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Probability of financial covenant violation. The case of internationally listed shipping companies.

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Tripartite Committee Page

The present Dissertation Thesis has been approved in unison by the Tripartite Committee that has been appointed from the General Assembly of special Composition, of the Department of Maritime Studies, of the University of Piraeus according to the Operation Regulation of the Program of Postgraduate Studies in Shipping Management.

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The approval of Dissertation Thesis from the Department of Maritime studies of the University of Piraeus does not denote the acceptance of the opinions of the author.

Abstract

Bank loans are a crucial financing instrument for the shipping industry. The sector is characterized by high uncertainty and volatility, and is affected deeply by geopolitical events, the global economy trends and the global trade outlooks. The sector is burdened with high investment and operational costs, and external funding is necessary to the functioning of the shipping companies. However, the advantages of debt are also accompanied with several drawbacks, in case the capital structure of the company is not optimal. As the shipping industry is especially volatile, shipping loans come with an extensive list of covenants, designed to closely monitor performance and allow the banks and the companies time for corrective measures, should the borrower's financial health declines. The purpose of this study is to provide a comprehensive snapshot of the financial covenants in the shipping industry sector and explain their consequences and the factors that cause financial covenant violation by the shipping firms, in order to help mitigate the risks faced by both borrowers and lenders in the industry. The empirical part of the study attempts to predict covenant breaches by using several statistical models. The analysis indicated that certain financial variables, such as cash flows from financing activities, have a statistically significant relationship with covenant breaches. Specifically, higher cash flows from financing activities were associated with an increased probability of covenant violations, suggesting that companies relying more heavily on external financing might be at greater risk of breaching financial covenants.

Key Words: financial covenant violation, prediction of financial covenant violation, risk assessment in shipping, shipping debt financing, shipping industry, shipping investment

Περίληψη

Τα τραπεζικά δάνεια αποτελούν κρίσιμο μέσο χρηματοδότησης για τη ναυτιλιακή βιομηχανία. Ο κλάδος χαρακτηρίζεται από υψηλή αβεβαιότητα και αστάθεια και επηρεάζεται βαθιά από τα γεωπολιτικά γεγονότα, τις τάσεις της παγκόσμιας οικονομίας και τις προοπτικές του παγκόσμιου εμπορίου. Ο κλάδος επιβαρύνεται με υψηλά επενδυτικά και λειτουργικά κόστη και απαιτείται εξωτερική χρηματοδότηση για τη λειτουργία των ναυτιλιακών εταιρειών. Ωστόσο, τα πλεονεκτήματα του χρέους συνοδεύονται και από αρκετά μειονεκτήματα, σε περίπτωση που η κεφαλαιακή διάρθρωση της εταιρείας δεν είναι η βέλτιστη. Καθώς ο ναυτιλιακός κλάδος είναι ιδιαίτερα ασταθής, τα ναυτιλιακά δάνεια συνοδεύονται από εκτενείς Χρηματοοικονομικές Ρήτρες, σχεδιασμένων να παρακολουθούν στενά την απόδοση και να δίνουν στις τράπεζες και τις εταιρείες χρόνο για διορθωτικά μέτρα, σε περίπτωση που η οικονομική υγεία του δανειολήπτη υποχωρήσει. Σκοπός αυτής της μελέτης είναι να παράσχει μια ολοκληρωμένη εικόνα των Χρηματοοικονομικών Ρητρών στον κλάδο της ναυτιλίας και να εξηγήσει τις συνέπειές τους και τους παράγοντες που προκαλούν παραβίαση των Χρηματοοικονομικών Ρητρών από τις ναυτιλιακές εταιρείες, προκειμένου να συμβάλει στην διαχείριση των κινδύνων που αντιμετωπίζουν τόσο οι δανειολήπτες όσο και δανειστές στον κλάδο. Το εμπειρικό μέρος της μελέτης επιχειρεί να προβλέψει τις παραβιάσεις των ρητρών χρησιμοποιώντας διάφορα στατιστικά μοντέλα. Η ανάλυση έδειξε ότι ορισμένες χρηματοοικονομικές μεταβλητές, όπως οι ταμειακές ροές από χρηματοδοτικές δραστηριότητες, έχουν στατιστικά σημαντική σχέση με τις παραβιάσεις των χρηματοοικονομικών ρητρών. Συγκεκριμένα, οι υψηλότερες ταμειακές ροές από χρηματοοικονομικές δραστηριότητες συσχετίστηκαν με αυξημένη πιθανότητα παραβιάσεων των ρητρών, υποδηλώνοντας ότι οι εταιρείες που βασίζονται περισσότερο στην εξωτερική χρηματοδότηση ενδέχεται να διατρέχουν μεγαλύτερο κίνδυνο παραβίασης των χρηματοοικονομικών όρων.

Λέξεις κλειδιά: παραβίαση χρηματοοικονομικής ρήτρας, πρόβλεψη παραβίασης χρηματοοικονομικής ρήτρας, εκτίμηση κινδύνου στη ναυτιλία, χρηματοδότηση ναυτιλιακού χρέους, ναυτιλιακή βιομηχανία, ναυτιλιακές επενδύσεις.

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Chapter 1: Introduction

Introduction to the shipping industry

The shipping industry plays a critical role in global trade, with approximately 90% of the world's merchandise volume being transported by sea, which corresponds to 50-60% of the value of global goods (KPMG, 2024). In 2022, international maritime trade amounted to 12.027 million tonnes, reflecting a 0.4% decrease compared to 2021. This slight decline highlights the normalization following the strong recovery in 2021 after the COVID-19 pandemic. Various factors contributed to this weak growth, including sluggish global economic activity, high inflation affecting consumer spending, China's COVID-19 containment measures, and the ongoing war in Ukraine (ICC, 2023).

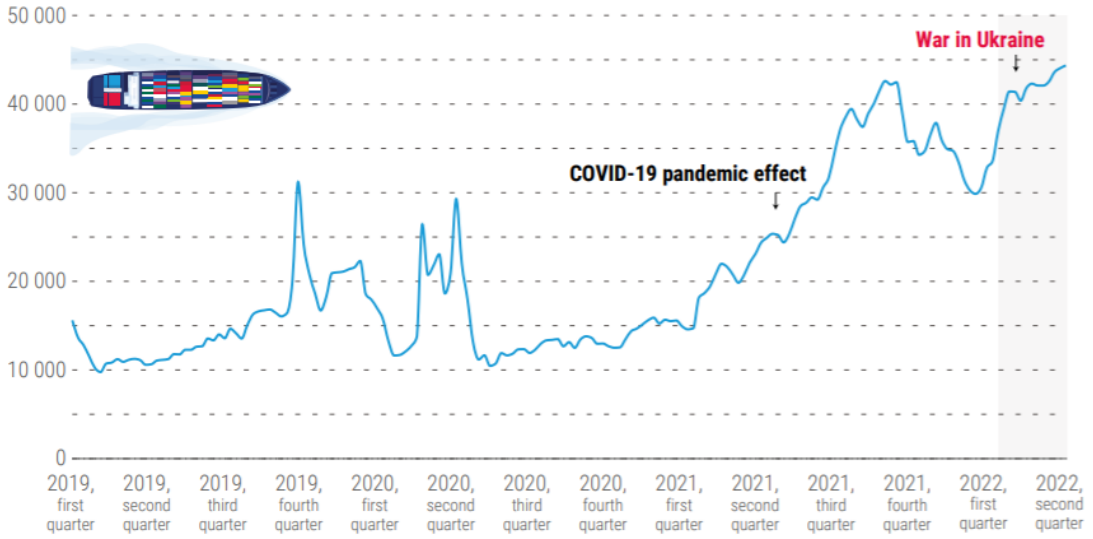


Figure 1: Clarksea index in dollars/day, all shipping markets. Source: UNCTAD, 2022a

The COVID-19 pandemic caused significant disruptions to global supply chains and commercial shipping flows, which continue to be affected by the conflict in Ukraine. This war has led to a 2.6% global decline in grain trade volumes in 2022 and caused considerable fluctuations in fossil fuel markets, as the Russian Federation is a major exporter of natural gas and oil. These disruptions, coupled with increased fuel demand post-pandemic, resulted in extremely high and volatile energy prices. Additionally, global inflation reached 8% in 2022, with developing regions experiencing the highest rates (IMF, 2023).

The reopening of the Chinese economy is expected to bolster modest growth in 2023 and 2024, particularly in Asian markets. Despite this, global inflation is predicted to remain above pre-pandemic levels until the end of 2024, and merchandise trade growth is projected to be modest, with a 1.7% increase expected in 2023 (World Trade Organization, 2023).

Decarbonization efforts mandated by global authorities are also a major source of uncertainty for the shipping industry, necessitating substantial investments in new technologies and infrastructure. The industry faces the challenge of reducing carbon emissions while dealing with higher operational costs and the need for extensive upgrades to support carbon-neutral fuels (DNV, 2022).

Importance of Financial Covenants in the Shipping Sector

The shipping industry is highly capital-intensive, with significant funds required for both shipbuilding and the acquisition of second-hand vessels. While various financing options exist, including leasing, bond issues, and private equity, bank debt remains the dominant source of capital due to its lower cost and availability in large amounts (Syriopoulos, 2022). Financial covenants are integral to loan agreements between banks and shipping companies, ensuring that the borrower maintains financial health and compliance with loan terms (Giannakoulis, 2016).

These covenants act as a warning system for lenders, signaling potential defaults, while borrowers must adhere to them to maintain access to credit and avoid penalties (Spoullos, 2016). Given the volatile nature of the shipping industry—characterized by fluctuating demand, increasing fuel prices, and regulatory changes—predicting and managing the risk of covenant breaches is crucial. Breaches can result in severe consequences, including debt prepayments, increased collateral requirements, or even default (Kagkarakis & Tsouknidis, 2023).

Problem Statement

In case a covenant is violated, the borrower is required to take remedial actions such as debt prepayments, increased collateral and equity increases to restore the breach

(Kagkarakis & Tsouknidis, 2023). Sometimes, a covenant breach may even lead to immediate default. The negative consequences of covenant breaches make their prediction a very important issue for both borrowers and lenders. Shipping operates in a particularly volatile environment, characterized by uncertainty and risks. Fluctuating demand for shipping services, increasing fuel prices, and regulatory changes might severely affect a company's financial performance and its capacity to adhere to the strict financial ratios set out in loan agreements.

Measuring the probability of covenant violations in either private debt contracts or bank loan agreements has been an important issue in accounting academia (DeFond & Jiambalvo, 1994; Dichev & Skinner, 2002; Christensen & Nikolaev, 2012; Demerjian, 2011; Demerjian & Owens, 2016), but only a few studies have researched the shipping sector in particular. Understanding the causes for financial covenant violations and the implications they have on stakeholders will be crucial for better prediction and mitigation strategies.

Research Objectives

The present study aspires to contribute to the bibliography on the issue of financial covenant violation by studying data from international shipping companies. Individual objectives of the study include:

- The identification of the most important financial covenants that are usually included in maritime shipping loans.
- The investigation of financial, operational and regulatory factors that lead to the breach of financial covenants by shipping companies.
- Analysis of the impact of financial covenant violation to companies and stakeholders
- To assess the probability of financial covenant violations in shipping
- The formulation of proposals for better risk management in shipping companies and the reduction of covenant violations

Research Questions

The research questions that will guide this thesis are the following:

- What are the most important financial clauses included in ocean shipping contracts?
- What are the main factors that lead shipping companies to breach the financial covenants of their loans?
- How can probability models be used to predict the probability that shipping companies will violate the financial covenants of their loans?
- What are the consequences for shipping companies and their stakeholders when financial covenants are breached?
- What strategies can be used to reduce the risk of breach of financial covenants in maritime loans?

Chapter 2: Bibliographic Review

2.1 Risk Management in Maritime Industry

Risk Factors in the maritime shipping industry

A corporation faces many different types of risks during its lifetime and must employ effective strategies to mitigate them. The term risk exposure (Adler & Dumas, 1984) is used to describe the sensitivity of a company's stock price to risk such as fluctuations in exchange rates (Allayannis, Ihrig & Weston, 2001; Jorion, 1990), interest rates (Hentschel & Kothari, 2001) or commodity prices (Berghöfer & Lucey, 2014; Jin and Jorion, 2006).

Risk can be classified in several categories. Market risks are caused by fluctuations in market prices such as equity prices, foreign exchange rates, interest rates, and commodity prices (Dowd, 2007). Liquidity risks are caused by transactions in markets characterized by low trading volume and large bid-ask spreads, in which case assets may be underpriced, and sales may happen within longer timeframes (Christoffersen, 2011). Operational risks correspond to losses due to natural catastrophes, technical failures, human errors or management and process failures (Moosa, 2007). Credit risks refer to the possibility that creditors may not fulfill their financial obligations either in part or in full, by the agreed upon date (Lando, 2009). Lastly, business risk is a result of changes in variables of a business plan such as changes in demand, business cycles, changes in competitors' behavior or the emergence of new technologies, that will destroy that plan's viability. Business risk is an integral part of the core business of the firm and is generally considered inescapable (Christoffersen, 2011).

The maritime shipping industry faces volatilities in vessel prices, foreign exchange, and interest rates, but the fluctuations in freight rates and bunker fuel prices are considered the most critical risk sources for shipping companies' earnings (Wang, Gao, Tan & Yang, 2019). Bunker fuel costs account on average for more than 60% of the total voyage costs (Alexandridis, Kavussanos, Kim, Tsouknidis & Visvikis, 2018) and about 50% of the total operating costs (Ronen, 2011) while freight rates directly determine revenue. Furthermore, capital-intensive sectors, such as shipping and

logistics, tend to be more susceptible to financial crises, depending on their financial structure (Zhang, Li & Wang, 2010).

The risks to maritime supply chains due to the aforementioned factors, have been researched in several papers. The determination and fluctuation of tanker freight rates was investigated by Alizadeh and Nomikos (2004) while other researchers examined spillover effects among freight rate return and volatilities (Drobetz, Richter & Wambach 2012; Bai & Lam, 2021). Stefanakos and Schinas (2014) sought to identify the factors affecting the time series of bunker fuel prices, while Adland and Jia (2017) analyzed the characteristics of physical basis risks in the Capesize dry bulk freight market. The above studies generally focus on the factors affecting freight rate and bunker fuel price fluctuations, with a particular interest in the return and volatility spillovers in different markets.

Financial Structure of shipping companies

Throughout the history of maritime shipping, financing investments in the sector was a major issue for shipowners and companies, due to the high costs of ships. In addition to the capital intensiveness and need for liquidity, the sector is also characterized by high volatility in vessel revenues, operating cash-flows, and asset values, all of which make access to finance challenging (Kavussanos, 2002; Kavussanos & Visvikis, 2006).

The financing methods and corporate structure of shipping companies have varied over time. In earlier times, ship financing was provided through individual owners, assisted, sometimes, by private loans. When capacity in ships increased, borrowing from banks became prominent in the industry, and charter backed finance was very popular in the post second world war period. In the 1980, asset backed finance became popular, and since the 1990s, shipping companies began to raise finance from the global capital markets, through either equity or debt (Albertijn et al. 2011). In the period between 2004–2007 new financial instruments such as initial public offerings (IPOs), secondary offerings, and issuance of high-yield bonds were increasingly used in the shipping sector. However, the financial crisis of 2008 created capital, credit and bailout problems for banks, and especially the ones specializing in the highly volatile shipping industry. Ship-lending banks reduced their exposure to the shipping industry

to minimize their losses, corresponding to a volume drop of about 60% in shipping loans (Albertijn et al. 2011). Stricter terms were also introduced to manage credit risk such as significantly lower Loan-to-Value ratios, shorter amortization maturities, higher margin spreads and more covenants and collaterals (Kavussanos & Tsouknidis, 2016). Alternative sources of capital such as high-yield bond issues and private equity started to gain popularity during this period (Kavussanos & Tsouknidis, 2014).

There are basically three ways a company can obtain long-term financing, through equity (or issuing shares), debt, retained profits, or some combination of the three. Equity involves ownership rights, while debt is a liability the company will have to repay over a certain time horizon. The decision relating to the mix of debt, equity and other outstanding securities that will be used to finance a company constitutes its capital structure. Usually, companies choose either through equity alone, or through a combination of debt and equity. The choice affect financial ratios such as the weighted average cost of capital, ROE and other risk-related ratios (Alizadeh & Nomikos, 2009).

Despite the main idea of the Modigliani-Miller Theorem, one of the most important theorems in corporate finance, being that the capital structure of a company does not affect its overall value (Modigliani & Miller, 1963), critics of the theorem highlight that, as a firm's debt increases, the risk of bankruptcy is ignored by the M&M theorem, though it can be substantial. Bankruptcy costs are composed of the probability of financial distress and the costs should the financial distress occurs. Companies aim to find an optimal level of debt where the tax benefits, such as the tax advantages outweigh the risks and costs associated with debt (Brusov et al., 2018). It is also important to consider what their financial decisions signal to the market and how it will affect stock prices. Generally, issuing new stock is perceived as a signal that the firms' prospects are not as strong, and could lead to the stock price dropping; while seeking new capital via debt offering is usually taken as a sign that the company is confident that it can repay the liability (Ross, 1977).

Syriopoulos (2013) proposed a pecking order of financing, based on the above considerations. In his opinion, companies should prefer to use internal funds, like reinvested earnings, then, if more capital is needed, finance it through debt or

preferred stock, and as a last resort issue common stock. This hierarchy considers the costs associated with raising external funds and the signals that certain financing decisions can send to the market. The optimal mix of debt and equity is one that maximizes the company's market value (its stock price) and involves a debt level lower than what would maximize short-term financial metrics like earnings per share (EPS). It is also important for the company to undertake projects with returns that are higher than their cost of capital funding.

As it has already been discussed, shipping is a capital-intensive industry, so some form of debt is needed to either build or purchase new ships. Shipping companies nowadays can choose between the traditional mortgage-backed loans and more complex structures including high yield debt, leasing, mezzanine financing and equity-linked debt, private equity or funding through the formation of publicly listed spin-offs.

The most important source of financing for the shipping industry is through bank loans. From the shipping companies' perspective, this is the most reliable and best long-term solution, and it accounts for the majority of capital invested to shipping every year. From the banks' perspective, despite the high volatility of the sector and the relatively low margins, the shipping industry remains favorable, as vessels change hands on a regular basis, guaranteeing that loans are refinanced before their maturity. Shipping assets are also characterized by high levels of liquidity and homogeneity, and thus allow for the deployment of large amounts of capital with relatively low overheads (Grammenos, 2013). Many banks specialized in shipping funding through a range of banking products and advisory services. The single most important financing instrument for the international shipping industry is the mortgaged-backed loan. The capital structure of shipping companies are usually a combination between mortgage-backed loans and equity invested by the shipowner. The levels of mortgaged-backed bank debt have been consistently around 70–75% of the total capital invested, until the financial crisis of 2008 when the availability of bank debt dropped to around 50–60% (Giannakoulis, 2016). This financial instrument uses the ship as collateral in a process taking place at the same time as the issuance of the loan. The collateral vessel must be registered to a legally acceptable jurisdiction, and the mortgage gives the lender direct access to it and isolates it form any claims or liabilities unrelated to the

financed asset. It is possible for a holding company to act as a guarantor for a single purpose company to which it owns shares, and it is also possible to finance multiple vessels with one mortgage-backed loan. In the second case, the loan is divided in tranches to allow for the event of the sale of any of the vessels (Stopford, 2008).

It should also be noted that a mortgage-backed loan can be issued pre-delivery, which significantly higher risk for the lender, because the asset is not available to be mortgaged, and there are no earnings used to repay the loan. In this case, the construction contract is awarded to a shipyard, and in case of default, it is transferred to the lender. The lender still bears the risk that the shipyard may not complete construction, and may also require additional collateral or guarantees. The pre-delivery loan is typically repaid upon delivery of the vessel, using the proceeds of a post-delivery loan, usually issued by the same bank (Grammenos, 2014).

The amount financed and the terms of the loan must be structured in such a way that the vessels provide enough collateral against the loan outstanding, taking into account the fluctuations of shipping rates and vessel values. The financing amount is usually between 50-80% of the value of the collateral vessel, depending on its age, the sector of business and any existing corporate guarantees. Pre-delivery loans usually do not go higher than 50-60%. It is possible to use additional collateral, other than the vessel, for example charges on the vessel's earnings accounts or from any charter contracts linked to it, assignments of the borrower's insurance proceeds or company shares. The amount of financing could be higher, in cases there is a long-term contract with a very creditworthy counterparty. Loans typically have to be repaid within five to ten years, in annual or semi-annual installments and one balloon payment at maturity, depending on the bank’s ability to secure funding and the age of the vessel. The loan repayment must be faster than the vessel’s depreciation, to ensure that it will be paid off during the asset’s useful life. Banks usually avoid financing vessels late into the useful life, preferring loan obligations to be repaid before the last five years of the vessel’s life. Interest is typically a spread between 100 and 400bp over LIBOR, depending on the trustworthiness of the borrower, the quality and liquidity of the vessels used as collateral, and the overview of the ship financing market (Giannakoulis,

2016). The loan agreement also stipulates a number of financial and non-financial covenants, that we will analyze in the next chapter.

Bank loans to shipping companies can also take the form of company loans, which do not include the need of any vessels, existing or under construction, used as collateral. The lender issues the loan based on the companies' balance sheet. This option is typically available to publicly listed companies with access to the capital markets (Stopford, 2008).

Mezzanine financing is a middle-ground solution when a company does not want to invest more equity and has no ability to add traditional debt. It can be provided by traditional shipping banks, private equity firms or hedge funds. This solution can be structured either as debt or equity and represents a claim that is senior only to the common equity. In essence, the lender places a second or third mortgage on the vessel, with a high interest rate and little or no installments, and at the maturity of the loan receives a certain percentage of the equity in the vessel as its value appreciates (Alexopoulos & Stratis, 2016).

Leasing is another option available to the shipping companies to finance their operations. In this case, the company operates assets without having ownership of them, for a period which might well extend to multiple years. It is also possible to sell a vessel and lease it back, thus retaining responsibility for the vessel's operation, but not ownership of it. It is also possible that the leasing agreement comes with the option or stipulation of buying back the vessel usually at the end of the leasing period, at a pre-agreed price (Alizadeh & Nomikos, 2009). In these cases, or in the event that a vessel's leasing period exceeds 75% of its useful life, or the present value of lease payments exceed 90% of the vessel's market value, the lease is called a capital lease, and the asset has to be included in the lessee's balance sheet, and not in its income statement, as is what happens in all other cases (Clausius, 2014). While leasing may provide a company with additional vessels without requiring additional capital, it can prove burdensome to the company's balance sheet if spot rates drop and the company struggles to cover the lease payments and the operational costs of the vessels (Li, 2006).

The increased needs for funding that are associated with the expansion of the global fleet has increased the seeking of funds from the capital markets. The increased visibility of the shipping industry that is a result of the growth in global trade and the inclusion of China in the global markets, as well as the anticipation of high returns, have incentivized all types of institutional and individual investor to invest in the shipping industry through debt or equity securities (Leggate, McConville & Morvillo, 2004). Capital market funding, and especially corporate bonds, have a range of advantages and disadvantages. On one side, these instruments allow the companies to enhance their returns and buy assets without issuing equity, thus avoiding shareholder dilution, they enhance the company's liquidity, as there are typically no interest fees and the agreed upon sum is paid upon maturity, and they come with light covenants. However, in weak markets, bonds may add significant amounts of risks, because their terms cannot be altered, in contrast with bank debts, in which case some covenants may be waived by the lander, of the repayment profile may be altered. The non-amortizing nature of the bonds may also increase leverage disproportionately compared to the depreciation of the fleet (Anagnostopoulos & Tsamanis, 2016). Conclusively, capital market funding may be a good medium-term solution, but should not provide a permanent substitute for equity.

Covenants in shipping loans

As mentioned in the previous section of this chapter, lenders enforce a series of covenants on the borrower, mainly as warning signs to avoid the possibility of default. Covenants may be financial, or non-financial. They also fall under the categories of general, corporate, financial and ship-related covenants, either positive or negative. In essence, the borrower promises to maintain its valid legal existence, remain in good financial standing, comply the with laws and its tax obligations and deliver financial information to the lender, including informing them of any default.

Financial covenants are imposed on the holding companies or on the borrowers. On mortgage-backed loans, a typical covenant is the value maintenance clause which requires the collateral vessel market value to exceed the outstanding loan amount by e certain predetermined percentage which is usually 120% at least.

In case this condition is not met at some point, because the vessels value may drop, borrowers must either provide additional guarantees, or prepay a part of the loan (Giannakoulis, 2016). Other financial covenants include minimum liquidity covenants, a cap on total indebtedness of the guarantor, or financial ratios, which we will analyze in this chapter. It may be also required of the borrower to keep a minimum amount of cash in its accounts with the lender. Non-financial covenants usually pertain to the ship, its seaworthiness and insurance status, and include issues relevant to the flag and jurisdiction of the borrower, insurance coverage and technical survey issues, vessel management and reviews of financial accounts (Paleokrassas, 2016).

The purpose of the Minimum Value Clause test is to determine if the market value of the ship is above the minimum required level, usually the point at leat 120% the outstanding amount of the loan. This is stipulated so that in the event of default, there is sufficient value in the asset to pay off the loan, interest and fees outstanding (Giannakoulis, 2016). If this clause is violated, the borrower needs to provide additional collateral, or prepay partin order to restore the ratio. Cash may act either as prepayment or as collateral and in the second case be recouped once the asset's value returns to levels over the Minimum Value Clause. In case that no action is taken within a specified grace period, violating the Minimum Value Clause will lead to default (Tenold & Tenold, 2019).

Lenders also periodically check on the company's financial ratios as a covenant. This term is in place to determine the company's financial health and predict events of default. In case any of those covenants are breached, the bank may either accelerate the loan and take enforcement action against the ship before financial deterioration occurs. The accounts provided will need to be adhering to agreed upon accounting standards, and most of the time, banks prefer to rely on compliance certificates issued auditors, who provide independent verification of the borrower's records. Typically, financial ratios selected as covenants in shipping agreements include both balance sheet ratios and cash flow ratios (Spoullos, 2016).

Balance sheet ratios often include a net worth covenant, which requires the borrower to maintain a minimum value of assets (with liabilities deducted). If the borrower's net worth falls below this threshold, they are typically required to inject additional share

capital. The purpose of this covenant is to ensure that, in the event of bankruptcy, there are sufficient assets left for shareholders after selling them at market value and repaying all liabilities, thus ensuring the borrower's ability to service the loan. A more stringent net worth test excludes intangible assets, which may have little or no value in liquidation scenarios. Given the volatility of the shipping industry, the market value of ships is considered rather than their book value, making this covenant more rigorous.

The leverage, or debt/equity ratio, reflects the capital structure of the borrower, particularly the ratio between internal and external capital. A high ratio indicates that a significant portion of the company's funding comes from debt, with liabilities exceeding equity, thereby increasing the lender's risk. The working capital or quick ratio, which measures the ratio of current assets to current liabilities, serves as a liquidity indicator. It assesses whether the company's current assets, excluding those that are not easily liquidated, are sufficient to cover its current liabilities (Spoullos, 2016).Violating covenants, especially the financial ratios covenants, may not immediately lead to default. In most cases, banks allow solutions such as equity injections or subordinated debt, to remedy a financial ratio violation. The financial ratios might also be used to inform decisions about dividends paid to shareholders, limitations on borrowings and capital expenditure, levels of loan prepayments, or adjustments to interest margin (Giannakoulis, 2016).

As mentioned in previous sections, covenants may also be related to positive or negative undertakings. A typical negative undertaking is the negative pledge clause, which prohibits the borrower to create any security on the relevant assets in favor of other creditors or enter into similar transactions with them. There are a few exceptions to this covenant, to allow business to be conducted. The non-disposal covenant prevents any company within the borrower's group to transfer assets to third parties either below their full market values or outside the ordinary course of business. Also there are covenants restricting distributions and payments, such as dividends, share redemption or payments on shareholders' loans, at least if the financial performance criteria set as part of the agreement are not met (Otto & Scholl, 2014).

Finally, the borrower must undertake all financial costs to ensure that the ship is operating as it should, and that it is insured against risk. This covenant requires that the vessel passes technical inspections, its class is maintained according to what is stated in the loan agreement, and it complies with its flag state laws, the international safety and ship and port facility codes and all international environmental legislations. Also, the borrower pledges not to employ the ship in any unlawful activities, not to enter any war zones, and promptly repay all debts damages, and liabilities incurred by the vessel. Usual insurance coverage includes fire risks, war risks, maritime risks, protection and indemnity risks and possibly loss of earnings if required by the bank (Otto & Scholl, 2014).

2.2 Violation of financial covenants in shipping

Theoretical perspectives

The previous chapter illustrated the point of loan covenants, and the consequences of violating them which range from restrictions and obligations on part of the borrower to the lender for the duration of the loan, to immediate default. Despite the severity of the consequences, there are instances of companies violating the covenants in their loan agreements. The reasons behind this behavior may range from economic downturns to strategic decisions by company management. Below, three theoretical perspectives are detailed that provide a framework to analyze covenant violations: moral hazard, adverse selection, and agency theory.

The term of 'moral hazard' originated in the insurance literature and was used to describe the possibility that insurance diminishes the incentive to prevent the events against which an entity was insured, thus causing an increase in the observation of this outcome. Put simply, an entity engages in riskier behavior because they do not bear the full consequences of that risk (Rowell & Connelly, 2012). The moral hazard problem is caused by information asymmetry among individuals and the belief that individual actions cannot be singled out and contracted upon (Holmström, 1979). Covenants are designed to increase monitoring and thus prevent cases of moral hazard. Under the moral hazard assumption, a shipping company might take on riskier contracts, decide to expand its fleet or neglect ship maintenance, under the impression that the lender or the insurer will absorb part of the cost.

Another reason leading to covenant violations is the role of asymmetric information in financial markets (Akerlof, 1970; Rothschild & Stiglitz, 1976; Stiglitz & Weiss, 1981). In an adverse selection situation, lenders are unable to judge the credit risk of the lenders correctly, due to asymmetric information. When adverse selection percentages increase, prices in perfect competition also increase as the riskier pool of borrowers average default cost increases (Crawford, Pavanini & Schivardi, 2018). In the volatile shipping industry, a high-risk borrower may hide operational inefficiencies or overestimate future revenue streams in order to secure a loan, and afterwards be unable to keep up with the financial covenants stipulated.

Agency theory has been researched through a lot of different fields, and analyzes the discrepancy between owners' and managers' interests in a company. The principal-agent conflict is a product of opposite risk preferences. The principals (owners) are willing to undertake risk to maximize the economic benefits of the firm while managers (agents) are risk averse and are interested in maximizing their personal profits (Arrow, 1971/1996; Wilson, 1968). Ross (1973) believed that the agency problem was in its essence an incentives' problem while Mitnick (1975) considered it an inherent problem of the institutional structure. Jensen and Meckling (1976) considered the agency relationship a kind of contract between principals and agents and theorized that incentive structure, labour market and information asymmetry may help reduce agency costs. In the case of covenant violations, agents might make decision to further their own personal interests at the expense of both lenders and owners of the company, for instance prioritizing short-term over long-term profitability if it is connected with personal bonuses. They might also deliberately choose to violate covenants if they believe renegotiating the terms or refinancing is more advantageous than adhering to the original agreement.

Impact of financial covenants violation

A breach of a covenant may result in immediate events of default or not, depending on the existence of a grace period that allows the borrower time to remedy the default, and the type of the covenant. Covenants like the minimum-value clause and the financial ratios are usually used as 'warning signals' and do not usually lead to immediate default. Their purpose is to give the bank more options to deal with the

situation, either by taking measures to prevent the negative effects from a default, or by exercising influence to prevent escalation of the situation (Giannakoulis, 2016).

Breaching of a debt covenant is a costly situation for borrowers, even in the case default is not imminent (Beneish & Press, 1995; DeFond & Jiambalvo, 1994; Sweeney, 1994). When covenants are violated, lenders may demand additional collaterals or prepayments, which may create tensions between stakeholders (Jensen, 1986). In the event of cross-default clauses, default on one loan also triggers default on other loans. While the repayment acceleration option is rarely used, breaches of financial covenants give lenders a stronger bargaining position, leading to higher interest rates or tighter covenants for borrowers (Chava & Roberts, 2008; HassabElnaby, 2006; Nini, Smith & Sufi, 2012). It is also possible to give lenders substantia control over various aspects of the firm's operations, investments, and capital structure. This might include managerial positions (Ferreira et al., 2018), reduction of capital expenditures and other forms of credit, which might cost the company growth opportunities (Chava & Roberts, 2008; Nini et al., 2012; Roberts & Sufi, 2009).

Prediction of financial covenants violation

In addition to covenant violation testing, credit scores are also used to predict the possibility of financial distress and default. The works of Altman (1968) and Ohlson (1980) have been pioneering in the modelling of corporate financial distress and bankruptcy, triggering other work in the field (Altman, Haldeman & Narayanan 1977; Shumway, 2001; Hensher & Jones 2007). These models employ generalize linear models such as logit, probit or linear discriminant analysis models.

However, after the financial crisis of 2008, it became evident that new models are needed to enhance predictive accuracy especially in the early stages. Conventional prediction models have certain restrictive assumptions including linearity, normal distribution, multicollinearity, autocorrelation, sensitivity to outliers and homoscedasticity, which do not sufficiently capture the complex relationships between the variables (Duffie, Eckner, Horel & Saita, 2009; Christoffersen, Matin & Mølgaard, 2019). The above limitations to statistical techniques have switched the focus of the industry and academics to deep learning methods (Lessmann, Baesens,

Seow & Thomas, 2015; Zhang, Liu, Zhang & Almpanidis, 2017). Machine Learning methods are now used in the financial distress literature and the general conclusion is that they outperform traditional methods, although data privacy issues remain to be solved (Clintworth, Lyridis & Boulougouris, 2023).

Previous Studies on the prediction of covenant violations and financial distress in shipping companies

Research into the prediction of financial distress in shipping companies has been scarce so far. Earlier studies in the sector have focused on the prediction of financial performance relying on binary logistic regression techniques for the case of either shipping bond markets or bank shipping debt (Grammenos, Nomikos & Papapostolou, 2008; Kavussanos & Tsouknidis 2016; Mitroussi, Abouarghoub, Haider, Pettit & Tigka, 2016; Lozinskaia, Merikas, Merika & Penikas, 2017).

As repeated regularly throughout the present study, bank loan is the preferred financing means for a variety of reasons. Most of the works in the field of shipping loans thus concerns the credit rating of borrowers and their ability to adhere to the loan contract terms. Usually a series of qualitative and quantitative criteria is used to assess creditworthiness. One method comprises on applying the five core Cs of credit ('character', 'capacity', 'capital', 'collateral' and 'conditions') to credit scenarios to conduct scenario testing (Antoniou et al. 1998; Grammenos, 2013). Other efforts use the Multi-Criteria Decision Making approach. Dimitras, Petropoulos and Constantinidou (2002) employed the Utilities Additives Discriminants (UTADIS) method and a wide set of credit criteria utilized in credit assessment, to which they assigned weights based on the subjective opinions of financial professionals. They found that the most important factors in default risk assessment for shipping companies were the ownership structure and the quality/experience of the management team (34%), the credit history of the obligor (20%) and fleet characteristics (12%). However, weights and utility thresholds employed could be contingent to the sample used and the risk appetite of specific banking institutes.

Using a similar method to an initial set of credit criteria based on a survey conducted on bank managers, Gavalas and Syriopoulos (2015) concluded that the probability of

moving between different credit rating threshold is affected by the debt-to-equity and asset coverage ratios. Gavalas and Syriopoulos (2016) also suggested a (weighed) multi-criteria integrated framework for the optimal selection of shipping loan collaterals, that would result to higher quality loan portfolios. The criteria included asset cash flow criteria such as freight rate volatility and ship age, asset value criteria such as vessel market value, construction shipyard and scrap value and financial recourse criteria such as loan coverage ratio and loan-to-value ratio.

Kavussanos and Tsouknidis (2016) used a logit credit scoring model to examine the default risk drivers of shipping bank loans and concluded that the most significant factors are industry specific current and forward-looking indications in freight markets, the risk appetite of shipowners and the arrangement fee over the amount of loan. Mitroussi et al. (2016) also utilized a logit credit scoring methodology on loans for dry bulk vessels, and concluded that market conditions and chartering policy are important factors in risk assessment of shipping bank loans. Lozinskaia et al. (2017) found both financial and non-financial variables important in assessing the credit worthiness of shipping companies while Gong et al. (2013) found the loan quality and collateral used to be the most important factors in predicting default risk. Finally, Lee and Pak (2018) found ship-lending decisions, followed by asset cash-flow and asset value criteria to be the most important factors.

Conclusively, the researchers above tend to consent over the most important predicting factors of shipping bank loan default being industry-specific, a finding that is general at odds with the general finance literature that consider the financial characteristics of obligors, such as the financial structure, profitability and liquidity of the borrower and other debt-related features to be more important in risk assessment of bank loans (Jiménez & Saurina, 2004; Bonfim, 2009; Chang et al. 2014). We could hypothesize that the increased cyclicality and volatility of freight rates might increase the probability of default in tough market conditions and high levels of debt (Alexandridis et al., 2018).

Chapter 3: Methodology

This study aims to assess the probability of financial covenant violations among internationally listed shipping companies. The analysis integrates a combination of descriptive statistics, visualization, predictive modeling, and stress testing to provide a comprehensive understanding of the financial dynamics within the shipping industry.

3.1 Hypothesis

- Hypothesis 1: There is a significant relationship between key financial metrics (such as Total Assets, Total Liabilities, EBITDA, and Net Result) and the likelihood of financial covenant violations among internationally listed shipping companies.
- Hypothesis 2: Stress scenarios involving reductions in EBITDA and Total Assets will significantly increase the probability of financial covenant violations.

3.2 Data Collection

The data utilized in this study consists of a comprehensive panel dataset that includes financial information from 55 maritime shipping companies listed on U.S. stock exchanges, specifically Nasdaq and NYSE. These companies are categorized under the Standard Industrial Classification (SIC) code 4412, which corresponds to Deep Sea Foreign Transportation of Freight. The dataset spans 27 years, covering the period from 1993 to 2020, allowing for an in-depth analysis of financial trends and patterns over time.

The dataset was carefully compiled from the U.S. Securities and Exchange Commission (SEC) archival records, ensuring a high level of reliability and validity due to the rigorous reporting requirements mandated by the Financial Accounting Standards Board (FASB) under ASC 850–10-50. This regulation requires U.S.-listed companies to

disclose related party transactions explicitly in their financial statements, providing a level of transparency that enhances the dataset's quality.

Key financial metrics included in the dataset are Total Assets, Total Liabilities, EBITDA, Net Result, and Payment Default indicators. The panel nature of the dataset, which tracks the same companies over multiple years, enables the study to analyze both cross-sectional and temporal variations in the financial health of these maritime shipping companies. The data was imported from an Excel file into the R environment for further analysis.

3.3 Statistical Analysis

The statistical analysis in this study was designed to assess the probability of financial covenant violations among internationally listed shipping companies. The primary focus was on developing a predictive model that could identify the key financial metrics influencing the likelihood of such violations. The steps involved in the statistical analysis are outlined below.

The dependent variable in this analysis is the Covenant Violation indicator, a binary variable representing whether a financial covenant violation occurred. This dummy variable was created from several related variables in the dataset, each indicating whether a specific covenant was violated (such as Loan Asset Cover, Minimum Liquidity, Minimum Interest Coverage Ratio, Consolidated Leverage Ratio, or Minimum Net Worth). If any of these covenants were violated, the Covenant Violation variable was set to 1; otherwise, it was set to 0. This variable serves as the primary outcome of interest in the logistic regression model.

The independent variables considered in the model include key financial metrics:

- ✓ Total Assets
- ✓ Net Result
- ✓ Interest & Finance Costs
- ✓ Cash Flows from Operating Activities
- ✓ Cash Flows from Financing Activities

These variables were selected based on their relevance to the financial health and operational performance of the companies.

Before fitting the logistic regression model, a correlation analysis was conducted to examine the relationships between the independent variables. The purpose was to identify any highly correlated variables, as including them in the same model could lead to multicollinearity, which distorts the model's estimates and reduces its predictive accuracy.

Variables with a correlation coefficient greater than 0.6 (either positive or negative) were flagged for potential exclusion. In this analysis, variables such as Total Liabilities, Total Non-Current Assets, and Total Current Assets showed high correlations with each other, as well as with other variables like Total Equity and EBITDA. To mitigate the risk of multicollinearity, these highly correlated variables were not included simultaneously in the final model.

The core of the statistical analysis involved fitting a logistic regression model to predict the likelihood of covenant violations. Logistic regression is particularly suited for this analysis because it models the probability of a binary outcome—in this case, whether or not a covenant violation occurred.

The logistic regression model was specified as follows:

$\text{Logit}(P(\text{Covenant Violation})) = \beta_0 + \beta_1(\text{Total Assets}) + \beta_2(\text{Net Result}) + \beta_3(\text{Interest \& Finance Costs}) + \beta_4(\text{CF from Operating Activities}) + \beta_5(\text{CF from Financing Activities})$

Where:

- $P(\text{Covenant Violation})$ is the probability of a covenant violation occurring.
- β_0 is the intercept of the model.
- β_1, β_2, β_3, β_4, and β_5 are the coefficients for the respective independent variables (Total Assets, Net Result, Interest & Finance Costs, Cash Flow from Operating Activities, and Cash Flow from Financing Activities).

The logistic regression model was estimated using maximum likelihood estimation, and the significance of each independent variable was assessed through the

associated p-values. Only those variables with acceptable levels of multicollinearity and significant predictive power were retained in the final model.

The performance of the logistic regression model was evaluated using several metrics:

- McFadden's Pseudo R-squared: This statistic provides an indication of the model's goodness of fit. Although the value was relatively low, it is typical for logistic regression models dealing with complex financial data.
- Likelihood Ratio Test: This test compared the full model with a null model (containing only the intercept), confirming that the inclusion of independent variables significantly improved the model's fit.
- Akaike Information Criterion (AIC): AIC was used to compare the fit of the model relative to its complexity, with lower AIC values indicating a better balance between model accuracy and complexity.

Chapter 4: Results

4.1 Descriptives

	Mean	Median	Maximum	Minimum	Stand. Dev.	Skewness	Kurtosis
Total Assets	2.31E+09	1.3E+09	2.52E+11	425142	1.02E+10	23.47637	573.695
Total Liabilities	1.17E+09	6.35E+08	9.1E+09	285000	1.41E+09	2.505652	10.98954
Total Current Assets	2.06E+08	1.18E+08	1.67E+09	0	2.51E+08	2.484693	10.57736
Total Non-Curr. Assets	1.72E+09	1.18E+09	1.17E+10	0	1.79E+09	2.327304	10.27906
EBITDA	1.63E+08	1.09E+08	1.2E+09	-4.8E+08	1.87E+08	1.811565	8.151707
Net result	7375987	9260000	1.23E+09	-2.8E+09	1.83E+08	-5.27889	97.21104
Interest & Finance costs	44833602	26759754	9.95E+08	0	64109739	6.66445	84.00189
Total Equity	7.48E+08	5.92E+08	4.29E+09	-2E+08	7.06E+08	1.770831	7.445334
Gross Operating Revenue	3.97E+08	2.19E+08	3.19E+09	0	4.96E+08	2.210396	8.186219
CF from Operating activities	1.08E+08	68574000	9.84E+08	-7.3E+08	1.4E+08	1.549746	12.03653
CF from Investing activities	-1.3E+08	-6.2E+07	1.39E+09	-2.3E+09	3.04E+08	-2.09512	15.98226
CF from Financing activities	53527081	1866000	2.11E+09	-1.1E+09	2.75E+08	2.098741	14.58601

Table 1: Descriptive statistic table

The descriptive statistics of the financial metrics provide a detailed overview of the financial position and performance of the entities analyzed. The mean and median values for total assets and total liabilities indicate that the average and median-sized firms have significant resources and obligations, though the distribution is highly skewed, as evidenced by the large skewness values, particularly for total assets. The extreme values, with maximums far exceeding the means and medians, suggest a presence of outliers, likely large firms with substantial asset bases, which is further confirmed by the high kurtosis, indicating a heavy-tailed distribution.

The analysis of profitability and metrics such as EBITDA and net result shows considerable variability, as reflected in the standard deviation and range between maximum and minimum values. The negative skewness for net results highlights that many firms experienced losses, with a few large positive outliers driving the mean upwards. This is supported by the extremely high kurtosis, which suggests that while most firms have modest results, there are significant outliers, possibly due to extraordinary items or varying business cycles.

The cash flow metrics also reflect high volatility, particularly in investing and financing activities, with substantial deviations from the mean and significant differences between the maximum and minimum values. The positive skewness in financing activities indicates that most firms have modest financing cash flows, but a few have undertaken large financing transactions, while the negative skewness in investing activities suggests a trend toward divestment or lower capital expenditures among most firms. These findings emphasize the diverse financial strategies and operational conditions across the companies in the dataset.

4.2 Correlation

	COVENANT_VIOLATION	Total Assets	Total Liabilities	Total Current Assets	Total Non-Curr. Assets	EBITDA	Net result	Int. & Fin. costs	Total Equity	Gross Operating Revenue	CF from Op. activities	CF from Inv. activities	CF from Fin. activities
COVENANT_VIOLATION	1												
Total Assets	-0.02793	1											
Total Liabilities	-0.06893	0.13761	1										
Total Current Assets	-0.01843	0.13044	0.862512	1									
Total Non-Curr. Assets	-0.05794	0.145091	0.960351	0.883644	1								
EBITDA	-0.0743	0.112883	0.801368	0.740116	0.843501	1							
Net result	-0.10062	-0.00164	-0.02899	-0.07681	0.020174	0.16169	1						
Interest & Finance costs	-0.04585	0.105542	0.744114	0.720804	0.749506	0.645345	-0.16432	1					
Total Equity	-0.00137	0.130266	0.812113	0.847756	0.913846	0.788999	0.074787	0.645213	1				
Gross Operating Revenue	-0.06444	0.092632	0.674757	0.735045	0.695367	0.676511	0.034238	0.594075	0.656042	1			
CF from Operating activities	-0.03545	0.081656	0.622069	0.567803	0.663933	0.852674	0.225899	0.50606	0.651813	0.666568	1		
CF from Investing activities	-0.10496	-0.09875	-0.44353	-0.42794	-0.45227	-0.43872	0.016229	-0.30978	-0.40576	-0.35867	-0.33133	1	
CF from Financing activities	0.090237	0.011223	0.338043	0.312943	0.326714	0.188244	-0.08369	0.230457	0.266034	0.135435	0.038492	-0.65407	1

Table 2: Correlation table

The correlation matrix reveals the relationships between covenant violations and various financial metrics, as well as the interrelationships among these metrics. The correlation between COVENANT_VIOLATION and other variables is generally weak, with all correlation coefficients close to zero. The strongest correlation is between COVENANT_VIOLATION and CF from Investing activities at -0.10496, suggesting a very slight inverse relationship. This indicates that financially robust companies with high CF from Investing and Operating Activities possibly have reduced probability of violating covenants. However, the weak correlations overall imply that covenant violations may be influenced by factors not captured by these financial metrics or that the relationship is non-linear.

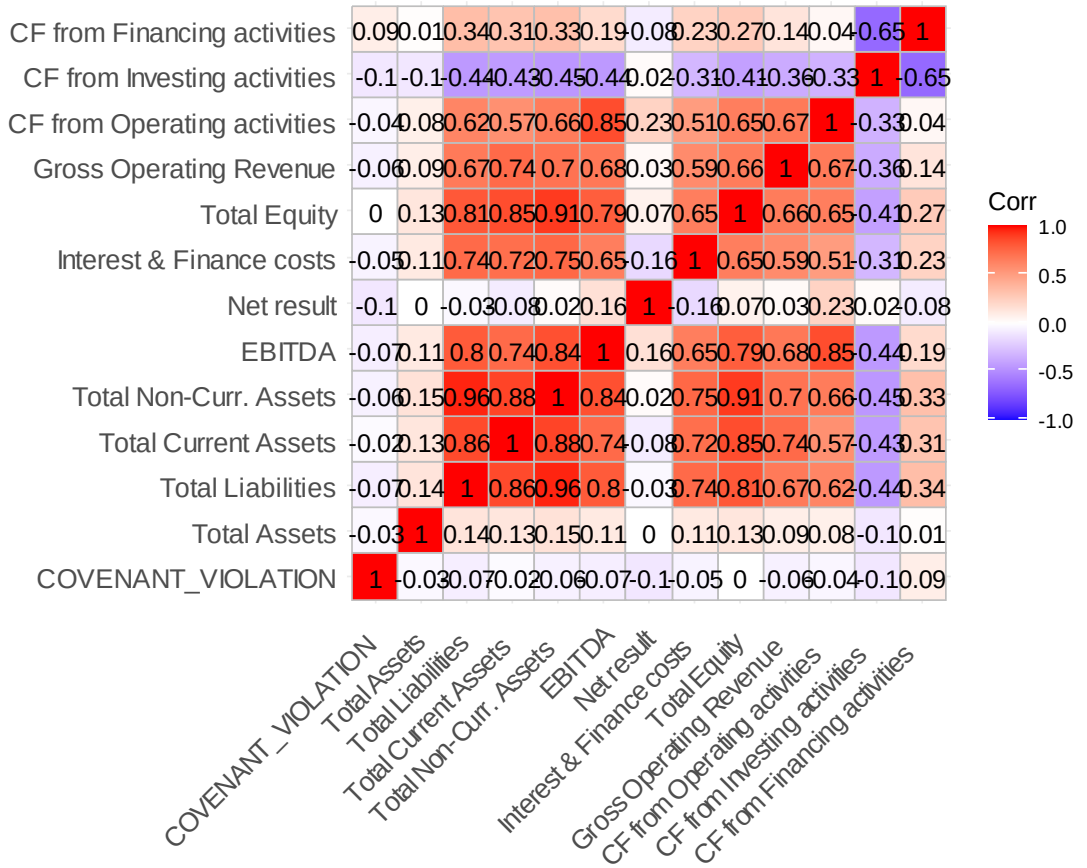
Among the financial variables, several strong correlations are observed, particularly among assets, liabilities, and equity components. For instance, Total Liabilities is highly correlated with both Total Non-Curr. Assets (0.960351) and Total Current Assets (0.862512). This strong relationship is expected, as liabilities typically finance a company's assets, both current and non-current. Similarly, Total Equity is also strongly correlated with Total Non-Curr. Assets (0.913846) and Total Current Assets (0.847756), reflecting the balance sheet identity where equity and liabilities together fund the assets. These strong correlations suggest that any regression analysis involving these variables must account for potential multicollinearity, as including highly correlated variables could distort the results.

EBITDA, a key indicator of a company’s operational profitability, also shows strong positive correlations with several asset and liability components. For example, EBITDA is strongly correlated with Total Non-Curr. Assets (0.843501) and Total Liabilities (0.801368). This suggests that larger companies with more assets and liabilities tend to generate higher EBITDA, which is logical given their larger scale of operations. However, the moderate correlation between EBITDA and Net result (0.16169) is noteworthy; it indicates that while EBITDA and net income are related, other factors (such as interest, taxes, depreciation, and amortization) significantly affect the final net income figure, leading to only a moderate correlation.

The correlation between Net result and other financial variables is generally weak, with the strongest being a negative correlation with Interest & Finance costs (-

0.16432). This negative correlation indicates that higher interest costs are associated with lower net income, which is expected since higher financing costs reduce profitability. However, the relatively low magnitude of this correlation suggests that other factors, such as operational efficiency or revenue generation, play a more significant role in determining net income. The weak correlation between Net result and other variables further emphasizes the complexity of net income, which is influenced by multiple factors beyond simple operational or financial metrics.

Finally, the correlation matrix highlights the relationships between different cash flow components and other financial metrics. CF from Operating activities has a strong positive correlation with EBITDA (0.852674), indicating that companies with higher operating profits tend to generate more cash from operations. Conversely, CF from Investing activities is negatively correlated with most other variables, particularly Total Liabilities (-0.44353) and Total Non-Curr. Assets (-0.45227). This negative correlation suggests that companies with higher liabilities and non-current assets might reduce their investing activities, possibly due to constraints on cash flow or a focus on servicing debt. The strong negative correlation between CF from Investing activities and CF from Financing activities (-0.65407) reflects the typical inverse relationship between these two cash flow components, where companies often finance investments through external financing or reduce investments when financing is constrained.



Graph 1

4.3 Model

Variable	Estimate	Std. Error	z value	Pr(>|z|)
Intercept	-1.798	0.1706	-10.54	<2e-16 ***
Total Assets	-1.9E-10	1.17E-10	-1.634	0.1023
Net result	-1.6E-09	8.26E-10	-1.892	0.0585 .
Interest & Finance costs	4.9E-10	2.68E-09	0.183	0.8548
CF from Operating activities	7.85E-10	1.32E-09	0.596	0.5515
CF from Financing activities	1.14E-09	4.64E-10	2.454	0.0141 *

Table 3: Logistic Regression Coefficients for Covenant Violation Prediction

The logistic regression model has been estimated to predict the likelihood of a covenant violation based on selected financial variables.

- ✓ Intercept: The intercept term is significantly negative (-1.798) with a p-value of less than 2e-16, which is highly significant. This suggests that when all the independent variables are equal to zero, the log-odds of covenant violation are strongly negative.
- ✓ Total Assets**:** The coefficient for Total Assets is -1.912E-10, which is negative, suggesting that as total assets increase, the likelihood of covenant violation slightly decreases. However, the p-value is 0.1023, indicating that this effect is not statistically significant at the conventional 0.05 level.
- ✓ Net Result**:** The coefficient for Net Result is -1.564E-09, also negative, implying that higher net results are associated with a lower likelihood of covenant violations. The p-value is 0.0585, which is marginally significant at the 0.10 level but not at the 0.05 level, suggesting a weak evidence against the null hypothesis that this variable has no effect.
- ✓ Interest & Finance Costs**:** The coefficient for Interest & Finance Costs is positive (4.899E-10), but with a very high p-value of 0.8548, indicating that it is not statistically significant. This suggests that interest and finance costs do not have a meaningful impact on the likelihood of covenant violations in this model.
- ✓ CF from Operating Activities**:** The coefficient for Cash Flow from Operating Activities is 7.849E-10, which is positive but with a p-value of 0.5515, suggesting that it is not statistically significant. This indicates that cash flow from operating activities does not significantly affect the probability of covenant violations.
- ✓ CF from Financing Activities: The coefficient for Cash Flow from Financing Activities is 1.138E-09 and is positive, with a p-value of 0.0141, which is significant at the 0.05 level. This suggests that higher cash flows from financing activities are associated with an increased likelihood of covenant violations. This may indicate that companies relying heavily on external financing are more likely to breach covenants.

Model	Residual Df	Residual Dev	Df	Deviance	Pr(>Chi)
Null Model	622	469.94			
Full Model	617	456.29	5	13.649	0.018 *

Table 4: Likelihood Ratio Test Comparing Null and Full Models for Covenant Violation Prediction

Null Model: The null model, which only includes the intercept, has 622 degrees of freedom (Residual Df) and a residual deviance of 469.94. This model serves as the baseline, assuming no relationship between the predictors and the likelihood of covenant violations.

Full Model: The full model, which includes the predictors Total Assets, Net Result, Interest & Finance Costs, CF from Operating Activities, and CF from Financing Activities, has 617 degrees of freedom (indicating that 5 parameters have been estimated, reducing the degrees of freedom by 5) and a residual deviance of 456.29.

Deviance and Chi-Square Test: The difference in deviance between the null model and the full model is 13.649, with 5 degrees of freedom. The p-value for this test is 0.018, which is significant at the 0.05 level. This result suggests that the full model provides a significantly better fit to the data than the null model. In other words, the inclusion of the predictor variables significantly improves the model's ability to explain the likelihood of covenant violations.

Metric	Value
McFadden's Pseudo R-squared	0.029043
AIC	468.2931
LR	13.64872
p-value	0.0180017

Table 5: Model Performance Metrics for Logistic Regression

McFadden's Pseudo R-squared: The value of McFadden's Pseudo R-squared is 0.02904343, which is quite low. McFadden's Pseudo R-squared is a measure of how well the model explains the variability in the dependent variable (in this case, covenant violations). A value closer to 1 indicates a better fit, while values closer to 0 suggest that the model does not explain much of the variation. With a value of approximately 0.029, this indicates that the model has a relatively weak explanatory power.

Akaike Information Criterion (AIC): The AIC value for the model is 468.2931. AIC is a measure used for model comparison; lower AIC values indicate a better-fitting model. However, AIC should be compared across different models fitted to the same dataset rather than interpreted in isolation. The AIC value helps in evaluating the trade-off between the goodness of fit of the model and its complexity, with lower values indicating models that balance these factors more effectively.

Chapter 5: Conclusions

The nature of the shipping industry is characterized by high volatility and cyclicality, which, combined with the high costs for operations and vessel purchase make the industry very capital intensive. The high costs are usually covered in part by some kind of debt instrument, usually bank loans, because they are relatively cheap and widely available. However, especially after the financial crisis, covenants in bank shipping loans have been especially strict and their violations incur significant costs, with both borrowers and lenders trying to avoid the destructive impact of defaults.

Proactive management strategies based on predictive analysis are crucial in preventing defaults and further financial deterioration. Open communication is important in order to maintain lender relationships, as well as mitigation strategies such as loan renegotiations. Usually, lenders might agree to readjust the terms of the loan, for example extend the repayment schedule or period, alter the interest rate or relax or waiver the covenants relevant to the financial ratios. Another strategy to avoid default is to inject fresh equity or provide additional collateral. Methods of cost control or enhancing operational efficiency and profitability, or even capital restructuring would help the company adhere to the covenants set and also improve its financial health, especially in times of financial difficulties.

Previous studies have documented the impact of both qualitative and quantitative factors, including owners' reputation, background, business commitment, know-how and credit history, as well as their financial position, market share, and fleet composition. However, most of the studies realized in the shipping sector have limited access to longitudinal financial data which limits their predictive capabilities, while also relying on limited linear methodologies.

This study aimed to assess the probability of financial covenant violations among internationally listed shipping companies, focusing on key financial metrics and their relationships with covenant breaches. Through a comprehensive analysis that included descriptive statistics, correlation analysis, and logistic regression modeling, several important insights were gained regarding the financial dynamics within the shipping industry.

The descriptive analysis highlighted significant variability in the financial metrics across the companies studied. The presence of substantial outliers, as indicated by high skewness and kurtosis values, suggested that the shipping industry is characterized by a wide range of firm sizes and financial performances. The data revealed that while some companies possess considerable assets and generate substantial revenues, others operate on much smaller scales, and many experience financial difficulties, as evidenced by negative net results and volatile cash flows.

The correlation analysis provided further insight into the relationships between different financial metrics. Strong correlations among assets, liabilities, and equity components were expected and confirmed the fundamental accounting relationships that exist on company balance sheets. However, the generally weak correlations between the covenant violation indicator and other financial variables suggested that financial covenant breaches might be influenced by a complex set of factors, many of which are not directly captured by the traditional financial metrics analyzed in this study.

The logistic regression model offered a more focused examination of the factors that influence the likelihood of covenant violations. The analysis indicated that certain financial variables, such as cash flows from financing activities, have a statistically significant relationship with covenant breaches. Specifically, higher cash flows from financing activities were associated with an increased probability of covenant violations, suggesting that companies relying more heavily on external financing might be at greater risk of breaching financial covenants. Other variables, such as total assets and net results, while logically expected to influence covenant violations, did not show statistically significant effects in the model, indicating that their impact may be more nuanced or may interact with other factors not captured in this study.

The results of this study underscore the complexity of financial covenant violations in the shipping industry. While certain financial metrics do play a role in predicting covenant breaches, the overall low pseudo R-squared value of the model suggests that much of the variation in covenant violations remains unexplained. This points to the possibility that non-financial factors, such as macroeconomic conditions, regulatory

changes, or industry-specific risks, might also significantly influence covenant breaches.

In conclusion, this study contributes to the understanding of financial covenant violations in the shipping industry by identifying key financial metrics that influence the likelihood of such breaches. However, the findings also highlight the limitations of relying solely on traditional financial metrics to predict covenant violations, suggesting that future research should consider a broader set of factors, including non-financial variables, to develop more comprehensive predictive models. These insights are valuable for both industry practitioners and researchers, as they provide a foundation for further exploration into the financial risks faced by shipping companies and the factors that drive financial covenant breaches.

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Annex

```
# Load necessary libraries
library(readxl)
library(dplyr)
library(ggplot2)
library(caret)
library(rpart)
library(rpart.plot)

# Load the data from the specified path
file_path <- "C:/Users /Downloads/margetas/combined_data.xlsx"
data <- read_excel(file_path)

# Display the column names to understand the structure of the dataset
print(colnames(data))

# Create a new variable to indicate covenant violations
data$COVENANT_VIOLATION <- ifelse(rowSums(data[, c(
  "Did any bank waive the Loan Asset Cover Covenant in the year under review?",
  "Did any bank waive the Minimum Liquidity Covenant in the year under review?",
  "Did any bank waive the Minimum Interest Coverage Ratio in the year under review?",
  "Did any bank waive the Consolidated Leverage (or net leverage) ratio in the year under review?",
  "Did any bank waive the Minimum Net Worth Covenant in the year under review?"
)], na.rm = TRUE) > 0, 1, 0)

# Calculate summary statistics for selected variables
summary_stats <- data %>%
  summarise(
    mean_total_assets = mean(`Total Assets`, na.rm = TRUE),
    median_total_assets = median(`Total Assets`, na.rm = TRUE),
    sd_total_assets = sd(`Total Assets`, na.rm = TRUE),
```

```
    mean_total_liabilities = mean(`Total Liabilities`, na.rm = TRUE),
    median_total_liabilities = median(`Total Liabilities`, na.rm = TRUE),
    sd_total_liabilities = sd(`Total Liabilities`, na.rm = TRUE),

    mean_ebitda = mean(EBITDA, na.rm = TRUE),
    median_ebitda = median(EBITDA, na.rm = TRUE),
    sd_ebitda = sd(EBITDA, na.rm = TRUE),

    mean_net_result = mean(`Net result`, na.rm = TRUE),
    median_net_result = median(`Net result`, na.rm = TRUE),
    sd_net_result = sd(`Net result`, na.rm = TRUE),

    mean_interest_costs = mean(`Interest & Finance costs`, na.rm = TRUE),
    median_interest_costs = median(`Interest & Finance costs`, na.rm = TRUE),
    sd_interest_costs = sd(`Interest & Finance costs`, na.rm = TRUE),

    mean_total_equity = mean(`Total Equity`, na.rm = TRUE),
    median_total_equity = median(`Total Equity`, na.rm = TRUE),
    sd_total_equity = sd(`Total Equity`, na.rm = TRUE),

    mean_operating_cf = mean(`CF from Operating activities`, na.rm = TRUE),
    median_operating_cf = median(`CF from Operating activities`, na.rm = TRUE),
    sd_operating_cf = sd(`CF from Operating activities`, na.rm = TRUE)
  )

# Print summary statistics
print(summary_stats)

# Install and load the knitr package for better table formatting
install.packages("knitr")
library(knitr)
```

```
# Print the descriptive statistics table in a more readable format
kable(summary_stats, format = "markdown")

# Select relevant variables for correlation analysis
selected_vars <- data %>%
  select(`COVENANT_VIOLATION`, `Total Assets`, `Total Liabilities`,
         `Total Current Assets`, `Total Non-Curr. Assets`, `EBITDA`,
         `Net result`, `Interest & Finance costs`, `Total Equity`,
         `Gross Operating Revenue`, `CF from Operating activities`,
         `CF from Investing activities`, `CF from Financing activities`)

# Compute the correlation matrix
correlation_matrix <- cor(selected_vars, use = "complete.obs")

# Print the correlation matrix
print(correlation_matrix)

# Optional: Visualize the correlation matrix
if (!requireNamespace("ggcorrplot", quietly = TRUE)) {
  install.packages("ggcorrplot")
}
library(ggcorrplot)
ggcorrplot(correlation_matrix, lab = TRUE)

# Identify highly correlated variables (> 0.6 or < -0.6)
high_corr_vars <- findCorrelation(correlation_matrix, cutoff = 0.6, verbose = TRUE)

# Exclude highly correlated variables
selected_vars_for_model <- selected_vars[, -high_corr_vars]

# Build the logistic regression model using the remaining variables
```

```
logistic_model <- glm(COVENANT_VIOLATION ~ ., data = selected_vars_for_model,
family = "binomial")


# Summarize the model to inspect the results

summary(logistic_model)
```