Optimal Capital Structure of Deep Sea Foreign Freight Transportation Companies

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SUBMITTED TO THE SYSTEM DESIGN AND MANAGEMENT PROGRAM IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUN 2014

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Submitted to the System Design and Management Program on Mar 6, 2013 in Partial Fulfillment of the Requirements for the Degree of Master of Science in Engineering and Management

Abstract

This thesis aims to understand the optimal leverage range for shipping companies (maritime foreign freight transportation companies - SIC 4412), through data analysis.

This study confirms that in a traditional industry like shipping, the Market value-leverage curve is very similar to the theoretical curve, as proposed by traditional capital structure theories. In comparison to other industries, the trend shows that there is allowance for more debt in shipping, since the optimal capital structure is reached in relatively higher values. Between shipping companies, the study shows that the most definitive factor in determining the optimal leverage is the company type (type of ships owned), and somewhat the year range the company operated. Contrary to other industries, company size does not seem to play a major role in shipping. Data analysis using pure plays (groups of very similar companies) reels trend lines with higher accuracy, indicating the optimal leverage range of certain types of shipping companies. The most consistent result is that for tanker shipping companies, where the optimal leverage range is 65-75%.

Thesis Supervisor: Xavier Giroud
Title: Assistant Professor of Finance and Ford International Career Development Professor of Finance
Acknowledgements

During my studies at MIT, I have benefited greatly from the System Design and Management program (SDM). The entrepreneurial spirit, system thinking culture and course infrastructure of the program has helped me realize my full potential as an engineer, a manager, a designer. I can say that the SDM program was the best academic experience of my life. Therefore, I would like to sincerely thank the director, the staff, the lecturers and my colleagues for boosting my engineering and management skills. I feel privileged to be a member of the elite SDM cohort.

I would like to express my sincere appreciation to my advisor, Assistant Professor Xavier Giroud, for his support throughout my thesis. His effective and 'to the point' teaching style, as a lecturer in course 15.402 (Finance Theory II), inspired me to pursue a finance related thesis in the first place.

I would like to express my gratitude to the Hellenic Navy and the Greek government in general, for sponsoring my studies in MIT. With the new skillset gained from my MIT studies, it is my aspiration to help my country's economy improve and stand on its feet again after the recent financial crisis.

Lastly, I am grateful for my family's unconditional support. Had it not been for my wife's emotional and practical everyday support, I would never have had the stamina and time to study so hard and complete my MIT degrees.
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Chapter 1: Review of traditional optimal capital structure theories

An investment's value depends on leverage

One of the most widely accepted methods for investment valuation is the Net Present Value (NPV) of the investment. First, the investment's projected future cash flows are estimated. Second, the future cash flows are discounted to reflect what they are worth today (time value of money). Third, the discounted cash flows are summed up. This sum is the NPV of the investment.

\[ NPV = \frac{CF_0}{(1+r)^0} + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \ldots \]

NPV: Net Present Value
CF_1: Cash Flow in year i
r: discount rate

The decision rule for investors is to undertake investments with the highest positive NPV.

The discount rate typically used is the 'Weighted Average Cost of Capital' (WACC). The WACC is a weighted average of the expected returns of shareholders and creditors (Higgins, 2012, pp. 305-314).

\[ WACC = \frac{(1-t) \cdot K_D \cdot D + K_E \cdot E}{D + E} \]

t: tax rate
K_D: expected return on debt or cost of debt
K_E: expected return on equity or cost of equity
D: amount of interest-bearing debt in the investment's capital structure
E: amount of equity in the investment's capital structure

Because the NPV is a function of the WACC, and the WACC is a function of D & E (amongst others), the NPV is a function of D & E as well. Therefore, one can expect the nominal value of an investment to change, as D & E changes.

Instead of using both D & E, the financial ratio named leverage will be used:

\[ Leverage = L = \frac{D}{D + E} \]

Damodaran examines how different leverage ratios influence the value of an investment (Damodaran, 1996, p. 247). It can be seen that the investment's value
receives a maximum for a specific leverage ratio. Not only that, but this optimal leverage ratio occurs when the WACC reaches its minimum value.

The WACC is at the denominator of every cash flow fraction in the NPV equation. Hence, the smaller it is, the greater the fractions, the greater their sum. To find this minimum WACC value, one would only need to find where the derivative of WACC with respect to time equals zero:

Using

\[
\frac{D}{D + E} + \frac{E}{D + E} = 1 \implies \frac{E}{D + E} = 1 - \frac{D}{D + E}
\]

we write

\[
WACC = (1 - t) \cdot K_D \cdot \frac{D}{D + E} + K_E \cdot \frac{E}{D + E}
\]

\[
= (1 - t) \cdot K_D \cdot \frac{D}{D + E} + K_E \cdot (1 - \frac{D}{D + E})
\]

\[
L = \frac{D}{D + E}
\]

Then

\[
WACC(L) = (1 - t) \cdot K_D \cdot L + K_E \cdot (1 - L)
\]

and

\[
\frac{d(WACC(L))}{dL} = 0 \implies (1 - t) \cdot K_D - K_E = 0
\]

Therefore, we have the maximum firm value when

\[
K_E = (1 - t) \cdot K_D
\]

Then the minimum WACC is

\[
WACC_{\text{min}} = K_E
\]

The above mathematical calculations are a simple theoretical assessment based on certain assumptions:

- Perfect capital market (with taxes)
- Market value-leverage curve is a concave curve and has only one maximum
- All other factors remain equal while the leverage ratio changes
However, in real capital markets, none of the above assumptions are entirely true. There are no perfect capital markets. The market value-leverage curve may have any shape. Other factors do not remain equal when the leverage ratio changes and these factors influence market value in their own way.

Conditional theories that attempt to explain the optimal capital structure

Modigliani and Miller proved that in a perfect capital market, a firm's value would be independent of its capital structure (Modigliani, 1958). Although this theory is not applicable to real capital markets, it led the way in understanding the main reasons of discrepancy between perfect and real capital markets. Namely, the reasons are taxes, information asymmetry and agency costs.

All theories that exist for the explanation of capital structure are conditional, meaning there is no global theory in existence. In fact, each theory is based on one or more of the three aforementioned reasons for discrepancy. A summary of the classical theories are given by Myers (Myers, Capital Structure, 2001).

1) Tradeoff Theory

In Tradeoff Theory, there are two opposing factors that determine the optimal capital ratio of an investment (Myers, Capital Structure, 2001, pp. 88-91).

The first factor is the advantage of the tax savings that debt interest payments are entitled to. When you finance an investment with debt, the interest payments to the debt holders are tax exempt. In essence, this means that the IRS is paying part of the interest payable to the loaners (liabilities are tax credit for the IRS).

The other factor is the cost of possible financial distress. The risk of default is the inherent downside of debt financing. If a company does not manage to pay back an interest payment, debt holders can demand liquidation of the company’s assets. Expensive legal and administrative procedures between the company's stakeholders take place. Even though declaring bankruptcy does not always mean foreclosure or depreciation of market value, it could very likely lead to it.

Although the first factor (tax savings) is manageable to determine, the second (cost of financial distress) is not as easy to estimate. This being the case, in real company valuation based on Tradeoff Theory, finding the leverage ratio at which the company will have its maximum market value, is not a straightforward calculation.

Tradeoff Theory does not explain the whole picture. There are many firms with very little risk of financial distress, which are underleveraged. In fact, it was
observed that the most underleveraged firms were also the most profitable ones (Myers, Capital Structure, 2001, p. 91).

A coherent extension of Tradeoff Theory recognizes that conflicts of interest between the stakeholders of a firm influence the optimal capital structure of a firm (Myers, Capital Structure, 2001, p. 95). The stakeholders in reference are the managers (agents), debt holders and shareholders. Almost never are the interests of the involved parties perfectly aligned. This leads to other costs, commonly referred to as agency costs. Moreover, on the verge of financial distress, managers potentially react irrationally. Some typical irrational responses are: overinvesting in risky assets, over borrowing, underinvesting, false reporting etc. In conclusion, the costs of financial distress are not determined solely by the legal, administrative and re-organizing costs, but also by other non-linear, unpredictable costs. These costs can act as a negative feedback loop which can alter a company's normal practice managerial decisions, and it can have devastating results. The last can explain why leverage ratios are most times much less than predicted by the traditional Tradeoff Theory: companies avoid taking too much leverage as an insurance shield against these negative effects. While this extended version of the theory captures more truth, it too makes assumptions, one of which is perfect information flow along capital markets. In real markets, this assumption is wrong: managers always know more than investors, and different level managers have different information. Information asymmetry is a fact and cannot be ignored.

2) Pecking Order Theory

Pecking Order Theory captures qualitatively the influence that information asymmetry has on a company's leverage ratio. It is based on the assumption that managers have more information about the firm than investors, and that investors act in a rational manner. It also makes the distinction between the true market value of a firm and the perceived market value by investors.

According to Pecking Order Theory, managers always prefer internal financing to external financing. To the perspective of investors, if managers are seeking external financing, it must mean they are not profitable enough to support their growth through their profits. Therefore managers will avoid external financing, so as not to trigger this perception to investors.

However, if external financing cannot be avoided, managers will prefer debt over equity financing. Investors perceive that managers must be 'selling high', when they are issuing stock. In other words, the true market value is less than the currently perceived market value of the firm. Evidence supports this theory: stock prices fall on average 3% upon announcement of equity issue (Myers, Capital Structure, 2001, p. 92).
The important issue of information asymmetry is partially solved by issuing hybrid securities. For example, the issue of equity which in a specified time period could be converted into debt by the shareholder is a tactic used by many companies nowadays, as a way of 'reassuring' the potential investor that management does not want to 'sell high'.

Lastly, debt has the additional advantage of motivating managers. Staying focused on paying up annual interest keeps managers on track and reminds them of their responsibility to keep the company's cash flows healthy. Certain leveraged buyouts are proof of this tactic. Therefore, debt can sometimes help managers work more efficiently.

3) Theoretical MV-leverage curve

All the above theories are summarized in the figure 1, where the value of a stock changes as the leverage ratio changes.

![Diagram of Theoretical Optimal Capital Structure]

Figure 1: Theoretical Optimal Capital Structure
Chapter 2: Theoretical Assessment of shipping companies' optimal leverage

Maritime is the most cost-effective mode of transport

Maritime transportation is the most effective mode of freight transportation over long distances:

1) Maritime transportation costs less than the other two modes, for the same amount of cargo:

a. It is more energy efficient than air transportation for the same cargo capacity. The natural properties of water create the force of buoyancy, which allows a ship to float. For a moving ship, comparatively limited friction is acted upon. Air transportation imposes even less friction, but significant energy is required for the vehicle to 'float' on air, making air transportation less energy efficient, for the same cargo capacity. However, for high-end cargo transportation, where the high cost of transporting the goods is "worth the money", air transportation has replaced ships, not to mention the dominance of air transportation in passenger traveling.

b. It allows greater economies of scale than ground transportation. Ground vehicles are limited in size from land infrastructure constraints, hence can carry limited amounts of cargo. On the contrary ships can be designed infinitely large, not limited by the oceans infinitely wide highways, only limited by the size of port terminals. For example, today's containerships carry several thousand TEUs (twenty-foot equivalent units), while the largest container truck will carry only two or three.

2) Recent age technological developments have further increased the mechanical efficiency of ships. The era of sailing ended with the development of internal combustion engines, a technology which allowed on-demand sea propulsion. Today's ships don't have to wait for the optimum wind direction to set sail, but travel towards any destination, whenever desired. Furthermore, the development of Global Positioning and Monitoring technology allowed the tracking of a ship's position with unprecedented accuracy. Due to this accuracy, ground transportation no longer has the advantage of better position tracking and monitoring over water transportation.

3) Trade routing and logistics have improved significantly. With the opening of the Suez and Panama canals, international trade routes have become shorter, allowing ships to bypass entire continents to deliver cargo. In
addition, modern day Information Technology has made communication between involved stakeholders instant and distance independent.

The aforementioned facts are the main reasons why maritime freight transportation prevails over other modes of transportation. This is why at least 90% of world trade occurs through maritime shipping.

Overview of the shipping industry

The product of the shipping industry is transport. Since there are many different types of goods to be transported, there are several types of freight transportation shipping companies.

The differentiating factors between competitors in the industry is determined by price, speed of transportation, reliability (quality of service) and security (intact cargo).

The inventory of maritime transportation companies are mainly ships. Ships are expensive assets to own and operate, hence shipping companies have high capital and operating costs. The main driver for the latter are fuel costs and port fees. The high terminal costs that ships pay can be explained by the fact that ports, like ships, are also very expensive to build and maintain (Stopford, 2009, p. 225).

The main players in the shipping industry are shippers, ship owners, brokers, shipbuilders, bankers and regulators.

The shipping industry has always been a cyclical industry. There are different types of cycles, depending on their average period: long, short and seasonal. Long cycles can last several decades, short cycles for about a decade and seasonal cycles for years (Stopford, 2009, pp. 94-100).

Hypothesis 1: MV-leverage curve shape and optimal leverage range

The hypothesis is that the industry’s MV-leverage curve will be very similar to the theoretical model of figure 1. In addition, it is expected that shipping will have a greater optimal leverage ratio than the cross-industry average.

Ocean freight transportation is a mature and traditional industry, one for which economists’ theoretical demand and supply models come very close to representing reality. There is no reason why maritime freight transportation companies’ MV-leverage trends should be extremely different than the theoretical models. The MV-leverage curve is expected to be very similar to the concave curve of figure 1.
The optimal leverage range (the maximum of the curve) is expected to be relatively high. Ocean shipping is not the most volatile of industries. Though it is a cyclical industry, cycles last several years, so a trend can be identified early on, and managerial actions can be taken to avoid the downside. According to the *Extended Tradeoff Theory*, we expect extra costs of financial distress, from irrational managerial responses. But these extra costs cannot be worse than those inherent in more volatile and risky industries. In addition, maritime shipping companies own expensive tangible assets. Therefore, they are a safer bet for lenders, relative to companies that have no tangible collateral, for example a company in the IT sector. Thus, in comparison to cross-industry average, we expect to find a higher optimal leverage ratio.

**Hypothesis 2: most important factors for the optimal capital structure of a shipping company**

The hypothesis is that three factors will play a major role in determining the optimal capital structure of a shipping company:

1. Year of operation (timing or general trend of the industry at the time).
2. Company size.
3. Company type.

1) The first factor that should influence the capital structure will be the growth or decline trend of the industry at the time. Specifically, at times of growth, we should expect higher leverage ratios.

According to *Pecking Order Theory*, the ship owner will prefer financing growth with debt rather than equity. Of course, the first preference of all would be internal financing. However, assuming the ship owner is only involved in the freight transportation market and not in the sales and purchase market (purchasing ships at low and selling at high), internal financing alone will not be enough to grow assets in times of industry growth.

In times of growth, ship owners would not have a hard time financing their growth with debt. Moreover, we expect the cost of debt to be more affordable in times of growth than in times of decline. In times of growth, there is less risk of bankruptcy, because cash flows should be sufficient to pay off interest payments.

2) The second factor expected to play a major role in determining optimal capital structure is company size. The larger the company, the larger the optimal leverage ratio.

Large companies have an easier time securing loans, since they are a safer investment for banks. They have more market share than smaller companies, and thus are less likely to default. But in case of bankruptcy, they can negotiate better
terms, because they have more influence on the market than smaller companies do. Therefore, it is expected that larger shipping companies will have a different optimal capital structure than smaller ones.

3) The third factor is the type of freight they are transporting. Two shipping companies transporting different types of freight essentially means that the companies are in a totally different business. For each type of company, there should be a different optimal leverage.

For example, LNG and containership markets are realizing growth at this time, so it is easier for a company involved in these markets to secure and pay off loans. Not the same can be said for bulk and tanker companies. The optimal leverage for companies within a freight market that is growing is expected to be higher.
Chapter 3: Data Analysis

Thus far a qualitative assessment has been made, in order to theorize on the optimal capitol structure expected trends of ocean shipping companies. But, in order to appreciate the actual trends, and put the theories to the test, analysis of real data is necessary.

Data preparation

Data analysis was based on 599 points of data gathered through the data base of Compustat, offered by University of Pennsylvania on their website WRDS (Wharton Research Data Services), accessed through the MIT libraries website. The data includes all companies with SIC (Standard Industry Classification) 4412 (Deep Sea Foreign Transportation of Freight), from 1980 until today.

Each data point contains information on the market value and leverage of a specific company name for a given year of operation. Leverage is defined as Long Term Debt/Assets Book Value. In Compustat the symbols for these variables are DLTT and AT respectively. The company’s market value is calculated as follows:

\[
\text{Market Value} = \text{Market Value of Equity} + \text{Liabilities}
\]

Liabilities is under the symbol LT in Compustat. The Market Value of Equity was calculated as

\[
\text{Market Value of Equity} = \text{Common Shares Outstanding} \times \text{Share Price}
\]

The share price was taken as the price close of the company’s stock in the last day of the annual calendar, PRCC_C in Compustat. The symbol of common shares outstanding in Compustat is CSHO.

Data refinement was necessary. This meant conducting research, adding information and categorizing the data through filters:

- I conducted research on all the companies present in the database and recorded basic information about their business profile. Most importantly I found out the type of ships they owned.

- I added information that was necessary to create the graphs: calculated the leverage ratio, defined as Long Term Debt/Assets Book Value.

- I created filters that would allow the categorization of data. The filters are based on the criteria presented in the table below.
Filter ID | Criterion | Values | Abbreviations | Ranges/Notes |
---|---|---|---|---|
A | Company size ($Millions) | small, medium, large | S, M, L | MV<$10M $10M<MV $1B<MV |
C | Company type | Bulk, Tankers, Containerships, LNG, Diversified and Other | B, T, C, L, D, O | Category Diversified refers to companies that own several different types of vessels but mainly bulk and tankers. Category Other refers to companies that own other types of vessels not covered by the existing categories, such as offshore supply vessels or tug boats etc. |

Table 1: Filters for data categorization

The criteria I used are based on Hypothesis 2 of Chapter 2, which is that these are the main factors that influence the optimal capital structure. Although this is an educated hypothesis, it remains a subjective one. It is not unlikely that there may be a better categorizing of the data, with other factors considered, that would reveal a more accurate pattern (better $R^2$). This is a potential motivation for future work on the topic.

Data categorization

To better understand the data, the charts that follow were created. The information presented in the charts conveys the categories that will gather most attention when trying to reach a final conclusion and a decision rule.
Figure 2: Companies by type of ships owned

Figure 3: Companies by Year of Operation
Figure 4: Companies by Size (Market Value)

Figure 5: Companies by Size (Market Value) - more increments
These charts visually present important information about the data in hand:

- Most of the companies own bulk, tankers or both (diversified), as seen in figure 2. In total, nearly 70% of the data consists of companies owning bulk or tankers.
- Most of the companies are either medium or large in size and specifically between $10\ M$ and $10000\ M$, as seen in figure 3. In fact, nearly 80% of the data consists of companies of $100\ M$ or more, as seen in figure 4.
- Most of the companies operated after 1990, observed in figure 5.

As mentioned before, the charts above indicate which categories and sub-categories matter when it comes to data analysis. This acts as a guide to impose certain filters, those which will yield a meaningful outcome.

Data analysis was carried out using excel. An excel sheet contained the refined data, as well as a central dynamic graph. The graph was dynamic because the output would change by imposing various filters on the data. The filters were based on the categorization of table, in order to obtain a trend line and $R^2$ for each case.

The trend curve type used was that of a third degree polynomial, because amongst all other types of curves available in excel (polynomials of other degree, logarithmic, linear etc.), the third degree polynomial always had the highest $R^2$. Having a highest $R^2$, the third degree polynomial gives a more accurate trend line to fit our data.


Data Analysis without filters

Before imposing filters, the data has been analyzed without them. Using all data, with no filters, the resulting trend line is shown in the figure below.

The resulting trend line has a coefficient of determination of 7.2%. This value of R² is not discouraging. It indicates that there is a trend line with which we can explain 7.2% of real world shipping company data. Even more, this curve looks very similar to the theoretical curve of figure 1. It is therefore a good start for this analysis.

To get a better estimate of the trend, I have grouped the data into 'bins', and calculated their regional average. Each bin contains all data that belong to a specific range of leverage ratios. For example, a bin between 8% to 9% leverage, contains market values of various data that correspond to leverages between 8-9%, and result in an average market value of $34.68 M.

Depending on the bin range, the results are different.
Figure 7: Data Averages Graph, All Data, Using Bins of 1% size

Figure 8: Data Averages Graph, All Data, Using Bins of 2% size
From the above three graphs, the following observations can be made:

- The general trend is consistent in all three curves. The curves look very similar.
- There is a maximum, which is reached in the leverage range 55-65% in all three curves.
- \( R^2 \) is much higher than in the initial graph. The best \( R^2 \) is reached in the second graph, where the bin size is 2%.

**Data Analysis with filters**

By imposing filters, only certain data feed into the dynamic graph. For example, by including only companies that own bulk ships, we are only analyzing and plotting data specific to bulk shipping companies. This categorization of data allows a more focused perspective, and allows for a better understanding of the results.

Most of the filters of Table 1 have been applied to the analysis. Those that have not been applied, unravel a category which is not important to the analysis. For example, the sole LNG company in the data is not a sample representative of the LNG industry, therefore the MV-leverage graph for LNG companies will not be presented in this study.
1) Data analysis with filter C (type)

The following graphs are with the filter of ship type. As mentioned, only types which contain a large enough sample are presented.

Figure 10: Bulk Shipping Companies
Figure 11: Tanker Shipping Companies

Figure 12: Container Shipping Companies
Figure 13: Diversified Shipping Companies

Figure 14: Other Shipping Companies
Observations made from the above graphs:

- There are differences between the trend lines for each type, not only in the shape of the curve, but also in the optimal leverage. Some of the trend lines have an 'S' shape. However, we can omit the left part of the 'S', specifically the part that is left of the annotated red line, because that part of the line is generated by very few sample data points. Another reason why this part should be omitted is that it is logically wrong. For example, in the trend line of containership company data, having leverage of 30% and 5% cannot logically result in the same market value for the same company.

- The optimal leverage is different for each type of company, as can be seen in the table below.

- The accuracy of the trend line is different for each type of company. This can also be seen in the table below. It appears that data belonging to Containership and Other type of companies have a higher $R^2$, and thus a more consistent trend than the rest.

<table>
<thead>
<tr>
<th>Company type</th>
<th>Optimal leverage range</th>
<th>Trend line accuracy ($R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk ships</td>
<td>35%-55%</td>
<td>6%</td>
</tr>
<tr>
<td>Tankers</td>
<td>60%-80%</td>
<td>7%</td>
</tr>
<tr>
<td>Containerships</td>
<td>60%-80%</td>
<td>20%</td>
</tr>
<tr>
<td>Diversified</td>
<td>50%-70%</td>
<td>10%</td>
</tr>
<tr>
<td>Other</td>
<td>15%-35%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Table 2: Optimal leverage range for different types of companies
2) Data analysis with filter A (size)

Figure 15: All small size shipping companies

Figure 16: All Medium Sized Shipping Companies
From the above graphs, the following observation can be made:

- Very few data points are available for small companies. From the available data, most small shipping companies have zero leverage, which can be seen in the first graph.
- Medium and large shipping companies have an optimal leverage between 50%-70%.
- Medium and large categories present two different curves, but both concave.

This information is summarized in the table below.

<table>
<thead>
<tr>
<th>Companies by Size</th>
<th>Optimal leverage range</th>
<th>Trend line accuracy (R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (MV&lt;$10M) - very few data points available</td>
<td>0%</td>
<td>14%</td>
</tr>
<tr>
<td>Medium ($10M&lt;MV&lt;$1B)</td>
<td>50%-70%</td>
<td>9%</td>
</tr>
<tr>
<td>Containerships ($1B&lt;MV)</td>
<td>50%-70%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Table 3: Optimal leverage range for different size ranges
3) Data analysis with filter type B (year of operation)

Figure 18: All Data before 1990

Figure 19: All Data between 1990 and 2000
Observations from the three graphs:
- Less data points are available before 1990 in comparison to the data points after 1990.
- $R^2$ values for companies operating between 1990-2000 and after 2000 are very close. The optimal leverage differs, being in the range of 40%-60% for the first period and in the range of 55%-75% for the second.

The above observations are summarized in the table below.

<table>
<thead>
<tr>
<th>Companies by year of operation</th>
<th>Optimal leverage</th>
<th>Trend line accuracy ($R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1990</td>
<td>30%-50%</td>
<td>52% (less data points available)</td>
</tr>
<tr>
<td>1990-2000</td>
<td>40%-60%</td>
<td>5%</td>
</tr>
<tr>
<td>2000-today</td>
<td>55%-75%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 4: Optimal Leverage for different year range
Data Analysis using pure plays

Thus far, the categorization and analysis of data has been performed using one filter. All the MV-leverage curves up to this point contain companies that are similar in the sense of only one characteristic: either they have the same type of ships, or the same size range, or they have operated in the same year range. This is effective for obtaining a general sense of understanding of the industry, as well as zooming in one layer down.

To gain a more specific insight, or in other words to zoom in one more layer, detecting and analyzing pure plays is necessary.

First, pure play shipping companies must have the same type of ships, they must have relatively the same size and must have operated in close year ranges. To find such companies, I imposed combined filters.

The filters for the types of ships and year ranges remain the same, but the size filter has been changed. I consider a shipping company to be pure play with another, when it has similar Assets Total (AT). Furthermore, because no company AT remains constant in time, pure play companies have a similar growing trend, therefore a similar AT change in time.

With the above criteria in mind, I identified pure plays and they are summarized in the table below. Included in the table below is the Optimal Leverage range and the $R^2$ of the trend line. The Pure Play groups are organized in descending market value range, in every group. For example, Pure Play group 1 contains the largest bulk companies, and group 4 contains the ones with the smallest market value. Due to the fact, that most companies operated after 1990, and many of them continued until 2012, the year range filter did not differentiate companies very much.

* Pure play companies are companies that are similar in all their aspects. Analyzing pure plays is, in essence, an ‘apples to apples’ comparison.
### Table 5: Summary of data analysis using pure plays

<table>
<thead>
<tr>
<th>Company type</th>
<th>Pure Plays Group No.</th>
<th>Company Names</th>
<th>Optimal Leverage Range</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Ships</td>
<td>1</td>
<td>EXCEL MARITIME CARRIERS LTD</td>
<td>50-70%</td>
<td>33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NAVIOS MARITIME HOLDINGS INC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GENCO SHIPPING &amp; TRADING</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>DIANA SHIPPING INC</td>
<td>15-35%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EAGLE BULK SHIPPING INC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>QUINTANA MARITIME LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NAVIOS MARITIME PARTNERS LP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>TBS INTERNATIONAL PLC</td>
<td>10-20%</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STAR BULK CARRIERS CORP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEANERGY MARITIME HLDGS CORP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>FRESEAS INC</td>
<td>45-65%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BRITANNIA BULK HOLDINGS INC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BALTIC TRADING LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GLOBUS MARITIME LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tankers</td>
<td>5</td>
<td>OVERSEAS SHIPHOLDING GROUP</td>
<td>65-75%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FRONTLINE LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TEEKAY OFFSHORE PARTNERS LP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>OMI CORP</td>
<td>65-75%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GENERAL MARITIME CORP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSAKOS ENERGY NAVIGATION LTD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>TEEKAY TANKERS LTD</td>
<td>65-75%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NAVIOS MARITIME ACQUISITION</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>STEALTHGAS INC</td>
<td>65-75%</td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DHT HOLDINGS INC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>OMEGA NAVIGATION ENT INC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1) Bulk pure plays

<table>
<thead>
<tr>
<th>Container ships</th>
<th>SCORPIO TANKERS INC</th>
<th>CRUDE CARRIERS CORP</th>
<th>Market Value vs. Leverage Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>SEASPA N CORP</td>
<td>DANAOS CORP</td>
<td>55-75% 23%</td>
</tr>
<tr>
<td>10</td>
<td>GLOBAL SHIP LEASE INC - OLD</td>
<td>DIANA CONTAINERSHIPS INC</td>
<td>40-60% 21%</td>
</tr>
<tr>
<td>Diversified</td>
<td>No Pure Plays were identified in this category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>GULFMARK OFFSHORE INC</td>
<td>SEACOR HOLDINGS INC</td>
<td>15-35% 22%</td>
</tr>
</tbody>
</table>

Figure 21: Pure Play Group No. 1

\[ y = -19824x^3 + 18618x^2 - 1233.8x + 77.857 \]
\[ R^2 = 0.33264 \]
Figure 22: Pure Plays Group No. 2

Figure 23: Pure Plays Group No. 3
Observations:
- The trend is more consistent for bulk shipping companies of very large and very small size, seen by the higher $R^2$ of groups 1 and 4.
- On the contrary, it is less consistent for groups 2 and 3, where a less solid conclusion can be reached.
2) Tanker pure plays

![Market Value vs. Leverage Graph](image)

Figure 25: Pure Play Group No. 5

![Market Value vs. Leverage Graph](image)

Figure 26: Pure Play Group No. 6
Figure 27: Pure Play Group No. 7

Figure 28: Pure Play Group No. 8
Observation from the graphs:
- Optimal leverage range is the same across all Pure Play groups.
- On average, accuracy is very good.

3) Container pure plays
Observations:
- Different optimal leverage ranges. Group with larger sized companies has higher optimal leverage range.
- Accuracy is almost the same for both groups.
4) Other pure plays

Market Value vs. Leverage Graph

Observations:
- Low optimal leverage ratio.
- Good accuracy.
Chapter 4: Conclusions/Recommendations

Data validation

In general, the sampling population and data information was enough to draw conclusions. This cannot be said for:

- LNG type shipping companies. Only 13 data points belonging to 1 company were available.
- Smaller size shipping companies. Only 15 data points belonging to shipping companies with MV<$10 M were available.
- Fewer data are available for companies before 1990. However they are enough to draw some conclusions.

Therefore, we cannot infer anything for LNG and smaller size shipping companies from the data analysis of Chapter 3.

Conclusion 1: Data analysis confirms theoretical models and some hypotheses

The results of the data analysis are consistent with the theory, hypothesis 1 and the major part of hypothesis 2.

Figure 6-9 confirm the theoretical MV-leverage curve of Figure 1. Although the $R^2$ values of the trend lines in these figures are not acceptable with the traditional statistical requirement of $R^2>95\%$, they are acceptable values for the analysis of real data. For example, the equation of Figure 8, has the $R^2$ as 44\%, therefore the trend line equation can explain up to 44\% of real data, which is a very positive result. Moreover, the shape of the curve looks very similar to the curve in Figure 1.

On average, the optimal leverage for shipping companies is between 40-70\%, a very high ratio compared to 20\%, which is the mean leverage of Publicly Traded, Non-financial US companies from data taken between 1950-2003 (Frank & Goyal, 2009, p. 13). Thus, hypothesis 1 is confirmed (on average).

Regarding hypothesis 2, clearly the type of ships owned is a very important factor in determining optimal leverage, evident in Figure 10-14. Tankers and containerships have a greater optimal leverage, on average. Diversified companies do not fall far behind, and bulk companies follow. The specific values are shown in Table 2.

Companies belonging in the ‘Other’ category have a very small optimal leverage, which is not consistent with the industry’s average. These companies own mostly offshore supply vessels and tugboats. They are essentially contractors of large offshore oil companies. Companies in the ‘Other’ category are second-tier shipping
companies, more volatile to shipping cycles than first-tier companies. A decrease in shipping demand will cause a revenue decrease for the first-tier, but it will cause an even greater decrease for a second-tier company. This may explain why these type of companies prefer to have less debt, so as to avoid the risk of bankruptcy in times of 'demand drought'.

On the contrary, Figure 15-17 indicate that market size is not as influential for shipping companies that have a market value of at least $10 M. For companies with a market value below $10 M, there are not enough data points to draw any conclusions. This may be due to the fact that small sized shipping companies (owning one or two ships) are mostly private.

As for year of operation, Figure 18-20 indicate an increase in the optimal leverage range from 1980 to today. This can be explained by the fact that the amount of cargo trade via the sea nearly doubled from 1980 to 2008 (Stopford, 2009, p. 120). More and more shipping companies emerged in the shipping industry to take advantage of this growth, and banks were willing to support more and more leverage as the years went by, until 2008 (start of decline in shipping cycle).

Conclusi on 2: Pure Play Analysis gives further insight

Data analysis using pure plays re e s results with higher accuracy. For example, if we compare Table 1 with Table 5, we notice much greater R² values in the second. The reason this is happening is because in the data analysis using pure plays, we are comparing 'apples to apples'. By comparing companies with similar characteristics we have a greater chance of observing a pattern. Hence, using pure plays proved to be the most effective way to organize the data in this study.

1) Bulk shipping pure plays (groups 1-4)

Apart from group 1, the other pure plays in this category make is hard to draw any conclusions for bulk shipping companies in general: group 2 data cluster around three points in Figure 22 and the rest of the groups have very few data points as seen in Figure 23-24.

It seems that large bulk shipping companies from our data base have a higher optimal leverage ratio than the other bulk shipping companies. This is not consistent with the finding that company size is not an important factor, but this may be the case for bulk companies. Figure 21 reveals this pattern for group 1. There is a clear preference for higher leverage ratios by the companies in this group, and the optimal leverage is higher than all other groups in this category. Group 4 has fewer data points, but with an equally good R², and with a slightly lower optimal leverage.
2) **Tanker shipping pure plays (groups 5-8)**

Tanker pure plays make it more convenient to draw conclusions, perhaps excluding group 7, which has too few data points to reach conclusions. Not only are all the optimal leverage ranges the same for all groups, R² values are also very good. It would not be illogical to recommend to a tanker company to stay within the leverage range of 65-75%, in order to have the maximum market value. At least, on average, this is what is observed from the data analysis.

3) **Container shipping pure plays (groups 9-10)**

Figure 29 has very few data points and does not lead to conclusions. On the other hand, figure 28 reveals a clear pattern, with a good R². It can be recommended to container shipping companies to stay within a 55-75% leverage range. Notice that a larger range was recommended here, because there is only one pure play group available for this category. However, the two companies that form this group have been very successful and have survived through many shipping cycles (so they must be doing something well).

4) **‘Other’ shipping companies (group 11)**

The two companies that form this group own and operate offshore supply vessels and tugboats. It is evident that these shipping companies cannot afford as much debt as the other categories, and the proposed reason was analyzed in page 38 of this study. Many of these companies are private, because they are too small to go public. The recommendation for companies in this category is to stay at a lower leverage level, 15-35%. Again, the proposed leverage range is larger, because the conclusion is drawn from only one pure play group.
Final Recommendations

Compared to other industries, shipping companies can afford to undertake more leverage. The main reason for this is that shipping companies have tangible, expensive assets as collateral. In addition, contrary to expectations, there is no indication from the data that company size plays a significant role in the optimal leverage ratio. In other words, even though we would expect larger companies to have a higher optimal leverage, it seems that is not the case for shipping.

It is recommended that tanker shipping companies undertake leverage within the range of 65-75%. This is indicated both by data analysis using filters and pure plays. It is the most consistent of findings in this study, based on the number of pure play groups that are available.

Container shipping companies can also afford a leverage of around 55-75%, while bulk companies should aim for a lower leverage, around 35-55%. There is no solid conclusion for diversified companies, since the level of diversification can differ for each one. Lastly, offshore supply and tugboat companies should aim for an even lower leverage ratio, around 15-35%.

Disclaimer: all recommendations in this study are made based on findings from the data analysis. However, the findings of this study are generic, based on statistical results and do not necessarily apply to each individual firm. In addition, these recommendations are based on data from the past, which is never a guarantee for future outcomes.
Bibliography


