.002	−0.004	−0.011	−0.012
	(0.029)	(0.037)	(0.036)	(0.023)	(0.029)	(0.029)
Operating leverage	0.034	−0.003	−0.033	−0.005	−0.035	−0.082**
	(0.032)	(0.040)	(0.041)	(0.033)	(0.043)	(0.039)
Dividend payer	−0.016	−0.027	−0.023	−0.006	−0.020	−0.015
	(0.017)	(0.019)	(0.019)	(0.014)	(0.015)	(0.016)
Asset risk	−0.392***	−0.304**	−0.370**	−0.506***	−0.446***	−0.546***
	(0.114)	(0.146)	(0.166)	(0.134)	(0.143)	(0.162)
Rating probability	−0.452**	−0.352	−0.449**	−0.236	−0.123	−0.194
	(0.177)	(0.216)	(0.217)	(0.165)	(0.169)	(0.186)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1005	1005	1005	1005	1005	1005
Adj. R^2	0.788	0.735	0.746	0.857	0.794	0.821

The table shows the results from standard leverage regressions using the alternative leverage measures suggested by Rajan and Zingales (1995). Leverage definitions are provided in Table A1 (book and market leverage (2)-(4)). The sample consists of 115 listed shipping companies during the period from 1992 to 2010. All variables are winsorized at the upper and lower one percentile. Standard errors clustered at the firm level are given in parentheses. Firm fixed effects and year fixed effects indicate whether calendar year and entity fixed effects are included in the specification.
* Statistical significance at 10% level.
** Statistical significance at 5% level.
*** Statistical significance at 1% level.

6. Conclusion

This study examines capital structure decisions of globally-listed shipping companies. In line with the common conjecture that shipping is a highly leveraged business, we document that listed shipping companies exhibit substantially higher leverage ratios and thus higher financial risk compared with large samples of industrial firms. The traditional capital structure variables exert a significant impact on the cross-sectional variation of leverage ratios, but the magnitude of their impact is different than in other industries and is related to the peculiar characteristics of the shipping industry. Most important, asset tangibility is positively related to leverage, and its economic impact is more pronounced compared with other industries. Asset risk and operating leverage are inversely related to leverage, potentially indicating that financial managers in the shipping industry use operational and financial hedges as complements in their corporate risk management considerations (i.e., they use both types of hedges to manage similar risks). In contrast, there is weak evidence for market-timing behavior in the shipping industry.

Country-level variables do not have an impact on the capital structure decisions of shipping companies, supporting the notion that shipping is a truly global business with limited local influences. As expected for the highly cyclical shipping industry, leverage behaves counter-cyclically. Using different dynamic panel estimators, we document that shipping companies' speed of adjustment subsequent to target leverage deviations is much higher than for other industrial firms. Moreover, we show that adjustment speed is significantly lower during economic recessions. Presumably, there are substantial costs of deviation from the target leverage ratio due to shipping companies' high expected costs of financial distress.

Taken together, the strong interdependencies between freight rate volatility, asset risk as well as operational and financing strategies make capital structure decisions a strategic choice of preeminent importance in maritime financial management. Our findings question the optimality of the industry's excessive leverage ratios in the past. Given the limited redeployability of their assets in times of crises and the higher regulatory standards faced by shipping banks, it is expected that the amount of leverage will decrease and equity requirements will increase in the shipping industry in the years ahead. Ship owners and investors alike will have to understand that these changes will imply decreasing expected returns to equity in the industry.

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Appendix A

See Tables A1–A4.

Table A4
Leverage and law regimes.

	Dependent variable: Book leverage				Dependent variable: Market leverage			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Tangibility	0.376***	0.318***	0.375***	0.269***	0.362***	0.347***	0.361***	0.299***
	(0.087)	(0.080)	(0.087)	(0.078)	(0.069)	(0.082)	(0.070)	(0.079)
Market-to-book ratio	0.006	−0.003	0.010	0.028	−0.131***	−0.154***	−0.111***	−0.104***
	(0.042)	(0.021)	(0.047)	(0.022)	(0.017)	(0.023)	(0.019)	(0.022)
Profitability	−0.318	−0.442***	−0.300	−0.451***	−0.430***	−0.526***	−0.341**	−0.436***
	(0.209)	(0.152)	(0.230)	(0.164)	(0.148)	(0.145)	(0.163)	(0.162)
Size	−0.021	0.019	−0.022	0.041	−0.031*	0.024	−0.036**	0.027
	(0.021)	(0.029)	(0.021)	(0.028)	(0.017)	(0.023)	(0.017)	(0.022)
Operating leverage	−0.105***	−0.045	−0.104***	−0.021	−0.110***	−0.057	−0.104***	−0.037
	(0.034)	(0.036)	(0.035)	(0.040)	(0.028)	(0.036)	(0.029)	(0.044)
Dividend payer	−0.067*	−0.010	−0.068*	−0.010	−0.068**	−0.012	−0.067**	−0.006
	(0.038)	(0.020)	(0.038)	(0.019)	(0.031)	(0.021)	(0.030)	(0.019)
Asset risk	−0.394***	−0.181	−0.409***	−0.179	−0.362***	−0.230	−0.391***	−0.254*
	(0.122)	(0.133)	(0.127)	(0.127)	(0.115)	(0.147)	(0.123)	(0.146)
Rating probability	0.237*	0.011	0.247*	0.140	0.256**	−0.247*	0.281**	−0.044
	(0.130)	(0.225)	(0.129)	(0.193)	(0.110)	(0.144)	(0.107)	(0.150)
Tangibility ∗ Law	−0.049	−0.104	−0.051	−0.073	−0.017	−0.085	−0.025	−0.076
	(0.116)	(0.123)	(0.117)	(0.121)	(0.102)	(0.118)	(0.103)	(0.114)
Market-to-book ∗ Law	−0.018	−0.022	−0.022	−0.019	−0.043	−0.015	−0.027	0.000
	(0.051)	(0.039)	(0.053)	(0.040)	(0.032)	(0.030)	(0.033)	(0.027)
Profitability ∗ Law	−0.282	−0.362	−0.279	−0.400*	−0.406*	−0.358	−0.351	−0.343
	(0.278)	(0.226)	(0.283)	(0.223)	(0.217)	(0.221)	(0.218)	(0.213)
Size ∗ Law	−0.007	−0.060	−0.007	−0.053	0.000	−0.051	−0.001	−0.033
	(0.019)	(0.057)	(0.019)	(0.054)	(0.017)	(0.047)	(0.017)	(0.044)
Operating leverage ∗ Law	−0.036	−0.018	−0.030	−0.041	−0.051	−0.017	−0.038	−0.039
	(0.057)	(0.047)	(0.058)	(0.051)	(0.049)	(0.052)	(0.050)	(0.059)
Dividend payer ∗ Law	−0.041	−0.024	−0.042	−0.021	−0.046	−0.017	−0.045	−0.022
	(0.048)	(0.033)	(0.049)	(0.033)	(0.043)	(0.030)	(0.043)	(0.029)
Asset risk ∗ Law	−0.255	−0.225	−0.266	−0.258*	−0.319**	−0.230	−0.343**	−0.299*
	(0.155)	(0.155)	(0.161)	(0.145)	(0.152)	(0.170)	(0.160)	(0.163)
Rating probability ∗ Law	−0.007	−0.106	−0.014	−0.052	−0.050	−0.302	−0.060	−0.115
	(0.171)	(0.380)	(0.171)	(0.364)	(0.161)	(0.307)	(0.159)	(0.315)
Firm fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Year fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	1007	1007	1007	1007	1007	1007	1007	1007
Adj. R^2	0.280	0.393	0.725	0.745	0.282	0.395	0.743	0.762

The table shows the results from standard leverage regressions, where the firm-level determinants of leverage are augmented by cross-product terms with an indicator dummy variable, which is set equal to one for countries with a common law regime (and zero otherwise). The sample consists of 115 listed shipping companies during the period from 1992 to 2010. All variables are winsorized at the upper and lower one percentile. Standard errors clustered at the firm level are given in parentheses. Firm fixed effects and year fixed effects indicate whether calendar year and entity fixed effects are included in the specification. See Appendix Table A1 for definitions of variables.

* Statistical significance at 10% level.

** Statistical significance at 5% level.

*** Statistical significance at 1% level.

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