THE EFFECTS OF UNDERWRITING
AND
RESERVING TECHNIQUES
IN INSURANCE OF SHIP FINANCING

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Submitted to the Institute for Graduate Studies in
Science and Engineering in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy

Graduate Program in Maritime Transportation and Management Engineering

Piri Reis University

2017

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DATE OF APPROVAL: 20.04.2017

ACKNOWLEDGEMENTS

This thesis has been prepared in fulfillment of the requirements for both the Ph.D. degree in Maritime Transportation and Management Engineering at Piri Reis University.

In the process of writing my thesis, I challenged myself with the assignment to explain underwriting and reserving effect by using factors which shipping finance insurers can better manage the creditworthiness risk that insurance companies face resulting from financial and underwriting volatility. I am happy with the results of my thesis, showing effects on multiple levels of analysis. I expect that this thesis will provide insights which can be used by shipping finance and insurance companies to support their choice. The work has been carried out in the period from March 2014 to Apr.2017 under the supervision of Professor Dr. Erhan ASLANOĞLU and Professor Dr. Sander ÇALIŞAL and Professor Dr. Süleyman ÖZKAYNAK at Piri Reis University, Istanbul, Turkey.

First, I would like to express my gratitude to my advisor, Prof. Dr. Erhan ASLANOĞLU, for his continuous support. I am also thankful to him for helping me complete the writing of this thesis as well as the challenging research that lies behind it.

Special thanks goes to my committee member, Prof. Dr. Sander ÇALIŞAL, Prof.Dr. Süleyman ÖZKAYNAK, Prof. Dr. Taner BERKSOY, Prof. Dr. S. Kaya ARINÇ, Prof. Dr. Dündar Murat DEMIRÖZ and Doç. Dr. Erkut AKKARTAL whom has been always there to listen and to give advice. I am deeply grateful to them for the long discussions that brought out the good ideas in me.

I want to thank to my sister Cansel ERKMEN TOYGAR for providing me with endless encouragement and for being a very best friend. Last but not least, my deepest gratitude is to my wife Marie ERKMEN and my children, Christopher ERKMEN and Nicole ERKMEN, whose unconditional love, concern, and support endowed me strength to complete this thesis. Especially through the hard times that I was away from them. Finally, thank you again to all those people who have made this thesis possible.

FOREWORD

The aim of this thesis is to investigate about the quantitative models used for pricing and managing shipping finance insurance risks. It was done analyzing the existing literature about methods and models used in the insurance field in order to developing new stochastic models for default risk and new pricing functions for shipping finance insurance policies.

Ship finance insurance is an evaluation of the ship owner's payment guarantee by the insurance company, typically the insurance company will give guarantee to the debtor's approved lender. Shipping finance risk can be defined as the deviations of the fair value of ship and debt obligations between expectations and realizations relating to the different factors that affect the value of its cash flow. Ship Finance insurance mathematics is perhaps the most interesting and challenging field at the line of modern actuarial and financial mathematics. It is the intention of this Ph.D. thesis to examine and understand some particular aspects of modern ship finance insurance which have not yet been sufficiently considered. Perhaps this work can make the gap of open questions, but also the gap between financial and actuarial mathematics, a little bit smaller.

By focusing on the results of financial models, including percentile distributions, I will try to identify potentially unacceptable results, and test alternative strategies and assumptions in an attempt to increase the likelihood of acceptable financial and operating performance. The output of a financial statement analysis simulation consists of a large number of random replicates for several output variables, which implies the need for sophisticated analysis and presentation techniques in order to be able to draw sensible conclusions from the result.

ABSTRACT

The Effects of Underwriting and Reserving Techniques in
Insurance of Ship Financing

The subject of this thesis is the effect of underwriting and reserving techniques in insurance of ship finance and based on this approach to analyzing insurer financial risks. We focus on a very specific application of actuarial science – to propose a new dynamic tool to the risk management industry for calculating probabilities of default and the relationship between underwriting and reserving risks which define the premium for ship finance insurance companies. Insurance is included in shipping finance is crucial for the financier for the financier to obtain as little credit as possible and we examine how the financing ship is sufficiently protected by the ship finance insurance.

The main idea behind presenting this thesis is to propose a dynamic approach which can be widely used in ship finance insurance for obtaining probability of default. My approach delivers confidence intervals for the probability of defaults of each rating grade. The probability of default range can be adjusted by the choice of an appropriate confidence level.

Based on a sample of 298 listed shipping companies in the world, we analysis whether they follow a target capital structure and examine the dynamics of capital structure changes succeeding to distresses in leverage. We have analyzed the financial information based on the results ending at companies' fiscal year of all shipping companies since 2011 till at the end of 2016, according to their financial statements. Ratios of complexity provide a view of the profitability in terms of percentages. This will be useful when comparing firms and default ratios over time within shipping industry.

Keywords: Ship finance insurance; Risk-adjusted value of underwriting; Reserve effects; Underwriting effects; Credit rating; Default.

ÖZET

Gemi Finansman Sigortasında Aktüerya ve Karşılık Ayırma Tekniklerinin
Sigorta Prim Hesaplamasına Etkisi

Bu tezin konusu, gemi finansman sigortasında aktüerya ve karşılık ayırma tekniklerinin sigorta prim hesaplamasına etkisi ve finansman sigortasının karşılaştığı finansal risklerin analiz edilmesidir. Aktüerya biliminin çok özel bir alanı olan gemi finansmanı sigorta yöntemi, sigorta şirketlerinin risk yönetiminde kullanabilecekleri yeni bir dinamik yaklaşımdır. Bu model denizcilik firmalarının kredi ödemelerinde yaşayacakları zorlukların sigorta prim hesaplama ve karşılık ayırma teknikleri üzerindeki etkilerini incelemektedir. Gemi finansmanı sırasında istenen gemi finansman sigortası, kredi sağlayanlar açısından geri ödemelerde doğabilecek riski en az seviyede tutulmasında önem arz etmektedir. Bu tezde gemi finansman sigortasının kreditörlere sağladığı koruma incelenmiştir.

Bu tezin temel hedefi, gemi finansmanı sigortasında kredi ödemelerinin zamanında yapılmaması olasılığına karşı yaygın bir şekilde kullanılabilecek bir dinamik model oluşturmaktır. Oluşturduğumuz model ile, her kredi notuna göre farklı güven aralıkları analizi yapılmakta ve kredilerin zamanında ödenmeme riski ise farklı güven aralıkları seçilerek hesaplanabilmektedir.

Hesaplamalarımızda kullandığımız verilerin tümü dünyada halka açık olan 298 denizcilik şirketinin mali tablolarının incelenmesi ile oluşmaktadır. 2011 ve 2016 dönemi arasındaki halka açık denizcilik şirketlerinin tamamının mali tablolarına göre finansal verileri incelenerek rasyo analizleri yapılmıştır. Kullandığımız model denizcilik firmalarının kredi ödemelerinin zamanında yapamayacaklarının yüzdesel ifade edilmesini sağlamaktadır. Bu çalışma denizcilik firmalarının finansmandan doğan borç ödeme risklerinin analizini sağlamaktadır.

Anahtar Kelimeler: Gemi finansman sigortası; Riske göre düzeltilmiş değer; Rezerv Etkileri; Değerleme etkileri; Ödeme riski.

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1 INTRODUCTION

insurances involved in ship finance are of vital importance for the lender to achieve as small credit risk as possible and we examine how the vessel loan is adequately protected by way of ship finance insurances. The ship financier will wish to minimize the credit risk by having the vessel as collateral security for the loan. However, the ship itself, and consequently the ship financier ’s security is exposed to several perils. The ship may become a total loss, in which case the loan becomes worthless or particular damage may render the vessel unemployed, which impairs the borrower’s ability to repay the loan. The ship owner’s financial position may deteriorate as a consequence of third party liability, e.g. for collisions or pollution, and if the third-party claim gives rise to a maritime lien the ship financier ’s position is directly threatened since the lien outranks the loan. A lender minimizes his exposure to such risks by requiring the borrower to take out insurances, from which also the lender benefits.

The practice of underwriting refers to the process of accepting or rejecting risks. It achieves this by first looking at where insurance fits into the ship financing structure and what the parties involved want from ship finance insurances. Insurance underwriting risk is the risk that an insurance company will suffer losses because the economic situations or the occurring rate of incidents have changed contrary to the forecast made at the time when a premium rate was set. Ship finance insurance is designed to cover non-payment of loan interest and principle payments. Ship Finance insurance is an evaluation of the ship owner’s payment guarantee by the insurance company, typically the insurance company will give guarantee to the debtor’s approved lender. Shipping finance risk can be defined as the deviations of the fair value of ship and debt obligations between expectations and realizations relating to the different factors that affect the value of its cash flow. In a ship finance loan transaction, the borrower is generally required to purchase insurance and thereby becomes the named insured under the policies issued. As the lender wants to protect its collateral and itself as well, the lender should ensure that it has the proper insured status under the policies as well. It is extremely important that a lender protect itself and its ship in any lending transaction, and therefore lenders should always require that borrowers adequately insure their ship and protect themselves against potential liability through purchasing insurance. As part of their due diligence, lenders should conduct a thorough review of the required coverages to ensure that borrowers have purchased the types and amounts of insurance required under the loan documents. Lenders should look to ensure that the appropriate supports are in place to ensure that in the event of a loss the lender will be protected. For the ship financier, the ship's value as security has two dimensions. Firstly, it serves as security in the case the borrower defaults under the loan agreement. Secondly, the ship generates income, which is expected to repay the loan.

Ship finance insurance is the one of the important innovations of modern shipping finance. The ship finance insurance enables the parties to the contract to manage and diversify risk, to take advantage of arbitrage opportunities, or to invest in new classes of risk that enhance market efficiency. The insurance cover, from a ship financier 's perspective, many times provide inadequate protection, something that is even more common during financial hardship. There are however measures available for the ship financier to take in order to gain a stronger position and thus achieve a smaller credit risk. What is essential though is for the financiers to obtain knowledge about the potential coverage pitfalls and also to learn how these can be confined as far as possible. Insurance obligations are, by their very nature, uncertain. The insurance industry exists to purchase uncertainty from policyholders by transferring at least part of this uncertainty for a price. Insurers offer this benefit in exchange for payment of a prearranged amount of money called premium. Shipping is an input to a wide range of industries and, as such, an important driver of long-term growth. Ship investment lenders could not only help to provide the financing, but also help to ensure that a shipping business run efficiently. If contracts are designed properly, lenders have an incentive to see that a shipping operation is executed efficiently – because it increases the likelihood that their investment is safe and as profitable as expected. "Stopford (2009) claimed that managing the shipping industry itself is volatile. The volatility in the shipping industry is driven by the freight rates, which is determined by the demand and supply in the shipping market the freight rates are the income for the shipping companies, i.e. they generate the revenue to shipping companies and thereby influence the stock price of the shipping companies (Stopford, 2009)." The freight rates in the shipping industry are extremely important for the price of the stock to a shipping company, since the freight rates determine the income to the shipping company.

The freight rates are the earnings to a shipping company. This earning affects the value of the shipping company. Generally, if the freight rates are high, then the earning to the shipping company will also be high. Thus, the stock to the shipping company will be high. If the opposite happens, i.e. freight rates are low, and then the value of the shipping company will be low. Mobilizing the necessary funds to satisfy the growing demand for shipping investment will require new sources and instruments of finance. As ship finance insurer involvement, can improve both the execution and the financing of a ship. Overall, the ship finance risk transfer to the insurance markets is still very limited. Despite the relatively small volume of ship finance insurance transactions to date, ship finance insurance has significant potential to improve ship building and ship sale/purchasing market efficiency and capital utilization in the shipping industry.

The role of insurance in ship finance is not limited to risk transfer as the insurance market also provides a source of finance directly and indirectly. Ship finance debt can be sold to insurance companies through private placements. The market for these placements tend to be concentrated within a few large companies, and from a borrower's perspective this is positive as it may reduce the cost and time required to arrange ship financing. In ship finance, there is a substantial degree of trust placed on the performance of the ship itself and as a result there is much stress on its feasibility and its sensitivity to various forms of risk. Ship financed transactions are different from corporate finance or structured finance assets because of their potential vulnerability to force majeure risks[1]. "This vulnerability arises out of the dependence on the ship as a single source of income and not having the comfort of a diversified asset portfolio to cushion the effects of a loss. Lenders want to have a number of risks covered by finance insurance, loss of profits/business interruption such possibility of risks as failure to honor financial guarantees in the event of default on loans (Golbeck & Linetsky 2013)."

A ship financier may only exercise its rights to ship if a borrower is in default on a loan. Issues undermining the attachment, perfection and priority of security interests generally only become apparent once the loan is in default, often long after the loan has been

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1 The risk that there will be a prolonged interruption of operations for a project finance enterprise due to fire, flood, storm, or some other factor beyond the control of the project's sponsors.

made. In order for a security interest to attach to ship, the borrower has to have rights in the collateral, there must be an authorized security agreement, and value must be given. Still another way for a lender to lose its secured position is by failing to perfect its interest in the ship. The most common way of perfecting an interest in ship is by filing a financing statement. But here again a lender can make a number of errors that may result in the failure of the interest to perfect. The current economic situation is resulting in an increasing number of problems for ship purchase lending. A review of recent cases reminds lenders how easily an interest in ship can fail to attach, perfect or have priority. While it is important to examine and update internal systems, review processes and personnel, lenders should also remember the role that third-party service providers, like ship finance insurers, can play. Financial institutions engaged in significant levels of shipping lending need to assess the risks of such lending, develop and implement internal policies, control systems and review processes, obtain legal opinions when necessary and consider the additional protections that may be afforded by a ship finance insurance coverage.

One of the main features of ship financing is the collateralization of loans with ship as an asset and their repayment purely on the basis of shipping earnings. The revenue generating capability of a ship is a critical financing factor and tough conditions regarding delays in scheduled ship building completion have been added to contracts between financiers and ship owner, and particularly to those between ship owner and shipbuilders. The major events of default in a shipping loan include non-payment of any sum payable when due to breach of agreements or undertakings, particularly insurance agreements, operational agreements and other financial agreements. Many finance insurers also use a percentage of 120% of the regulatory capital to price their insurance products. Similarly, there is usually a requirement that the vessel is insured also for a higher value at about 120% of her actual market value; the idea in all these cases is to cover administration expenses and interest.

If the borrower is unable to cover the shortfall either by prepayment or by granting additional security then this is a typical event of default which enables the lender to begin enforcement. Other important events of default include misrepresentation which in effect elevates the importance of the representations and warranties clause, cross default which is an equally important event of default and heavily debated between the parties. In effect, this is the prime example of a clause which is not a violation of the agreement in question, but it allows the lender to begin enforcement on the basis of a breach in another financial agreement usually non- payment. There are several other events of default which are typically included such as unlawfulness/unfeasibility, physical adverse change, etc. “A ship owner needs a certain level of capital, which, with a certain level of confidence, prevents it from becoming insolvent. The capital required covers both the risks for the insurer that the ship owner cannot meet its obligations and the risks for the lender in the ship that they will lose their investment (Stopford 2009).” The capital is needed to protect against a change in value of the ship, such that the likelihood of default, undesired loss, or insolvency of the ship owner over a given time horizon is less than a specified confidence level. “This confidence level is set either by the regulators or the market in such a way as to be consistent with the level of comfort risk-aversion required by these institutions (Fsa 2014).” However, the use of similar methodologies in the evaluation and analysis of the risks of the ship owner would make comparisons possible.

1.1 Insurance Security Demand of Ship Financier

A ship financier will demand an insurance security for the loan provided to a ship-owner. Marine insurance taken out by ship owners cannot be viewed as a guarantee of financial compensation. This is achieved by means of a letter of undertaking from hull insurer to ship financier. Should hull insurance not respond, the ship financier will require an additional insurance. Typically, this might occur if the assured is in breach of warranties or has acted with gross negligence. Since covers are void in these circumstances, there is no payment from insurers and the ship financier would face a loss. “The ship financier can protect himself by a loan interest insurance. This covers the outstanding loan amount, should the other covers become void. In some cases, the ship financier takes this cover and charges the owners (Hans & Bull 2005).” The cover may also be arranged by owners, in favor of the ship financier. The ship owner has several different types of insurance to protect his ship sometimes called the underlying insurance. This policy will have company funded and ship financier will have their interest protected by an assignment of insurance. Ship loan interest

Insurance (MII)[2] and financing the right insurance is designed to protect the ship financier in situations where the company's primary insurance coverage for certain reasons not pay. In addition, "some insurance and MII will not cover the ship financier of default arrears due to loss of the ship is not proven to be caused by a danger to the sea MII does not cover. Insolvency at H&M and P & I insurance and also break the boundaries of owner's policy (Hans & Bull 2005)."

"Before a loan is granted, the financier would want to make sure that the borrower is a trustworthy party and that the money made from the operation of the vessel by far exceeds the amortize requirements including interest. If the borrower gets forced to sell the vessel, the sales proceeds shall also preferably be of an amount big enough to clear the debt (The Banker's Guide to Insurance Aspects of Ship Financing, 2003)." An extensive insurance package shall be obtained and paid by the borrower, including Hull and Machinery (H&M), Increased Value, War, Protection and Indemnity[3] (P&I) and ideally also additional ship financier s insurances. Furthermore, in order for the bank to enjoy the full benefits of the insurance policies, adequate assignments of the insurances need to be made. This will give the financier a position as a loss payee and will thus become the party to whom the insurance proceeds are paid out to. Most of the banks involved in ship finance today have become more cautious and more demanding when it comes to the insurances in relation to the ship. They wish to underpin the credit in the best possible way and the insurance cover is certainly one important element in order to run as small credit risk as possible. As such, the credit insurance in the real ship finance insurance which case the ship owner will definitely happen on a certain probability of occurrence, and economic purpose is to spread the risk over a large pool insured. The probability of occurrence may be small, but the result, if it happens, is catastrophic. Insurers understand the probability of occurrence through extensive factual information and pricing coverage for financing the actuarial risk and make a profit.

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2 Loans Interest Insurance - cover for the assured (bank/financial institution) for outstanding loans and interest, if the claim itself is collectible under the hull or P&I policy, but not paid - due to breach of cover, breach of warranty or owner's non-disclosure of facts.

3 P&I cover includes: a carrier's third-party risks for damage caused to cargo during carriage;[2] war risks;[3] and risks of environmental damage such as oil spills and pollution.

As the ship financing business, the financing ship insurance usually carries an annual premium and have a certain period of coverage, usually a year. Standards must be made within a certain standard filing period which may or may not be the same extent as the period of coverage. The ship finance insurances provide the ship financier with a comprehensive and effective tool for mitigating the risks of total loss, damage, and third party liability. For the ship financier the insurances serve two purposes: The insurance proceeds are an economic replacement for the vessel, which ensures the lender recovery of the debt owed to him, even though the loan has demised.

During its operation and employment, a vessel is constantly exposed to the perils of the sea. Such perils may materialize into damages that render the vessel inoperative, perhaps placing it off-hire if fixed on a time charter. The consequence is that the vessel is reduced in value due to the damage itself, and that it stops to generate income for the ship-owner, which in turn might impair his ability to service his commitments under the loan agreement. To exclude this, risk the ship-owner will be required to take out Hull & Machinery (H&M)[4] insurance. This insurance covers the vessel against total loss and partial damage. In relation to total loss, the insurance proceeds will be a surrogate for the vessel, which, provided the insured value is sufficient enables the ship financier to recover the debt owed to him.
In relation to partial damage, the insurance further ensures that the ship-owner will be financially able to repair the vessel, and thus maintain the value of the loan and continue a revenue generating operation. “In addition to H&M insurance, the loan agreement usually allows the borrower to take out hull and freight interest insurances, which covers the vessel for total loss same perils as the H&M insurance (Baranoff 2012).” It will not be required that these insurances are taken out; rather, they are optional and allow the ship-owner to insure a portion of the ship financier ’s required insured value, cf. below, at a lower premium.

The lender will usually require the borrower to take out Loss of Hire (LOH)[5] insurance only if the vessel is financed against a long-term charter party, usually three years

4 An H&M policy protects ship owners against physical loss or damage to the vessel’s hull, machinery and everything connected therewith.

5 The loss of hire cover protects the ship owner from a daily loss of income arising from physical damage to the ship in a wide range of situations

or more. “The LOH is triggered by the occurrence of an insured event under the H&M cover, and indemnifies the assured for loss of income while the vessel is inoperative (Baranoff 2012).” The proceeds from the LOH insurance thus enables the borrower to service the loan repayments, while the vessel is not generating income due to a partial damage. It is a standard requirement under the loan agreement that the vessel is insured to the lender’s satisfaction. Firstly, this means that the conditions on which the vessel is insured must be satisfactory. Usually, the loan agreement specifies which conditions are acceptable to the lender. The loan agreement will usually stipulate that the lender may approve equivalent conditions, and usually such approval shall not be unreasonably withheld. When determining the extent of the lender’s right to reject alternative conditions, it is natural to look at whether the alternative conditions’ capacity of cover is wider or narrower than the current ones. Secondly, the vessel must be sufficiently insured in monetary terms. This relates both to the sum insured and to deductibles.

Finally, underwriting security must be satisfactory, the ability of insurance companies to pay claims is a function of their available cash reserves and re- insurance arrangements. The financial standing of each insurer may be assessed by referring to professional credit rating agencies, such as Standard & Poor, Fitch and Moody’s.[6] One may think it useful to regulate the lowest acceptable rating in the loan agreement, but this could create problems if the rating falls below the minimum level during the insurance period, as the borrower might be required to replace the insurance with a sufficiently rated underwriter. For the ship financier, the sum insured is significant both in relation to total loss and partial damage. Firstly, the sum insured must be sufficient to provide the ship financier with an economic substitute for the loan in case of total loss. Secondly, if the sum insured is less than the insurable value, the liability of the insurer is reduced on a pro-rata basis. With regard to partial damage, this would impair the mortgagor’s ability to repair the vessel and restore the value of the loan. It may also have cash-flow consequences in case of general average, as the insurer’s liability for the ship’s contribution is also reduced.

6 The Big Three credit rating agencies are Standard & Poor's (S&P), Moody's, and Fitch Group. S&P and Moody's are based in the US, while Fitch is dual-headquartered in New York City and London, and is controlled by Hearst.

1.2 Ship Finance Insurance from a Financial Perspective

An insurance company commits itself to pay a claim amount, for a premium if a default has occurred. If we introduce a timeline, we find that first the policyholder signs up for an insurance, then pays a premium and when received by the insurance company, the company starts to earn the premium. During the duration of the insurance policy, as premiums are earned, there might or might not occur a default. If a default has occurred, it will eventually be known by the insurer. When the default is known by the insurer, the insurer reserves the default and later possibly pays out an amount. There are several problems to solve before,

- How do we measure the number and size of unknown defaults?
- How much premium is earned?
- How much premium is unearned?
- How do we know if the reserves on known defaults are sufficient?

The method that solves the two first problems are traditionally called premium reserve. The solution to the two last problems are called incurred but not reported reserve. Sometimes there is a split and it is talked about totally unknown defaults, incurred but not yet reported[7], and incurred but not enough reported, when reported reserves are believed to be insufficient. An insurance company has two main purposes for finding out how big the defaults on written shipping are.

- First, and most important, to feed back this into the pricing.
- The second reason is to produce financial statistics for analysis and to produce income statements and balance sheets for the company.

Most types of assets held by insurers can be analyzed in various historic market conditions due to the existence of long term, active markets. A wealth of standardized and consistent financial market data also exists to create a needed alternative for market values of most other asset types. Insurance liabilities on the other end of the variety position some unique challenges. No active market exists for shipping finance insurance company liabilities. In a limited way, market prices can be observed through sales of ships/companies, reinsurance transactions or securitizations. The numbers of transactions are small and information is not

7 Incurred but not reported (IBNR) claims is the amount owed by an insurer to all valid claimants who have had a covered loss but have not yet reported it.

always public, so even this information is of limited value. "The ability to analyze reserve risk over fi time horizon is important from several perspectives. First from a risk management perspective, the time horizon over which a risk will likely emerge is crucial. Understanding the time horizon allows for the creation of appropriate mitigation strategies and an understanding of interrelations with other risks. Second most other financial risks are measured over short fixed time horizons (Kerdpholngarm 2007)." A comparable measure of reserve, underwriting risk is important and require for many emerging capital measuring applications. Having a clearer picture of reserve risk will influence future underwriting, risk management and reinsurance-buying decisions. "The ability to model future trend risk in a realistic manner is essential in forecasting profitability, understanding the accumulation or aggregation of underwriting risk and to the process of setting capital (Kerdpholngarm 2007)."

The risk associated with reserve errors would be expected to be closely linked with the risk associated with pricing errors depending on the line of marine insurance and insurer characteristics. Further, the link between reserve and underwriting errors has important implications for firm risk management and regulations. "In conjunction with sound policies, they can help reduce the likelihood of balance of payment crises and preserve economic and financial stability. Reserves, however, can result from both precautionary and non-precautionary policy objectives and institutional settings. While they can bring several important benefits, reserve holdings can sometimes be costly (Forte et al. 2007)."

1.3 A Ship Financial Insurers' Credit Rating Assessment

The ship finance is one of a fund-raising method backed by the cash flow generated from an acquisition and operation of ships. It includes such a financing method relying on the credit worthiness of the specific company as ship owner but this report is drafted for the credit rating method in the premises of such fund raising solely relying on the value of the ship and the cash flow generated from the operation of a ship. The required analyses for the ship finance are briefly classified into (1) grasping the project arrangement, (2) analysis of the ship owner, (3) analysis of the cash flow, (4) analysis of the future market structure. The core of the repayment resources is the ship owner and it is important to analyze the credit worthiness of the ship owner as well as examining the spec of the ship and the overall job plan. Then analysis is to be made focusing on what measures are to be taken to mitigate the fluctuating risk of the cash flow. Furthermore, the contractual relationship is examined in view of whether the generated cash flow is surely sized and appropriated for the repayment of a loan or for the case of failure of the repayment whether the creditor's right can be quickly exercised. As credit is crucial for financial companies' business model, any downgrade affects the company's ability to write new business. There is a widespread perception among the ship's Insurance financial analysts to a rating reduced to 'A or BBB' can allow the company to write any new business. In practice, the economic situation in the ship financing business is rapidly decreasing for a number of reasons. For example, because of downgrade financier might ask the shipping company extra money to back up their contracts. The extent to which these situations actually exist depend on the exact specifications of financial contracts, which differ from one contract to another. It seems that most companies have a tendency to not accept such clauses, so they are less likely to face demands for additional security in the event of a rating change. But there is almost no information in the public area of the exact terms of such agreements, so it is difficult to assess the risk that a ship owner will face liquidity problems with regard to the cuts.

2 LITERATURE REVIEW

Literatures are drawn from various fields, including ship finance, underwriting, insurance premium, default, market value of liability, value of demand for insurance, efficiency and profitability, investment, moral hazard, premium, underwriting cycle, insurance pricing, asset liability management and insurance, option pricing, risk management, solvency /insolvency and confidence intervals for the probability of insolvency. Numerous studies investigate various aspects of insurers' operating, investing and financing activities. Another prolific area of research explores differences across organizational structures, primarily stock versus mutual companies. Studies have also looked at issues relevant to the insurance industry overall, including the value of and demand for insurance, the problems of adverse selection and moral hazard in insurance, and the underwriting and reserving cycle. We discuss these studies in separate categories by main focus.

2.1 Ship Finance

Commercial vessels are very expensive items. Some vessel can cost up to as much as 400 million USD. These huge investments mean that the shipping industry is one of the world's most capital-intensive industries. This implies that finance is an important factor for the shipping industry, especially in times of new investments. The commercial banks are the most important providers of debt to finance the bulk segment of the shipping industry. Commercial banks usually offer term loans of 2-10 years which they in turn have financed by borrowing from the capital and money markets. Most banks are not comfortable lending for more than 10 years possibly with a balloon payment in the end. The commercial banks' loans are usually quoted at a margin over LIBOR (London Inter Bank Offered Rating). Large loans, more than 50 million USD, are usually syndicated between a number of banks. There are also some financial institutions, with substantial funds under their management that have specialized shipping departments, which lend directly to the shipping industry. Financial statements usually provide the information required for planning and decision making. Information from financial statements can also be used as part of the evaluation, planning and decision making by making historical comparisons. In relation to equity finance, Grammenos were the first to document that an increasing number of shipping companies were accessing the capital market. **Grammenos. C, (2008)** used a logistic regression analysis to estimate the probability of default for high yield bonds issued by shipping companies. They use a sample of 60 observations, and 19 variables. Five variables are included in his final model the gearing ratio, the amount raised over total assets ratio, the working capital over total assets ratio, the retained earnings over total assets ratio and an industry specific variable that captures the shipping market conditions at the time of issuance. This approach can be applied for probability of default model development for shipping companies (C. Th Grammenos et al. 2008). **Haider et al. (2008)** during the period 2004 – 2007, it can be observed that there was an increased number of Initial Public Offerings (IPOs), secondary offerings, and issuance of high-yield bonds related to the shipping industry. However, since the financial crisis of 2008, bankruptcy amongst firms operating in the shipping industry has been a familiar theme. Corporate finance is therefore an important consideration within the shipping industry which remains in a precarious situation. This has brought additional pressures in terms of shipping companies establishing sound and rigorous, as well as transparent, financial practices (Haider et al. 2008). **Nicolas Berman, Jos´e de Sousa, Philippe Martin, Thierry Mayer, (2012)** they show that the negative impact of financial crises on international trade is magnified for destinations with longer time-to-ship. They analyze a specific theoretical mechanism that could explain this time-to-ship effect. Exporters react to an increase in the probability of default of importers by increasing their export price and decreasing their export volumes to the destination in crisis (Berman et al. 2012). **Victoria Ivashina and David Scharfstein, (2010)** they have argued that cyclical variation in the demand for loan participations—whether through shocks to bank capital or variation in investor sentiment—can help to explain variation in the lead share and thus also increase the cyclicality of credit (Loan Syndication and Credit Cycles). One limitation of this analysis is that we have ignored the role of securitization in the syndication process (Ivashina & Scharfstein 2008).

2.2 Underwriting

There are many theories about the causes and mechanics of the underwriting. One of the more popular is the "capacity constraint" theory. This focuses on the dynamic relationship between pricing and surplus. Since insurance needs capital to support it, any shock that reduces capital, such as a natural catastrophe, will reduce capacity and therefore raise prices as supply becomes restrained. Profitability for an insurer is linked to investment income, and cost of capital is linked to the wider economy. **Lin & McNichols (1998)** their paper examines whether research reports issued by analysts whose employer is affiliated with a company through an underwriting relationship are more favorable than research reports issued by unaffiliated analysts. They examine the effect of underwriting relationships on analysts' earnings forecasts and recommendations. Lead and co-underwriter analysts' growth forecasts and recommendations are significantly more favorable than those made by unaffiliated analysts, although their earnings forecasts are not generally greater (Lin & McNichols 1998). **Cummins and Weiss (2002)** studied the impact of reinsurance on insurance prices and profits, while Meier and Outreville (2006) determined the role of reinsurance on the cyclical behavior of underwriting cycles (Cummins & Outreville 1987). **Daniel Becker (2010)** his paper outlines the key structure trends that are reshaping banks' credit underwriting processes and discusses practical measures banks should take to extract significant higher value from lending operations (Becker 2010). Basel Committee on Banking Supervision (2013) its report examines the interaction of mortgage insurers with mortgage originators and underwriters, and makes a set of recommendations directed at policymakers and supervisors which aim at reducing the likelihood of MI stress and failure in such tail events (Committee et al. 2013).

2.3 Insurance Premium

The literature review of the researches in insurance premium estimation highlights the problems facing those who seek to identify the correct estimation model, and those who want to apply it. **Bourgeon, Picard, and Pouyet (2008)** develop an alternative theory of insurance market dynamics based on two assumptions. First, insured risks are dependent. Under this assumption, insurers' net worth determines the market capacity since it is necessary to back the contractual promises to pay defaults. Second, in raising net worth, external equity is more costly than internal equity. Equilibrium price also might be affected if policyholders and/or (re)insurers change their loss expectations after events such as catastrophes (probability updating), leading to increased prices. Thus, the price increases follow the loss shocks because of constriction in supply and increased demand. The risky debt hypothesis predicts that policyholders are willing to pay higher premiums for greater financial quality; loss shocks that deplete the capital (surplus) of the firm are hypothesized to affect prices by driving insurers away from their optimal capital structures (Jean-Marc Bourgeon, 1995)**. Chung and Weiss (2007)** investigate the determinants of reinsurance prices in an attempt to shed light on the role of reinsurance in observed underwriting cycles in the primary market. Non-proportional reinsurance is highlighted, since it is designed to cover the tail of the loss distribution and is therefore considered to be relatively riskier than proportional reinsurance. The results support both the capacity constraint hypothesis and the risky debt hypothesis (Weiss 2007). **Doherty and Garven (1995)** show that changes in interest rates simultaneously affect the insurer's capital structure and the equilibrium underwriting profit. Depending upon asset and shipping finance maturity structure, capital market access, and reinsurance availability, insurers will be differently affected by changing interest rates. The average market response to changing interest rates roughly tracks market clearing prices. These cyclical effects are enhanced for firms with mismatched assets and ships and more costly access to new capital and reinsurance. This evidence supports the capacity constraint hypothesis (Doherty N. a., 1995). **Meier & Outreville (2003)** show that the fluctuations in the price of reinsurance during the past ten years have been documented recently in the business literature. Reinsurance allows a primary insurer to increase its premium volume by more than would otherwise be possible with a given amount of capital. If the price of reinsurance decreases, reinsurance becomes more affordable for insurance companies and this will be reflected in more capacity, price competition and at the end an increase in the loss and combined ratio (Meier & Outreville 2003).

2.4 Default

Shipping is an industry characterized as being highly cyclical, volatile, capital intensive and often highly geared. This might constitute a problem for companies when they have to make interest and capital repayments in a recessed shipping market as they may not have sufficient cash flows to meet their obligations. Most of the previous studies predict financial distress by using financial data for a number of months or years prior to the default event and only one uses financial data at the time of issuance; when the decision by the high yield bond investor to buy, or not, the financial instrument, is made. **Avenhuis (2013)** uses a logistic regression analysis to estimate probability of default for non-financial companies. His study is concerned not only with the predictive ability of the model, but also the model's coefficient estimates. Four variables are included in his final model: total liabilities over total assets; total assets over GNP price-level index; some performance measure (Avenhuis 2013). **Laitinen and Kankaanpaa, (1999)** in their study discussed si alternative methods to the multivariate discriminant analysis and logit models, which have been applied in their search for PD models, and concluded that no superior method – compared to the MDA and logit models – was found with the variables they employed (Laitinen 2006). **Jessen & Lando (2013)** They use simulations to investigate the robustness of the distance-to- default measure to different model specifications. Overall, we find distance-to-default to be robust to a number of deviations from the simple Merton model that involve different asset value dynamics and different default triggering mechanisms. A notable exception is a model with stochastic volatility of assets (Jessen & Lando 2013).

2.5 Market Valuation of Liability

Market value estimates of insurance liability reflect expected cash flows, the time value of money and an adjustment for risk. Over last fifteen years, many methods for estimating the fair value of property/casualty insurance liabilities has been introduced. **Girard (1998)** recently showed that the two methods are equivalent depending on the assumptions made in the free cash flows and cost of capital of the actuarial appraisal methods. Indeed, Girard enables us to focus on the main issue of market valuation of liability. That is, if we want to assign a value to liability such that the value represents the market value, we need to focus on the salient features of the product and calibrate the value to the market. When we use the actuarial appraisal method or the option method, the assumptions used should be consistent with the market valuation. This way, we are assured that our valuation is consistent with the law of one price (Girard 1998). **Ho, Scheitlin, and Tam (1996)** noted that at the time the liability is sold and at the termination date, the transaction value should be related to the market value. Further, Reitano proposes that liability should be valued consistent with other debts in the liability structure. Therefore, to determine the market value of liability is to determine the underlying assumptions that enable us to calibrate the liability to the market observed parameters and prices, and less so on the methodology or the procedure in determining the liability market value (Ho et al. n.d. 1996). **Wallace (1997)** has discussed the use of transfer pricing for asset liability management where benchmarks are constructed to measure asset and liability management performance. This paper focuses on the derivation of the transfer pricing in relation to the product pricing (or the liability valuation) by the use of credit spread and the profit release. How these measures are modeled within the context of liability valuation will be described (Appellant et al. 1997).

2.6 Value of Demand for Insurance

The value of insurance to customers may not be as clear as the value of other products or services. Accordingly, studies have investigated the value of and demand for insurance. **Cummins and Danzon (1997**) developed a model of price determination in insurance markets. Insurance is provided by firms that are subject to default risk. Demand for insurance is inversely related to insurer default risk and is imperfectly price elastic because of information asymmetries and private information in insurance markets. The model predicts that the price of insurance, measured by the ratio of premiums to discounted losses, is inversely related to insurer default risk and that insurers have optimal capital structures. Price may increase or decrease following a loss shock that depletes the insurer's capital, depending on factors such as the effect of the shock on the price elasticity of demand. Prior research suggests that the occurrence of a catastrophe may lead to increases in risk perception, risk mitigation, and insurance purchasing behavior. Given the extensive damage that often is inflicted by natural disasters, such a phenomenon is intuitive for vessel risks (Cummins & Danzon 1997). **Ligon and Cather (1997)** argue that insurance reduces uncertainty regarding future wealth and so allows insureds to make better decisions regarding consumption and investment. This informational value of insurance does not require consumer risk aversion. Lines of insurance with longer resolution periods should impact relatively more decisions and have higher informational value (Ligon and Cather 1997). **Bruce B. Rosner (2013)** The upcoming Solvency II European solvency capital standard contains a market-consistent-type balance sheet. Market-consistent accounting produces a value that is consistent with the price of related financial instruments in the market. The intention is that all companies (e.g., banks and insurance companies) will account for their business on the same basis (Rosner et al. 2013).

2.7 Efficiency and Profitability

This area of research concerns the success of insurance companies in conducting their operating activities, primarily in terms of efficiency and profitability. Studies examining efficiency consider several dimensions, including cost efficiency, technical efficiency, allocative efficiency, and revenue efficiency. Cost efficiency measures the insurer's success in minimizing costs by comparing the costs that would be incurred by a fully efficient firm to the costs actually incurred by the firm. Cost efficiency can be decomposed into technical efficiency and allocative efficiency. Revenue efficiency measures the firm's success in maximizing revenues by comparing the firm's actual revenues to the revenues of a fully efficient firm with the same quantity of inputs. Primary factors that affect revenue efficiency include product-line diversification and geographic diversification. **Cummins and Xie (2010)** examine efficiency, productivity and scale economies in the US insurance industry over the period 1993-2006. Over the sample period, the industry experienced significant gains in total factor productivity, and there is an upward trend in scale and allocative efficiency. However, cost efficiency and revenue efficiency did not improve significantly over the sample period. Regression analysis shows that efficiency and productivity gains have been distributed unevenly across the industry (Xie 2010). **Liebenberg and Sommer (2008)** develop and test a model that explains insurers' performance as a function of line-of-business diversification and other variables using a sample of vessel-liability insurers over the period 1995-2004. The results indicate that undiversified insurers consistently outperform diversified insurers. In terms of accounting performance, the diversification penalty is at least 1 percent of return on assets or 2 percent of return on equity (Liebenberg & Sommer 2013). **Eling and Luhnen (2015)** conduct an efficiency comparison of 6,462 insurers from 36 countries. They find a steady technical and cost efficiency growth in international insurance markets from 2002 to 2006, with large differences across countries. Denmark and Japan have the highest average efficiency, whereas the Philippines is the least efficient. Guaranty fund assessments are usually a flat percentage of premiums (Eling 2015). **Cummins (1988)** argues that this structure can induce insurers to adopt high-risk strategies, a problem that can be avoided through the use of risk-based premiums. The study develops risk-based premium formulas for three cases: a) an ongoing insurer with stochastic assets and liabilities, b) an ongoing insurer also subject to jumps in liabilities (catastrophes), and

c) a policy cohort, where claims eventually run off to zero. Premium estimates are provided and compared with actual guaranty fund assessment rates (Service & Publications n.d.1988) **Lee, Mayers, and Smith (2003)** examine changes in vessel-liability insurers' risk-taking around enactments of state guaranty fund laws which occurred over the period 1969-1981. Evidence suggests that the risk of insurers' asset portfolios increases following enactments. But this increase in risk is significant only for stock insurers. Evidence of increased risk-taking following guaranty-fund adoptions suggests that the way these funds are organized creates counterproductive investment incentives, especially for stock companies (Sætersdal et al. 2003). **Chiang (2005)** develop a multiperiod model to measure the costs posed to the guaranty fund in a setting that incorporates risk-based capital regulations, interest rate risk and the possibility of catastrophic losses. The guaranty contract is modeled as a put option on the asset of the insurance company with a stochastic strike price and an uncertain maturity. The impacts of the key factors of this model are examined numerically and shown to make material differences in the costs to the guaranty fund (Chiang 2005).

2.8 Investments

A significant threat for shipping businesses, regardless of company size or the commercial field in which they operate is business failure. In the literature, it has been argued that the use of financial management practices may be related to improved financial performance. Some of the studies indicated that sophisticated capital budgeting techniques mostly NPV and IRR had a positive relationship with ROA while the traditional methods showed an insignificant relationship. However, similar reported a negative relationship between the capital budgeting techniques and financial performance. **Consiglio & De Giovanni (2006)** point out that investment officers of publicly held insurance companies wrestle with the question of how best to contribute to shareholder value. One approach is to manage the investments independent of the insurance operations, as if they were a closed-end investment company that happens to be funded by insurance underwriting. They argue that the investment policy of most insurance companies should have two primary objectives: (1) immunizing insurance reserves with a fixed-income portfolio and (2) earning "abnormal returns" on surplus in "a responsible and disciplined" way (Consiglio & De Giovanni 2008).

Chen, Yao, and Yu (2007) find that active equity mutual funds managed by insurance companies underperform peer funds by over 1% per year. The lower returns of insurance funds are not due to less risky investments; instead insurance funds have lower risk-adjusted returns, and their fund flows are less sensitive to performance when they perform poorly. Across insurance funds, those with heavy advertising, directly established by insurers, using parent firms' brand names, or whose managers simultaneously manage substantial non-mutual-fund assets, are more likely to underperform (Chen, Yao, and Yu 2007).

2.9 Moral Hazard

Moral hazard in insurance relates to the tendency of insureds to engage in more risky activities than they would if they had no insurance. It also refers to the possibility that insureds may deliberately cause an insured event or pretend that such an event occurred to obtain insurance payments. Moral hazard concerns are mitigated through selective underwriting (e.g., moral individuals, thriving business, occupied properties), insurance deductibles, policy exclusions, contingent pricing, and other methods. I reviewed several studies dealing with adverse selection and moral hazard in insurance. **Derrig (2007)** the article tests the hypothesis that insurance price subsidies lead to higher insurance cost growth. Cross-subsidies were explicitly built into the rate structure through rules that limit rate differentials and differences in rate increases across driver rating categories (Derrig 2007). **Kessler (2008)** discusses the market for long-term care insurance. There are three major risks for insurers risk of escalating costs, risk of adverse selection and risk of moral hazard. Despite these risks, the long-term care insurance is a potentially expanding market for insurance companies able to innovate and design products tailored to this very specific demand (Kessler 2008).

2.10 Premium

According to conventional theory, insurance premiums should be informationally efficient predictors of the present value of policy claims and expenses. **Bourgeon, Picard, and Pouyet (2008)** develop an alternative theory of insurance market dynamics based on two assumptions. First, insured risks are dependent. Under this assumption, insurers' net worth determines the market capacity since it is necessary to back the contractual promises to pay claims. Second, in raising net worth, external equity is more costly than internal equity. The theory explains the variation in premiums and insurance contracts over the insurance cycle and is supported by tests on postwar data. Negative shocks to industry capital and significant capital adjustment costs have been offered as an explanation of periodic "crises" in the vessel-liability insurance market. According to these capacity constraint models, in which post-shock production must meet a solvency constraint, increases in price can cause some or perhaps all of the cost of a negative shock to capital to be shifted to policyholders. **Luyang Fu (2008)** analyze whether the 1994–1999 "soft" market in medical malpractice insurance led some firms to underprice, grow rapidly, and subsequently experience upward revisions in loss forecasts loss development, which could have aggravated subsequent market "crises". Consistent with the underpricing hypothesis, the results indicate a positive relation between loss development and premium growth among growing firms. Underpricing was likely more prevalent among non-specialist malpractice insurers (Fu 2008). **Cagle and Harrington (2004)** develop a model of insurance supply with capacity constraints and endogenous insolvency risk that incorporates limited liability and potential loss of insurer intangible capital. If industry demand is inelastic with respect to price and capital, the model predicts that price will increase following a negative shock to capital, but by less than the amount needed to fully offset the shock. Equity value and the expected recovery by policyholders for post-shock production are predicted to decline. Elastic demand mitigates shock- induced price increases (Harrington 2004). **Savelli, Nino, Clemente (2008)** investigate the determinants of reinsurance prices in an attempt to shed light on the role of reinsurance in observed underwriting cycles in the primary market. Non-proportional reinsurance is highlighted, since it is designed to cover the tail of the loss distribution and is therefore considered to be relatively riskier than proportional reinsurance. The results support both the capacity constraint hypothesis and the risky debt hypothesis. Under the capacity constraint hypothesis, insurance prices are bid-up when capital is scarce and fall when capital is plentiful. Equilibrium price also might be affected if policyholders and/or (re)insurers change their loss expectations after events such as catastrophes (probability updating), leading to increased prices. Thus, the price increases follow the loss shocks because of constriction in supply *and* increased demand. The risky debt hypothesis predicts that policyholders are willing to pay higher premiums for greater financial quality;

loss shocks that deplete the capital (surplus) of the firm are hypothesized to affect prices by driving insurers away from their optimal capital structures. Insurance profits exhibit cyclical behavior that has been attributed to capital market constraints. (Savelli, Nino; Clemente 2008). **Doherty and Garven (1995)** show that changes in interest rates simultaneously affect the insurer's capital structure and the equilibrium underwriting profit. Depending upon asset and liability maturity structure, capital market access, and reinsurance availability, insurers will be differently affected by changing interest rates. The average market response to changing interest rates roughly tracks market clearing prices. These "cyclical" effects are enhanced for firms with mismatched assets and liabilities and more costly access to new capital and reinsurance. This evidence supports the capacity constraint hypothesis (Neil A. Doherty 1995).

2.11 Underwriting Cycle

Underwriting cycle covers several issues. The first is the measurement of income. The underwriting cycle derives its name from periodic fluctuations in underwriting gains and losses. But insurance profitability depends on total operating income, both underwriting returns and investment returns. In fact, the industry has suffered underwriting losses during most of the past two decades. Underwriting income alone is not a good measure of profits. **Meier (2006)** examines the existence of underwriting cycles in vessel-liability insurance for Switzerland, the USA, Japan, and West Germany over a period of 40 years (1957-1997). Cycles are found for the USA, West Germany and Switzerland, whereas most specifications for Japan have not revealed cycles. For West Germany, much longer cycles than in earlier studies are found. In general, the cycles get longer for the longer period, 1957-1997. The author concludes that the hypothesis of cycles of si years in length no longer holds globally (Meier 2007). **Meier and Outreville (2006)** discuss the findings of the existence of an underwriting cycle in vessel-liability insurance for France, Germany and Switzerland and for the European reinsurance industry. The study also reveals that the reinsurance price inde has a strong influence on the primary market loss ratios of the three countries (Meier & Outreville 2006). **Rocco Roberto Cerchiara (1995)** The aim of this paper is to correctly model the underwriting cycle for non-life insurance companies, also taking into account its effect on the solvency ratio. Starting from collective risk theory, a dynamic control policy is defined to specify the relationship between solvency ratio and safety loading, to model the underwriting cycle. The corresponding dynamic equation for the solvency ratio, under some assumptions, assumes the form of a one dimensional piecewise linear map. In the first part of the work a deterministic version of this map is analyzed, where aggregate losses are simply regarded as a parameter. Numerical analysis and stochastic assessments of the model conclude the work (Cerchiara 2009). **Martin Eling and Sebastian D. Marek (2010)** The aim of this paper is to analyze the impact of underwriting cycles on the risk and return of non-life insurance companies. They integrate underwriting cycles in a dynamic financial analysis framework using a stochastic process, specifically, the Ornstein- Uhlenbeck process, which is fitted to empirical data and used to analyze the impact of these cycles on risk and return. They find that underwriting cycles have a substantial influence on risk and return measures. Their results have implications for managers, regulators, and rating agencies that use such models in risk management, e.g., to determine risk-based capital requirements (Marek & Eling 2010). **Mary A.(Weiss 2007)** Underwriting cycles are associated with a mystique that few topics in the area of risk and insurance share. Many explanations and theories have focused on underwriting cycles, but little research exists to discern the relative importance of these theories in explaining insurance pricing and profitability. This research provides an intuitive review of the existing literature on underwriting cycles in the context of a demand and supply model. Specific, unaddressed issues about underwriting cycles are raised in the literature reviewed (Weiss 2007). **Cummins & Outreville (1987)** This paper proposes instead that insurance prices are set according to rational expectations. Although rational expectations per se would be inconsistent with an underwriting cycle, the authors hypothesize that cycles are “created” in an otherwise rational market through the intervention of institutional, regulatory, and accounting factors. Empirical evidence is presented indicating that underwriting profits in several industrialized nations are consistent with the hypothesis (Cummins & Outreville 1987). **Leng and Meier (2006)** discuss the findings of a study of multinational underwriting **cycles in vessel-liability insurance in Switzerland, Germany, the United States and Japan. A description of the study** design and methodology is given. The study provides a hypothesis that the factors affecting underwriting cycles are mainly country-specific rather than global/international (Leng and Meier 2006).

2.12 Insurance Pricing

Insurers compete for business on the basis of price, financial strength, availability of coverage desired by customers (servicing specific customer groups or needs, or offering a degree of customization that is of value to the insured), and quality of service, including the quality of the claim adjustment service. **Cummins, Phillips, and Tennyson (2001)** investigate the effects of political influence on the price of automobile insurance to consumers. It examines whether the average price per dollar of insurance benefits received (the unit price of insurance) is affected by political influence activities of consumer and industry interest groups in states that regulate insurance prices. The tests are obtained by statistical analysis of the unit price of insurance on variables designed to capture the effects of political influence, using data from all 50 US states over the time period 1980-1996. The results support the hypothesis that political influence plays a role in determining prices in regulated states. (Cummins 2001). **Milevsky and Posner (2001)** use risk-neutral option pricing theory to value the guaranteed minimum death benefit (GMDB) in variable annuities (VAs) and some mutual funds. Specifically, the authors compute the fair insurance risk fee, charged to assets, that funds the embedded option. The authors' main conclusion is that a simple return-of-premium death benefit is worth between one and ten basis points, depending on gender, purchase age, and asset volatility (Milevsky & Salisbury 2006). **Saito (2008)** examines whether adverse selection or moral hazard could be induced by rate regulation, which prohibits insurance companies from considering some attributes of drivers in setting premiums. Using an individual data set from a heavily regulated automobile insurance market, the authors find no evidence of adverse selection or moral hazard: risk and coverage are not statistically dependent. This finding supports the view that the adverse selection phenomenon exists only to a very limited extent in this market (Saito et al. 2008).

2.13 Asset Liability Management and Insurance

Asset/liability management theory and practices of insurers have matured and developed from early applications to guaranteed investment contracts to all annuity and insurance products today. **Brotons and Terceno (2011)** used fuzzy logic to study immunization strategies to mitigate the risk of interest rate movements within an ALM framework where the combination of expected return and risk, chosen to achieve higher liquidity, are obtained from the midpoint and width of relevant fuzzy numbers respectively. A risk-return map is created using this approach to account for the investor’s risk aversion, which allows the investor to track differences in return of the adopted strategy for a given level of duration (Brotons and Terceno 2011). **Huang et al. (2009)** studied probability of ultimate ruin in an insurance risk framework where the individual claim amount is modeled as an exponentially distributed fuzzy random variable and the claim process is characterized by a Poisson process (Huang et al. 2009). **Lai (2006)** conducted an empirical study of the underwriting profit margin of a Taiwanese vessel/liability (P/L) insurance company in an intertemporal capital asset pricing model (ICAPM) framework. He found that the best fitting parameters of the models can be expressed as an asymmetric triangular fuzzy number. He also showed how the derived skew factors could be used to forecast the underwriting profit margin. Lai (2008) extended the above study to investigate transportation underwriting of systematic risk made by the insurances related to major lines of transportation, ranging from automobile to aviation(Lai 2006).

2.14 Option Pricing

There are a great number of studies have been made in dealing with the theoretical price of an option by using the technique of mathematical programming. In recent years, a considerable number of research is concentrated on finding the new approaches to recover the asset price’s probability from the observed market option price. Mathematical programming is the most important tool to deal with the path- dependency problem of real options valuation. **Muzzioli and Torricelli (2001)** proposed a one-period binomial option pricing model (OPM) based on a risk-neutral valuation technique. They incorporated different levels of market information while modeling the option payoff by means of triangular fuzzy numbers. Lee et al. (2005) applied fuzzy set theory to the Cox, Ross and Rubinstein (CRR) interest rate model to develop a fuzzy binomial OPM that allows investors to update their portfolio strategy based on their individual risk preferences. The proposed model provides reasonable ranges of option prices allowing investors to use it for arbitrage or hedging. An empirical study using S&P 500 inde options is also conducted to support their theoretical results. In the context of a real option valuation model, **Zmeskal (2001)** observed that the required input data often lack quality and therefore identified two types of input data uncertainty: risk and vagueness. Since risk is stochastic in nature and vagueness results from inherent fuzziness in the reported input, he proposed a fuzzy-stochastic American real option model where the inputs are used in the form of fuzzy numbers and the option value is determined as a fuzzy set. **Derrig and Ostaszewski (1996)** studied the ta burden of a vessel-liability insurance company in an option theoretic framework where the appropriately priced insurance liabilities are used as a hedging instrument. The relevant parameters were modeled using fuzzy numbers to account for uncertainty in the ta rate, rate of return and the hedge liability (Derrig and Ostaszewski 1996).

2.15 Risk Management

To attain faster decisions and reduce human error in the credit evaluation process, automated credit risk assessment systems play an important role. **Lahsasna (2009)** built and investigated the accuracy (to enable correct assessment) and transparency (to understand the decision process) of a credit-scoring model using German and Australian credit data sets and two fuzzy model types. The proposed modeling approaches allow users to perform additional analysis such as defining customer attributes that influence the credit underwriting decision and quantifying the approximate values of these attributes (Lahsasna 2009). **Cheng at el. (2006)** claimed that the observed value may be better considered as a fuzzy phenomenon but not a random one. They thereby used an interval instead of a single value for financial variables. They constructed an early-warning model for financial distress using fuzzy regression as an alternative to well-known methods, namely discriminant, logit and artificial neural network analysis. **Vaughn (1996)** presents a comprehensive framework for property/liability insurance risk management and securitization. Section 2 presents a rationale for P/L insurance risk management. Sections 3 through 6 describe and evaluate the four categories of P/L insurance risk management techniques: (1) maintaining internal capital within the organization, (2) managing asset risk, (3) managing underwriting risk, and (4) managing the covariance between asset and liability returns. Securitization is specifically discussed as a potential method of managing underwriting risk. (Vaughn 1996).

2.16 Solvency / Insolvency

Financial institutions, and insurance companies in particular, play and perform an important intermediary role, and as such they face significant risk on a daily basis. Since the importance of the insurance sector and its stability is beyond doubt, most claim that the collapse of an insurance company, in contrast to the bankruptcy of any other institution, has a huge impact upon the whole society. **Dickinson (1997)** discusses that risk-based capital is employed in two different contexts. Firstly, it is used within a regulatory framework to determine an acceptable minimum level of capital which an insurance company must hold as part of its solvency assessment. Secondly, it is used in financial planning and control within an insurance company to help determine the overall optimum level of capital for an insurance company and to provide a basis for allocating this capital across its various activities or operations (Dickinson 1997). **Cerchiara (2009)** The aim of the paper is to correctly model the underwriting cycle for non-life insurance companies, also taking into account its effect on the solvency ratio. Starting from Collective Risk Theory, a dynamic control policy is defined to specify the relationship between solvency ratio and safety loading, to model the underwriting cycle. The European Project Solvency II is devoted to the appraisal of a Solvency Capital Requirement that should capture the overall risk profile of insurance companies. In this framework, there is a growing need to develop so-called internal risk models to get accurate estimates of liabilities. In the context of non-life insurance, it is crucial to correctly assess risk from different sources, such as underwriting risk with particular reference to premium, reserving and catastrophe risks (Cerchiara 2009). **Elena Veprauskaite (2014)** analyzes the relation between loss reserving errors, solvency and risk management (reinsurance and derivatives hedging) in the United Kingdom’s (UK) property-casualty insurance industry using a dynamic panel data model. They test two alternative hypotheses. first, we test whether insurers under-reserve to reduce reported liabilities in order to improve their reported solvency position. This hypothesis implies a positive relation between weak solvency and under-reserving. Second, we hypothesize that the insurance industry regulator is likely to require additional capital maintenance if an insurer’s loss reserves are understated(Veprauskaite 2014).

2.17 Confidence Intervals for the Probability of Insolvency

Confidence intervals are taught as an appropriate way to qualify results from small samples. The addition of confidence intervals to default rate estimates helps both the financier and insurers of usability reports understand the irregularity characteristic in small samples. The necessity to rate confidence on an outcome-by-outcome basis follows from the variability in confidence that regularly occurs across outcomes. **Ran Barniv, John Hathorn, Abraham Mehrez Douglas Kline (1999)** The main purpose of this article is to provide and illustrate a method of constructing confidence intervals for insolvency probabilities. They examine various measures of the confidence intervals, such as their minimum lengths and minimum upper bounds. Two examples show a substantial improvement (reduction) in the length and the minimum upper bound of the confidence intervals at the optimal level of the financial accounting variables. A third example depicts a confidence interval for the probability of failure for an insolvent insurer. (Barniv et al. 1999). **Harrington (2005)** This paper deals with capital adequacy and capital regulation of insurers and reinsurers. He first reviews the main risks, degree of market discipline, and scope of solvency regulation in insurance and reinsurance markets, with an emphasis on the U.S. Given that background, He next consider key principles of efficient capital regulation, focusing on the relation between optimal capital requirement stringency and market discipline. He then briefly describes and evaluate in relation to those principles capital requirements and related supervision of U.S. and E.U. insurers and reinsurers. He compares the U.S. and E.U. systems, consider the implications of possible federal insurance /reinsurance regulation in the U.S., and discuss whether regulation of reinsurers should be expanded abroad (Harrington 2005).

3 THE OBJECTIVE OF SHIP FINANCE INSURANCE

The objective of shipping finance insurance is to protect a ship financier in a situation when the underwriters under front line insurance policies decline to pay loss or damage sustained by the loaned vessel because such loss or damage has been suffered by any act or omission of one or more of the owners, operators, charterers or managers of the vessel or their agents including breach or alleged breach of warranty or condition whether expressed or implied or non-disclosure or alleged non-disclosure of any fact or circumstances of any kind whatsoever.

3.1 Shipping Industry

The Shipping industry in all its three major segments i.e. dry bulk carriers[8], tankers[9] and containerships[10]. The international shipping industry is responsible for the carriage of around 90% of world trade. Shipping is a very important part of the global economy. Without shipping, intercontinental trade, the bulk transport of raw materials, and the import/export of affordable food and manufactured goods would simply not be possible. Ships are technically sophisticated, high value assets and the operation of commercial ships generates an estimated annual income of over half a trillion US Dollars in freight rates. We may need to look at the movement of the Baltic Exchange[11]. There are over 50,000 merchant ships trading internationally, transporting every kind of cargo. The world fleet is registered in over 160 nations, and manned by over a million seafarers of virtually every nationality. There are many ways of financing ships, from traditional bank lending to private placements

8 A commodity which is shipped in large, unpackaged amounts. There are many transport companies that specialize in dry bulk delivery.

9 A tanker is a merchant ship designed to transport liquids or gases in bulk. Major types of tankship include the oil tanker, the chemical tanker, and gas carrier.

10 Container ships (sometimes spelled containerships) are cargo ships that carry all of their load in truck-size intermodal containers, in a technique called containerization.

11 As stated by the Baltic Exchange on www.balticexchange.com “The Baltic Exchange is the world's only independent source of maritime market information for the trading and settlement of physical and derivative contracts. (see http://www.balticexchange.com)

and public issues of debt and equity. They are all associated with different risks and the investor, financier has to make a decision based on the return in order to justify exposure to the risk. Shipping debt by way of ship finance by itself can take many forms, it could be from a plain vanilla single currency bilateral loan agreement to a multi-currency syndicate loan agreement, revolving facilities, swap transactions or mezzanine finance by hedge funds and/or with a series of documents relating to the security the borrower may be granting. As maritime companies have increasingly turned to the financial markets to raise capital they have come under closer scrutiny by investors and shareholders. They have strengthened their corporate structure, and they have become larger in size, due to their growth strategies through mergers and acquisition. In relation to debt finance, argued that bankruptcy and default on a debt instrument represent different phases of financial distress. "Grammenos studied debt finance for shipping companies for the first time. They investigated determinants of the primary pricing of shipping company high yield bond issues (C Th Grammenos et al. 2008)." "He also studied factors affecting the dynamics of yield premium[12] on seasoned high yield bonds of shipping companies. They found the explanation factors to be: credit rating; term-to-maturity changes in earnings in the shipping market, as well as in the yield on 10-year Treasury bonds and the yield on the Merrill Lynch single-B index. While default against individual financial instruments can represent early phases of corporate failure, predicting overall failure at the firm level is worth investigating (C. Th Grammenos et al. 2008)." The challenges in shipping have been known to shipping creditors which include primarily financiers but also shipping suppliers and other trade creditors, as well as to the owners and the other market participants for quite some time. The major events of default in a shipping loan include (a) non-payment of any sum payable when due; (b) breach of covenants [13] or undertakings, particularly insurance covenants, operational covenants and other financial covenants (this are set out in other sections of the loan agreement), incidentally, an important and very usual covenants an undertaking that the

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12 A yield spread premium (YSP) is the money or rebate paid to a loan broker for giving a borrower a higher interest rate on a loan in exchange for lower upfront costs, generally paid in origination fees, broker fees or discount points.

13 Covenants is a condition in a commercial loan or bond issue that requires the borrower to fulfill certain conditions or which forbids the borrower from undertaking certain actions, or which possibly restricts certain activities to circumstances when other conditions are met.

value of security, in case security includes a ship loan, the ship value is more than a certain percentage of the loan security requirement, usually it should be about 120% to 160%.

3.2 The Securitization of Shipping Default Risk

Shipping finance insurance covers for the assured (bank/financial institution) for outstanding loans and interest. This insurance covers the outstanding loan amount, should the other covers become void. In some cases, the ship financier purchases this cover and charges the owners. The cover can also be arranged by owners, in favor of the ship financier. Recent defaults have highlighted the high risks ship operators (and consequently also the ship financiers) run and the massive defaults that could follow in a worst-case scenario. It is therefore important for ship financiers to be aware of the significant role the insurance package involved in a transaction serves and also the potential pitfalls that may occur if these are not regularly inspected by insurance experts. The ship finance insurance can be seen as a back-up policy for the ship financier. For practical reasons the two parties agree that in the event of defaults below a certain amount, the insurer is allowed to pay the owner, shipyard or other party directly. Since the ship financier 's position as an assignee and loss payee is only as good as that of the original assured ship-owner, the ship financier is exposed to nonpayment risks, and ship finance insurance steps in to protect the ship financier against such risks. The sum which can be defaulted would be the ship financier 's losses, i.e. the loan outstanding, at point of time, subject to a maximum sum insured. “There is a provision in the ship finance loan agreement states that the ship financier is entitled to receive the proceeds from Hull and Machinery cover and any increased value covers, in the event of a total loss or if the default exceeds certain amount (Schinas et al. 2015).” Following a Notice of Assignment[14], the hull insurer would normally issue a letter of undertaking in favor of the ship financier based on a Loss Payable Clause[15]. However, hull insurers may decline to pay a default in certain circumstances. Typically, this might occur if the assured face a potential risk of a loss, as it is likely the ship owner without receiving the insurance defaults proceeds,

14 An assignment takes place when one party is holding a right to property, defaults, bills, lease, etc., of another party and wishes to pass it along (or sell it) to a third party.

15 Container ships (sometimes spelled containerships) are cargo ships that carry all of their load in truck-size intermodal containers, in a technique called containerization.

would be unable to perform and comply with the terms of the loan agreement. Therefore, the financier must demand an additional insurance security for the loan provided to a ship owner in respect of financing ship. This is achieved by a ship finance insurance and ship financier' additional perils insurance[16] which covers the outstanding loan amount, should the owner's insurance cover become void. Financing rights insurance[17], If a loan asset or ship is deployed to, or flagged or chartered into, jurisdictions with cross border sovereign problem, there are risks that the asset or ship will be removed, disadvantaged, seized, compulsorily acquisitioned, appropriated, expropriated, detained, nationalized, or restrained of refusal by the foreign government to allow the ship financier to exercise its rights of repossession in the event of default of refusal by the foreign government to allow the ship financier to remove the insured asset or ship from the foreign country of refusal by the authorities of the flag country to allow the ship financier to deregister the insured ship, including refusal to issue a deletion certificate or a closed transcript, of refusal by the authorities in the foreign country to allow the ship financier to obtain or to remit the proceeds of sale following a sale or disposal of refusal by the foreign government and/or authorities of the flag country or the United Nations to allow the ship financier to exercise its rights to repossess and/or remove the insured asset as a result of sanctions being imposed on the foreign country or flag country by or at express instruction of the United Nations or any future supranational authority embodied with similar powers. Before accepting the risk cover, insurers would have to be assured that no such risks exist under the principal laws or regime of the foreign country or flag. "Regularly, insurers will insist, prior to accepting the risks, that the ship financier provides a legal opinion, from a suitably qualified independent lawyer in that foreign country, confirming that the principal laws of the foreign country do not prevent or hinder the ship financier from enforcing the financing or will the existing laws impair the ship financier 's priority rights. In many cases, the challenge lies not only in getting a legal opinion confirming that no such risks exist under the principal laws or regime, but in finding a suitably qualified independent lawyer in such countries (Ang & Ngeow, 2010)."

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16 This insurance indemnifies the assured (bank/financial institution) if an insured peril results in legal liabilities for the owner exceeding the P&I policy/cover, e.g. confiscation of ship, priority liens, sequestration of default settlements or sale proceeds.

17 Financing rights insurance insures the ship financier against risks which prevent the ship financier from enforcing its security and recovering its losses.

3.3 Insurers Capital Requirement

The appropriate measurement of required capital by modeling economic capital[18] levels has become an important issue for ship finance insurers. Insurance company use of economic capital models is considered a key element of effective risk and capital management, both of which are considered in the rating process. While insurance companies seek to manage, risk using EC tools or US tools, no universal methodology exists. The insurance standard that has emerged in all of Europe, driven by Solvency II[19], is derived from banking risk management and capital analysis paradigms. Under the Solvency II framework, insurers will have to establish technical provisions to cover future defaults expected from policyholders. Technical provisions will be equivalent to the amount another insurer would be expected to pay to assume and meet the original insurer's policyholder obligations. Insurers must also have available financial resources sufficient to cover both a minimum capital requirement and a solvency capital requirement (SCR)[20]. The SCR is meant to cover all risks that an insurer faces, including insurance, market, credit and operational risks. Loss reserve risk is usually considered a component of insurance risk, along with underwriting and catastrophe risks. "After many ship financiers, have suffered economic downturns, leading to financial concern in the shipping industry, the lending business has in general become harder. This can be reflected, not only in the loan agreement and its insurance requirements, but also by the way the banks and other ship financiers supervise and follow up the insurances involved. There are many types of insurances to keep track of since the insurance package required normally is very complex. It may consist of both ship owner's insurances and other insurances specially designed to protect the financier and its credit risk. Because of banks being more and more cautious, the second type of insurances have become

18 Economic capital (EC) is the amount of risk capital that a bank estimates in order to remain solvent at a given confidence level and time horizon.

19 Under Solvency II, insurers will need enough capital to have 99.5 per cent confidence they could cope with the worst expected losses over a year. The rules take a risk-based approach to regulation: the riskier an insurer's business, the more precautions it is required to take.

20 The Solvency Capital Requirement (SCR) should reflect a level of eligible own funds that enables insurance and reinsurance undertakings to absorb significant losses and that gives reasonable assurance to policyholders and beneficiaries that payments will be made as they fall due.

more popular and is a common requirement nowadays in order to have a loan granted (Haider et al. 2008).” For shipping financiers’ changes in the environment have thrown up new opportunities for conceptualizing more innovative financing structures, finding new sources of capital, and diversifying both the client base and the portfolio. Some of the institutions have leveraged on this by coming up with modified financing structures, partnering with strategic investors, such as wealthy individuals and private equity funds, expanding relationship footprints, and also diversifying their portfolio into the offshore sector. These are now being widely used in the insurance market and they are taken out directly by the ship financier who therefore will be noted as the assured. The ship owner as the borrower will however in general be the party liable for the premium costs also for these insurances since this normally is a requirement stipulated by the financier in order to have the loan granted. Assignment of the ship owner’s insurance policies is, as mentioned above, one way for the ship financier to protect the loan and his interest in the collateral ship. The insurance policies shall from the ship financier’s point of view preferably contain wide terms and conditions together with reasonable warranties if any. The amount for which the ship is insured shall also by margin exceed the outstanding loan amount and the underwriting security shall have good credit strength.

Insurance relies on good faith. It is economically not practical to verify every aspect of the insurance application. While most individuals act on good faith, there are always those that will try to take advantage of this situation. Misrepresentation, non-disclosure, defaults simulation or self-inflicted losses count to the list of fraudulent acts that insurance is tackled with on a regular basis. “Profitability for an insurer is linked to investment income and cost of capital is linked to the wider economy. Expected losses in insurance sector affected by inflation, freight rates, growth or trading network. Therefore, cycle in the shipping business result in cycles in ship finance insurance (Santomero 1997).”

3.4 Risk Associated with Ship Finance Insurance Contracts

The financier’s obligation to insure can be either statutory or contractual. It is a standard requirement under the loan agreement that the ship is insured to the financier’s satisfaction. Firstly, this means that the conditions on which the ship is insured must be satisfactory. Secondly, the ship must be sufficiently insured in monetary terms. This relates both to the sum insured and to deductibles. Finally, underwriting security must be satisfactory the ability of insurance companies to pay defaults is a function of their available cash reserves and reinsurance arrangements. “The supply for shipping services depends on factors such as the fleet size, the scrapping of ships, the flow of new orders for ships, the capacity for shipbuilding, the labor and capital productivity etc. (Stopford, 2009).” All the above factors affect the supply and demand for services and therefore the level of freights. If for instance the capacity for shipbuilding shrinks the supply curve will shift to the left and freights will rise or if a natural disaster occurs the demand for shipping services will drop and therefore freights will normally decline when maritime companies have increasingly turned to the financial markets to raise capital they have come under closer scrutiny by investors and shareholders. They have strengthened their corporate structure, and they have become larger in size, due to their growth strategies through mergers and acquisition. “A generation of younger ship owners began to raise finance by utilizing international capital markets, particularly during the 1993–1997 and 2004–2007 periods (Haider et al. 2008).” There are many ways of financing ships, from traditional bank lending to private placements and public issues of debt and equity. They are all associated with different risks and the investor/financier has to make a decision based on the return in order to justify exposure to the risk financial standing of each ship owner may be assessed by referring to professional credit rating agencies, such as Moody’s, Standard & Poor and Fitch[21]. One may think it useful to regulate the lowest acceptable rating in the loan agreement, but this could create problems if the rating falls below the minimum level during the insurance period, as the borrower might be required to replace the insurance with a sufficiently rated underwriter. The ship’s finance insurances provide the ship financier with a comprehensive and effective tool for mitigating the risks of total loss, damage, and third party liability. For the ship financier the insurances serve two purposes. The insurance proceeds are an economic surrogate for the ship, which ensures the Financier recovery of the debt owed to him, even though the financing has demised. In case of partial damage or ship-owners liability,

21 The Big Three credit rating agencies are Standard & Poor's (S&P), Moody's, and Fitch Group. S&P and Moody's are based in the US, while Fitch is dual-headquartered in New York City and London, and is controlled by Hearst.

insurance enables the mortgagor to keep the ship in repair and free from maritime liens, thus maintaining the value of the loan.

The ship finance insurances provide the ship financier with a comprehensive and effective tool for mitigating the risks of total loss, damage, and third party liability. For the ship financier the insurances serve two purposes. The insurance proceeds are an economic surrogate for the ship, which ensures the Financier recovery of the debt owed to him, even though the financing has demised. In addition to ship finance insurance, the loan agreement usually allows the borrower to take out hull and freight interest insurances. The Financier will usually require the borrower to take out loss of hire insurance only if the ship is financed against a long-term charter party. The loss of hire is triggered by the occurrence of an insured event under the H&M[22] cover, and indemnifies the assured for loss of income while the ship is inoperative. The proceeds from the loss of hire insurance enables the borrower to service the loan repayments, while the ship is not generating income due to a partial damage. Ship Finance Insurance risks can be classified into the three main groups,

- The uncertainty with respect to the timing and size. The timing of the benefits to be provided by the insurer depends on the terms specified in the contract conditions, and in addition the nature of the covered default settlement process for ship finance insurance.
- The risks related to the deal provided by the insurer. This category of risk relates to the default level of the company as well as to expense allowances in the product.
- The ability of the ship owner to continue to pay the premiums.

For the ship financier, the sum insured is significant both in relation to total loss and partial damage. Firstly, the sum insured must be sufficient to provide the ship financier with an economic substitute for the financing in case of total loss.

Secondly, if the sum insured is less than the insurable value the liability of the insurer is reduced on a pro-rata basis. With regard to partial damage, this would impair the mortgagor's ability to repair the ship and restore the value of the loan. It may also have cash-flow consequences in case of general average, as the insurer's liability for the ship's contribution is also reduced. In marine insurance, the principle of assessed insurable value which is

22 Marine Hull & Machinery Insurance covers physical loss or damage to the hull and machinery which constitute the ship itself.

agreed between the insurer and the assured, ensures that the ship may be insured for a value sufficient to cover the ship financier's exposure, and at the same time avoid problems related to under and over insurance.

3.5 Risk-Shifting Alternatives for Ship Financier

Ship finance insurance falls within the general category of risk-shifting[23] insurance, whereby the chance or probability of loss is shifted to the insurance carrier. As such, credit insurance is under the umbrella of true ship finance insurance where the matter insured will definitely occur at some probability of occurrence, and the economic purpose is to spread the risk over a large pool of insureds. The insurance carrier understands the probability of occurrence through extensive accurate data and prices the coverage to fund the actuarial risk and make a profit. During its operation and employment, a ship is constantly exposed to the perils of the sea. Such perils may materialize into damages that render the ship inoperative, perhaps placing it off-hire if fixed on a time charter. The consequence is that the ship is reduced in value due to the damage itself, and that it ceases to generate income for the ship-owner, which in turn might impair his ability to service his commitments under the loan agreement. To exclude this, risk the ship-owner will be required to take out ship finance insurance. "The challenges in shipping have been known to shipping creditors which include primarily financiers but also shipping suppliers and other trade creditors, as well as to the owners and the other market participants for quite some time. However, the current issues in the shipping industry as well as in the global economic environment seem to be more acute (Timagenis 2014)." The ship finance insurance typically carries an annual premium and has a specific term of coverage, usually one year. Defaults need to be made within some specified default filing period that may or may not be coextensive with the period of coverage.

23 Risk shifting, which is also known as asset substitution, occurs if managers make overly risky investment decisions that maximize shareholder value at the expense of debtholders' interests.

3.6 Underwriting Pricing Structure

The ratemaking process is challenging because the amounts of unexpected future loss and their associated expenses are unknown when the insurance prices are developed at the beginning of an insurance contract period. “In risk management process in the insurance industry, insurance products have served as both risk control and risk financing techniques. The first function is designed to eliminate or reduce the likelihood or amount of loss. On the other hand, as a risk financing technique, an insurance product also provides a mean to pay for losses that do occur (Mhyr & Markham, 2003).” The current cost of buying protection on credit exposure to financial insurers via credit default swaps would suggest that market participants attach a significant probability to a default by these entities over the short term. “In insurance pricing, ratemaking refers to the process by which an insurance company calculates the price it seeks to charge its customers for the insurance it provides (Bischa 2008).” So, some earlier analysis interpreted the increase in ship finance insurance premiums as a sign that there was at least some concern on the part of market participants that losses on shipping business would turn out to be so substantial that they affected not just the unrated and lowly rated but also the most highly rated tranches of ship finance insurances. Ship finance insurers have argued that these price developments reflect an exaggeration of their problems and an underestimation of their actual financial health. It is possible that a lack of understanding on the part of many investors of the situation of ship finance insurers, including of issues related to their balance sheet accounting, has contributed to recent price developments. This suggestion is not debatable given that the business of financial guarantee insurance in general and specific issues such as calculating adequacy of capital, capacity and reserves, in particular, are perhaps not widely understood, reflecting the limited transparency of the sector. “The volatility in the underwriting results of an insurance of ship finance analysis requires assumptions regarding,

- the amount of premium to be written, earned and/or collected
- the fixed and variable expenses associated with the portfolio
- the aggregate distribution of losses
- the timing of the premium, expense and loss cash flows
- an appropriate rate to discount the cash flows
- the correlations or dependencies between lines of business

- the impact of or interaction with other economic variables (Myhr and Markham 2003)." Ship finance insurance pricing should take into account of the amount needed to pay potential financing costs, and expenses as well as the targeted profits by the insurance company (which, if achieved, compensates the capital invested by the insurer in support of the process and the risk of uncertain financial outcomes that is shouldered by the insurer). The pricing methodology used in ship finance insurance industry depends significantly on the variable (ship type, ship owner, business cycle, routes, and activity) to be priced and the statistical data available.

3.7 Risk Shifting Coverage and Valuation of Liability

A ship finance insurer is a party who is not automatically a party to the policy but to whom the ship owner wishes to or is required to extend a measure of protection under the policy. Additional ship finance insurers have direct rights to the policy and may demand payment of losses, settlements and judgments, or demand a defense. Ship finance insurance falls within the general category of risk-eliminating insurance, whereby the chance or probability of loss is shifted to the insurance carrier.

Ship finance insurance follows the model of insuring the results of the review of an information database. If the insurance carrier that is managing the review process effectively does its job, as a theoretical matter there should never be a default. For this reason, ship finance insurance is usually issued for an annual premium and for the life of the indebtedness secured by the subject ship, rather than for a single premium for a stated term for credit insurance. Given the risk-shifting coverages of ship finance insurance, it is perhaps incorrect to categorize ship finance insurance as either risk shifting or risk elimination, but a combination of both types of coverage to provide the financial institution an effective risk management tool. Ship finance insurance status is generally accomplished through an endorsement to the policy. These endorsements can vary from those that simply list parties as additional insureds to those that spell out the limits of protection afforded additional insureds. The most important strengths of the primary ship finance insurers are their ratings skills. As a consequence, they work closely with the shipping companies to preserve them. Capital suitability and payment reliability obviously play a key role in the rating agencies' credit assessments, same as liability insurers. In addition, rating agencies require that all potential transactions be of investment grade quality (i.e., at least A or BBB equivalent) before any ship finance insurance protection is considered.

Ship finance insurance requires extensive interaction between the ship owner/ financier and the ship finance insurer during the term of the credit insurance policy because ship owner credit analysis is not static. The capital is needed to protect against a change in value of the business, such that the likelihood of default, undesired impairment, or 'insolvency of the company'[24] over a given time horizon is less than a specified confidence level. Ship finance insurance covers the financier for extended default due to slow pay of a covered earning cash flows. That being said, a number of real concerns are not typically covered by ship finance insurance. First of all, ship finance insurance does not cover contract risk. A dispute between the financier and a ship owner over whether the payments fit to the contract is not covered. Ship finance insurance, subject to all the qualifications discussed above, covers the Financier for credit risk associated with non-payment by an insolvent ship owner. That's very useful coverage for the Financier to the insured if a) the ship owner has no recoverable assets, and b) the ship owner is a very weak credit risk for the financier and the financier is looking to the receivables as the sole source of loan repayment. However, if the ship owners are a going concern with sufficient projected cash flow to sustain its level of operations and indebtedness, ship finance insurance is a very expensive way of risk management. Ship finance insurance covers the insolvency of the ship owner. Ship finance insurance covers the insolvency of the ship owner. As such, ship finance insurance covers, to some extent, the credit risk to the lender of the insolvency of the ship owner in an asset based credit facility. In addition to the provision for insurance of ships, an

24 A company is considered to be insolvent under English law if it is unable to pay its debts. There are two tests for corporate insolvency: The cash-flow test: is the company currently, or will it in the future, be unable to pay its debts as and when they fall due for payment?

The balance sheet test: is the value of the company's assets less than the amount of its liabilities, taking into account as-yet uncertain and future liabilities?

insurer holds capital as a comfort margin[25] that provides assurance regarding the ability of the insurer to meet its obligations. The solvency margin can be used to measure the strength of the insurer to withstand adverse developments. The essential liability valuation principle is that to measure all the expected cash flows. These cash flows are uncertain with respect to the timing and the amount to be paid. Consequently, there is a need to risk-adjust the valuation process. Here the cash flows are risk-adjusted reflecting the market perception of risk. To project the future expected cash flows of insurance contracts when determining the fair value of the ships, estimates for each source of the cash flows have to be made (e.g., default, expenses, and default frequencies and sizes). "If the underlying parameters of the expected value of the cash flows could be determined with 100 % certainty and the parties involved are risk-neutral, then the 'expected value' would equal the market price. Therefore, the fair value of the ships will not equal the 'expected value of the liability', but rather the expected value plus an addition for the risk. This addition is defined here as the market value margin (Berman et al. 2012)." The market premium for risk, the price for uncertainty, is by definition independent of the shipping company. However, the market value margin 's for a particular company reflect the market's perception of the risk within that company and hence include the characteristics of the business. As such, the market value margin is derived from the market's view of a risk within the company and the premium for that risk charged by the market. In principle, the market value margins for a given portfolio of contracts are a function of the risk threat of the market. If the market were to become more risk-averse while the actual risk-averse the same, the market value margin 's would increase. It is, however, very difficult to separate the effect of a more risk-averse market from an outright increase in risk itself.

The ship value is defined as the discounted value of expected future cash flows (DCF)[26], for required capital purposes. We need to consider possible events occurring over the chosen time interval that affect either the cash flows in that time period, or expected cash flows in future time periods. "DCF techniques are also used to determine the fair value of

25 The comfort margin is a minimum excess on an insurer's assets over its liabilities set by regulators. It can be regarded as similar to capital adequacy requirements for banks. It is essentially a minimum level of the solvency ratio, but regulators usually use a slightly more comple calculation.

26 Projected future cash flows associated with a ship.

assets either explicitly or implicitly (Kerdpholngarm 2007)." A simplification typically is needed and so an estimate will be made of the parameters of the ship expected earnings and future value. The first will be included in the calculation of the cash flows. The second will be the basis for the market value margin. There are three aspects to the uncertainty with which the market value margin's is meant to deal. The first is the wrong model is chosen. The second is the risk that the expected values have been misestimated in the first place. The third is the risk that the expected values will change over time as actual experience differs from expected. The volatility of the assumptions, can form the basis of determining needed economic capital calculations. The complexity of modeling future cash flows is greater for insurance financed liabilities than for many other financial instruments because of the specific structure of the earning cash flows. Ship finance insurance liability cash flows should be modeled and valued using option-pricing theory. This concept implies that the market value of a financial security product producing uncertain cash flows is the same as the cost of hedging this uncertainty. This equivalence only holds in efficient markets meaning that the uncertain factors can be traded in liquid and deep financial markets. If the market value margin's lower confidence levels are used, the remaining part of the uncertainty risk is included in the required capital. As such, there is an inter-relationship between the three key elements, expected values, market value margins and required capital. The assumptions used in estimating the future cash flows are set as expected values used when determining the expected values plus a market value margin.

3.8 Valuation Standards of an Underwriting

The valuation of ship as an asset requires serious management skills, when determining whether the credit risk on a ship has increased significantly, to consider reasonable and supportable information available, in order to compare the risk of a default occurring at the reporting date with the risk of a default occurring at initial identification of the ship. To find out what a ship is worth. The main questions would be; what is it worth to me? I will emphasis these questions by first focusing the valuation part of pricing in a complete market setup, and then include also incomplete market based purchasing preferences. Equivalent questions are well known and handled within financial option pricing theory. Hence the market model context of option pricing fits well into the practical nature of non-life insurance[27] pricing. To get more hands-on pricing similarities and differences let us therefore outline insurance and option pricing in a parallel approach.

The insurer observes the true risk of loss for each individual, losses are due to states of nature beyond the control of the insured, and the insurance contract price reflects the expected loss costs of the insured. However, in practice the insured's true risk level is not directly observable by the insurer, and problems of adverse selection and moral hazard arise. Moral hazard exists when the insured changes behavior in a way which increases the probability or severity of loss after the contract has been written so that the contract price no longer reflects true expected loss costs. That is, adverse selection arises from hidden knowledge and moral hazard arises from hidden action. Ship valuation principles are similar to all liability valuation principles. If there is no risk, discount the future cash flows at the risk-free rate. A major issue in the use of present values is determination of the discount rate. So, what interest rate should be used for fair valuation? It is generally accepted that the degree of risk affects the interest rate. Higher interest rates are associated with greater risk to the holder of a security. That suggests, of course, that there is a market-determined interest rate that is associated with zero risk. Such an interest rate is called the risk-free rate[28]. The risk- free rate should be used in a present value calculation for cash flows that involve zero risk. If there is risk in the future cash flows, the present value estimate should include a risk adjustment to reflect the market price of risk.

The Ship Finance Insurance model relies on a relative assessment of credit risk[29]. Ship finance insurance have the most direct exposure of any insurance sector to financing credit risk. Their core business is founded on ship finance insurance that are relatively high-

27 General insurance or non-life insurance policies, including automobile and homeowners policies, provide payments depending on the loss from a particular financial event. General insurance is typically defined as any insurance that is not determined to be life insurance. It is called property and casualty insurance in the U.S. and Canada and non-life insurance in Continental Europe.

28 The risk-free rate of return is the theoretical rate of return of an investment with zero risk. The risk-free rate represents the interest an investor would expect from an absolutely risk-free investment over a specified period of time.

29 A credit risk is the risk of default on a debt that may arise from a borrower failing to make required payments

risk or otherwise non-standard. When it comes to the valuation of Ship finance insurance, the driving intuition behind the two most common valuation approaches fails us. This is because, for the vast majority of Ship finance insurance, there are neither liquid markets where prices can be disciplined by the forces of arbitrage and continuous trading, nor are there close comparable in this market. “The risk of ship finance refers to the chance that any unforeseeable negative elements may occur in the future and its scope of influence on the value of ships (Goerlandt & Montewka 2015).” Comparing with risks of financing in other branches of business, shipping financing has its own features in explaining type of risk and risk elements. To avoid risk in shipping financing is in fact to learn how one should recognize, measure and analysis these risks. It is a scientific management that tries to obtain a maximum safety at a minimum cost. “The process of risk recognition is in fact a process of picking out the best among various financing possibilities, i.e. choosing the best financier, the best scheme and best loan size to gain the lowest cost and largest profit. This process requires knowledge in management, accounting, finance, statistics, strategy and probabilities (Tapiero 2010).” It seems that ship finance banks do not regularly inspect or value ships which they are to finance, and that, even with older tonnage, many Financiers do not regard it as necessary to inspect the asset which will form the main security for repayment of the loan. Political, cultural, financial, taxation and government policy, etc. that may have impact upon macroscopic economical circumstance will affect the business operation of the ship.

The most effective way of avoiding risk in financing of ship is to reinforce the work of collecting and analyzing political as well as economical information from other countries, to best forecast future political risk by digesting the information and relying upon experience from the past. In order to be an effective valuation, a ship finance valuation should be capable of producing various types of output, both financial and analytical. Valuation, fundamentally, remains the same no matter what type of firm, one is analyzing.

4 THE CHALLENGES FACING SHIPPING FINANCE INSURANCE

The maritime sector is regarded as a commodity with signs of capital-intensive, high-risk and low return, the outlook for the financing of ships rather difficult. The periodic change in the international transport market requires investors ship right capture investment opportunities. Conventional types of values taken for finance capital base is insufficient when the asset is a ship. Because of the mobile and international nature of the ship he is responsible for claims of third parties under the law, have rights. Watching the same ship as collateral for the credit will not be enough for economic reasonable. In the event of total loss of the ship, and if the owner's insurance policies do not respond, or if you do not pay the debts exceed the value of the ship finance will be no other warranty. “Many of the risks associated with debt financing of the insurance containers are highly correlated (Gwilliam & Molenaar 1993).” For example, yields affect future benefits through loan quotas, while creating a competitive advantage (disadvantage), affecting ship prices and freight rates in the future of the marine market.

The risk of ship-financing refers to the ability to anticipate the future unpredictable negative elements and their ability to influence the value of the ships. Compared to the financing risks in other areas, the transport of finance sending their own characteristics to explain what kind of risk and risk elements. risk recognition process is actually a process of choosing the best of several possible funding, that is, to choose the best, the best economic system and the best size of credit to get the lowest cost and most of the benefits. This process requires experience in management, accounting, economics, statistics, strategy and odds. Fluctuations in future market interest rates and the exchange rate plays an important role in the financial capital retirement and the effect on the ability of the company to repay the credit. The times and the size of the ship cash flows to a usually means both uncertainty and long-term insurance. The experience of an actuarial valuation includes expected values relatively complicated for these liabilities, which contain various risks and integrated options. “Stopford (2009) defaulted that managing the shipping industry itself is volatile. The volatility in the shipping industry is driven by the freight rates, which is determined by the demand and supply in the shipping market. Furthermore, the freight rates are the income for the shipping companies, i.e. they generate the revenue to shipping companies, and thereby influence the stock price of the shipping companies (Stopford, 2009)." So, if the freight a rate goes up then the stock price to the shipping companies also goes up and vice versa if the freight rates goes down. The freight rates in the shipping industry are extremely important for the price of the stock to a shipping company, since the freight rates determine the income to the shipping company.

Ship Finance insurance is designed to cover non-payment of loan interest and principle payments. Ship Finance insurance is an evaluation of the ship owner's payment guarantee by the insurance company, typically the insurance company will give guarantee to the debtor's approved lender. Shipping finance risk can be defined as the deviations of the fair value of ship and debt obligations between expectations and realizations relating to the different factors that affect the value of its cash flow. The freight rates are the earnings to a shipping company. This earning affects the value of the shipping company. Generally, if the freight rates are high, then the earning to the shipping company will also be high. Thus, the stock to the shipping company will be high. If the opposite happens, i.e. freight rates are low, and then the value of the shipping company will be low. Mobilizing the necessary funds to satisfy the growing demand for shipping investment will require new sources and instruments of finance. As ship finance insurer involvement, can improve both the execution and the financing of a ship. Overall, the ship finance risk transfer to the insurance markets is still very limited. Despite the relatively small volume of ship finance insurance transactions to date, ship finance insurance has significant potential to improve ship building and ship sale/purchasing market efficiency and capital utilization in the shipping industry. Ship finance insurance is the one of the important innovations of modern shipping finance. The ship finance insurance enables the parties to the contract to manage and diversify risk, to take advantage of arbitrage opportunities, or to invest in new classes of risk that enhance market efficiency.

Ship finance insurance provides investors in debt securities with guaranteed payment of interest and principal in the event that the issuer of the guaranteed debt is unable to meet its financial obligations. The insurance provided by ship finance insurer consisted of a guarantee of the flows of payments rather than stocks of outstanding debt. There are two types of ship finance insurance companies that were closely involved in the construction of many of the new comple financial products based on securities exposed to credit (ship) risk. Further to the ship finance insurance companies that provide guarantees related to flows of payments on outstanding debt, there are private financing loan insurers that provide guarantees of the stocks of outstanding credit debt. The latter repay a certain percentage of the loan, typically between 25 and 35 per cent, if the borrower defaults. Both types of insurance companies are referred to as monoline insurance companies, as they focus on just one specific type of risk, which is credit risk. Ship finance insurers have the most direct exposure of any insurance sector to ship credit risk. Their core business is founded on insuring ship that are relatively high-risk e. g. where loan-to-value ratios exceed a specific percentage) or otherwise non-standard. In many countries, banking regulations require banks to demand credit insurance in those instances.

Despite the growing role of ship finance insurance in the shipping business that has come to characterize modern financial markets, the entities providing this specific financial service received relatively limited attention until early 2008. When several rating agencies openly discussed the possibility of taking adverse rating actions related to the biggest entities in the sector. The current challenges facing some preliminary findings,

- Over the short term, current pressures on ship finance insurers raise the question as to how relevant are these developments and the possibility of further credit rating downgrades.
- Transparency of the ship finance insurance sector is limited.
- Perhaps the most significant uncertainty is the timing of potential losses at ship finance insurance companies. Regardless of the specific point estimate of such losses, the key question is over what period of time these losses may be spread out.

Shipping is an input to a wide range of industries and, as such, an important driver of long-term growth. Ship investment lenders could not only help to provide the financing, but also help to ensure that a shipping business run efficiently. If contracts are designed properly, lenders have an incentive to see that a shipping operation is executed efficiently, because it increases the likelihood that their investment is safe and as profitable as expected.

In a ship finance loan transaction, the borrower is generally required to purchase insurance and thereby becomes the named insured under the policies issued. As the lender wants to protect its collateral and itself as well, the lender should ensure that it has the proper insured status under the policies as well. It is extremely important that a lender protect itself and its collateral (ship) in any lending transaction, and therefore lenders should always require that borrowers adequately insure their ship and protect themselves against potential liability through purchasing insurance. As part of their due diligence, lenders should conduct a thorough review of the required coverages to ensure that borrowers have purchased the types and amounts of insurance required under the loan documents. Lenders should look to ensure that the appropriate supports are in place to ensure that in the event of a loss the lender will be protected.

The role of insurance in ship finance is not limited to risk transfer as the insurance market also provides a source of finance directly and indirectly. Ship finance debt can be sold to insurance companies through private placements. The market for these placements tend to be concentrated within a few large companies, and from a borrower's perspective this is positive as it may reduce the cost and time required to arrange ship financing. In ship finance, there is a substantial degree of trust placed on the performance of the ship itself and as a result there is much stress on its feasibility and its sensitivity to various forms of risk. Ship financed transactions are different from corporate finance or structured finance assets because of their potential vulnerability to force majeure risks. This vulnerability arises out of the dependence on the ship as a single source of income and not having the comfort of a diversified asset portfolio to cushion the effects of a loss. Lenders want to have a number of risks covered by finance insurance, loss of profits/business interruption; such contingency risks as failure to honor financial guarantees in the event of default on loans.

A ship financier may only exercise its rights to collateral (ship) if a borrower is in default on a loan. Issues undermining the attachment, perfection and priority of security interests generally only become apparent once the loan is in default, often long after the loan has been made. The current economic situation and the resulting increase in charge-offs and delinquency rates have many lenders scrambling to assess the quality of their commercial loans and to re-examine their policies and practices regarding protection of the collateral securing such loans. In order for a security interest to attach to collateral, the borrower has to have rights in the collateral, there must be an authorized security agreement, and value must be given. Still another way for a lender to lose its secured position is by failing to perfect its interest in the collateral. The most common way of perfecting an interest in collateral is by filing a financing statement. But here again a lender can make a number of errors that may result in the failure of the interest to perfect. The current economic situation is resulting in an increasing number of problems for ship purchase lending. A review of recent cases reminds lenders how easily an interest in collateral can fail to attach, perfect or have priority. While it is important to examine and update internal systems, review processes and personnel, lenders should also remember the role that third-party service providers, like ship finance insurers, can play. Financial institutions engaged in significant levels of shipping lending need to assess the risks of such lending, develop and implement internal policies, control systems and review processes, obtain legal opinions when necessary and consider the additional protections that may be afforded by a ship finance insurance coverage.

One of the main features of ship financing is the collateralization of loans with ship as an asset and their repayment purely on the basis of shipping earnings. The revenue generating capability of a ship is a critical financing factor and tough conditions regarding delays in scheduled ship building completion have been added to contracts between financiers and ship owner, and particularly to those between ship owner and shipbuilders. The major events of default in a shipping loan include non-payment of any sum payable when due; breach of agreements or undertakings, particularly insurance agreements, operational agreements and other financial agreements. Many finance insurers also use a percentage of 120% of the regulatory capital to price their insurance products. Similarly, there is usually a requirement that the ship is insured also for a higher value at about 120% of her actual market value; the idea in all these cases is to cover administration expenses and interest.

If the borrower is unable to cover the shortfall either by prepayment or by granting additional security then this is a typical event of default which enables the lender to begin enforcement. Other important events of default include misrepresentation which in effect elevates the importance of the representations and warranties clause, cross default which is an equally important event of default and heavily debated between the parties. In effect, this is the prime example of a clause which is not a violation of the agreement in question, but it allows the lender to begin enforcement on the basis of a breach in another financial agreement usually non- payment. There are several other events of default which are typically included such as unlawfulness / unfeasibility, physical adverse change, etc. A ship owner needs a certain level of capital, which, with a certain level of confidence, prevents it from becoming insolvent. The capital required covers both the risks for the insurer that the ship owner cannot meet its obligations and the risks for the lender in the ship that they will lose their investment. The capital is needed to protect against a change in value of the ship, such that the likelihood of default, undesired loss, or insolvency of the ship owner over a given time horizon is less than a specified confidence level. This confidence level is set either by the regulators or the market in such a way as to be consistent with the level of comfort, risk-aversion[30] required by these institutions. As regulators usually require more prudence, the comfort levels of regulators might differ from that of investors. However, the use of similar methodologies in the evaluation and analysis of the risks of the ship owner would make comparisons possible.

4.1 The Valuation of Ship Finance Insurance

When it comes to the valuation of ship finance insurance, the driving intuition behind the two most common valuation approaches, arbitrage and comparable, disappoints us. This is because, for the vast majority of ship finance insurance, there are neither liquid markets where prices can be disciplined by the forces of arbitrage and continuous trading, nor are there close comparable in this market. We are left in a difficulty. If we can refocus our attention from market value to present value, progress can be made. A useful question to begin my valuation of liabilities is: ‘How much money would we need today to satisfy completely, on an expectations basis, the obligations imposed on me through the insurance policies we have written?’ It turns out that this is not only a good starting point, but a strong case can be made that it is also a good ending point insofar as liability valuation is concerned. The actuarial profession can best serve insurance management, financial

30 Risk averse is a description of an investor who, when faced with two investments with a similar expected return (but different risks), will prefer the one with the lower risk

markets, regulators, and investors by addressing that question. It can then be left for others to argue about the value of the default put option, franchise value, and the spin-off values of certain lines of business. If the focus is on determining the number of assets necessary to satisfy, on an expectations basis, the obligations imposed by the liabilities, the next question is how best to estimate that amount. We could take an indirect or a direct valuation approach. In the case of insurance companies, it becomes readily apparent that the indirect method of valuing liabilities may be quick, but is inefficient in addressing the question posed in the previous paragraph. Under the indirect method, tangible assets are valued and the market value of owners' equity is subtracted, presumably resulting in an estimate of the market value of ship. The present value of liabilities tells us the number of tangible assets needed today in order to satisfy, on an expectations basis, our liabilities. This present value, properly computed by means of treasury-rate-based lattices or simulations properly calibrated to current Treasury security prices, takes into account any interest rate sensitivities in the cash flows.

Valuation, fundamentally, remains the same no matter what type of firm one is analyzing. There are three groups of firms where the exercise of valuation becomes more difficult and estimates of value noisier. The first group includes firms that have negative earnings. Given the dependence of most models on earnings growth to make projections for the future, analysts have to consider approaches that allow earnings to become positive, at least over time. They can do so by normalizing earnings in the current period or by adjusting margins from current levels to sustainable levels over time or by reducing leverage. The approach used will depend upon why the firm has negative earnings in the first place.
The second group of firms where estimates are difficult to make are young firms, with little or no financial history. Here, information on comparable firms can substitute for historical data and allow analysts to estimate the inputs needed for valuation. The third group of firms where valuation can be difficult includes unique firms with few or no comparable firms. Due to the nature of derivation of the international shipping market, as well as to the complexity and uncertainty of both internal and external circumstance, shipping enterprises must exercise analysis, evaluation and judgement over the various unmeasurable elements in such situation, so that it can control the process of decision-making and gain the most favorable result from it. This will reduce the risk of ship financing.

The valuation of ship as an asset requires serious management skills, when determining whether the credit risk on a ship has increased significantly, to consider reasonable and supportable information available, in order to compare the risk of a default occurring at the reporting date with the risk of a default occurring at initial identification of the ship. The ship finance insurance model relies on a relative assessment of credit risk. The risk of ship finance refers to the chance that any unforeseeable negative elements may occur in the future and its scope of influence on the value of vessels. Comparing with risks of financing in other branches of business, shipping financing has its own features in explaining type of risk and risk elements. To avoid risk in shipping financing is in fact to learn how one should recognize, measure and analysis these risks. It is a scientific management that tries to obtain a maximum safety at a minimum cost. The process of risk recognition is in fact a process of picking out the best among various financing possibilities, i.e. choosing the best financier, the best scheme and best loan size to gain the lowest cost and largest profit. This process requires knowledge in management, accounting, finance, statistics, strategy and probabilities. "It seems that ship finance banks do not regularly inspect or value vessels which they are to finance, and that, even with older tonnage, many lenders do not regard it as necessary to inspect the asset which will form the main security for repayment of the loan (Finance 2012)." Risk in economical circumstance refers to the uncertain elements that exist in economy and influence the profit perspective of shipping enterprise which in normal cases will not be able to control the pattern of change of these risks.

It might be assumed that a financial institution lending on the security of an asset would take a close interest in the condition of that asset, not least because, in the institution's own interest, the asset itself is its security. A loan on a ship at the bottom of the sea, or on which pollution claimants have a prior lien, is of no value. The lender's interest in those circumstances will center on the insurances on the vessel, which will have been assigned to it. This involves the assumption that such insurances will respond in the event of a casualty. This may or may not be the case. There are numerous reasons why insurers under a hull policy may have a defense to claims by the assured or the lender as the assignee. The question must be asked whether the lender has any real interest in the quality of the asset which it is financing. Every asset, financial aswell as real, has a value. Ships being investments like any other, the traditional set of criteria used to evaluate investments in any industry can also apply to ships. The key to successfully investing in and managing these assets lies in understanding not only what the value is but also the sources of the value. The value obtained from any valuation model is affected by ship-specific as well as market-wide information. In some cases, new information can affect the valuations of all ships in a sector. It is unrealistic to expect or demand absolute certainty in valuation, since cash flows and discount rates are estimated with error. This also means that you have to give yourself a reasonable margin for error in making recommendations on the basis of valuations.

To find out what a ship is worth. The main questions would be, what is it worth to me? We will emphasis these questions by first focusing the valuation part of pricing in a complete market setup, and then include also incomplete market based purchasing preferences. Equivalent questions are well known and handled within financial option pricing theory. Hence the market model context of option pricing fits well into the practical nature of credit insurance pricing. The insurer observes the true risk of loss for each individual, losses are due to states of nature beyond the control of the insured, and the insurance contract price reflects the expected loss costs of the insured. However, in practice the insured's true risk level is not directly observable by the insurer, and problems of adverse selection and moral hazard arise. “Moral hazard exists when the insured changes behavior in a way which increases the probability or severity of loss after the contract has been written sothat the contract price no longer reflects true expected loss costs. That is, adverse selection arises from hidden knowledge and moral hazard arises from hidden action (Riley, 1985). “
When we try the value of a ship we use all available methods—discounted cash flow, multiples, and other methods. In theory, valuation is a relatively simple process of discounting a firm’s expected cash flows by investors required rates of return.
A number of valuation principles come into play when applying this hierarchy to insurance liabilities. The Shipping Finance Insurance hierarchy of methods for fair valuation would be:

- Use market value when available. Estimated prices for similar assets or liabilities.
- Estimated prices for identical or similar assets or liabilities in markets that are not active in which, use the market value of similar instruments, adjusted for differences between the instrument to be valued and the similar instruments. Market inputs other than quoted prices such as interest rates

- If no market value is available and no suitable similar instruments are available, use a present value estimate of future cash flows. This present value should include an adjustment for risk.
- Market inputs derived principally from or corroborated by other observable market data through such techniques as analysis of correlations.

To find out what an asset is worth requires consideration of risk tolerance, sometimes risk tolerance is captured by a utility function, sometimes risk tolerance is captured in an ad hoc way by artificially inflating a risk- adjusted discount rate. Fair ship values are estimated on the basis of the results of one or more valuation techniques that make maximum use of market inputs, with as little reliance on unobservable market inputs as possible. A fair value measurement technique should reasonably reflect how the market could be expected to price the asset or liability by incorporating all the factors that market participants would consider in agreeing to a price and be as consistent as possible with accepted economic methodologies. In addition, the inputs to the valuation technique should reasonably represent market expectations and measures of the risk-return factors inherent in the asset or liability being measured.

4.2 Ship Finance Insurance Techniques

There are three categories of ratemaking methods insurers should use for underwriting models. First, via a cash flow analysis, one estimates the length of time an insurer will have premium dollars on hand, prior to paying losses and expenses. Second, one estimates how much investment income an insurer will earn on this cashflow and the necessary equity backing up the policies. Finally, one sets the expected return on equity equal to a target return on equity. One can then solve this equation for the underwriting profit provision.

In theory and often in practice a discounted cash flow can be used to determine the discounted value of expected cash flows. The financial pricing model has replaced traditional assessment techniques for underwriting profit margin and underwriting systematic risk in vessel-liability insurers. An important advance in insurance financial pricing was the linkage of algebraic model of insurance firm with the capital asset pricing model. “The Capital Asset Pricing Model[31] developed in the mid-1960s by (Sharpe 1964).” If there is no active market, the valuation of a liability based on discounted cash flow techniques might be perceived to reflect subjective assessments. However, a concern should not arise as long as the valuation is based on a disciplined approach and difficult development of assumptions. The liability value can be estimated by discounting the projected value of all applicable future cash flows. The ship finance value of the liabilities should represent the amount of money that would have to be transferred in order for a willing third party (insurer) to take over the obligations that give rise to the liabilities. The process of adjusting the assumptions in order to alter the expected cash flow, in a way that follows what the market would do, is called a market value margin. The concept of incorporating market value margins in the valuation process is an important and interesting subject. The market value margin can be thought of as the difference between two expected cash flow measures. One is the measure using the true, or realistic, probability distribution and the other is the expectation calculated under the risk-neutral probability distribution. In the second case, the realistic probability distribution is tweaked so that the expected cash flow reflects how the market would assess the risk. In modern finance this probability distribution is called the Q-measure. The probability distribution based on the realistic probability distribution is called the P-measure. Some have argued that market value margins should be zero or very tiny for some, if not all, insurance risks. They argue that insurance risk is uncorrelated or orthogonal with the capital markets. If so, insurance risk would have a zero-market beta. For a fair valuation, a zero beta implies that expected cash flow should be calculated under the P-measure and discounted at the risk-free rate without an adjustment for risk.

To project the future expected cash flows, ship purchase/building contracts when determining the true value of the liabilities, estimates for each source of the cash flows have to be made. If the underlying parameters of the expected value of the cash flows could be

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31 The capital asset pricing model (CAPM) is used to calculate the required rate of return for any risky asset. Your required rate of return is the increase in value you should expect to see based on the inherent risk level of the asset. ra = rrf + Ba (rm-rrf)

where: rrf = the rate of return for a risk-free security , rm = the broad market's expected rate of return , Ba = beta of the asset.

determined with 100 % certainty and the parties involved are risk-neutral, then the "expected value" would equal the market price. However, in practice, uncertainty will exist with regard to the various parameters will not be risk-neutral. The uncertainty includes but is not limited to the appropriateness of models selected, the distribution functions used in the valuation, future development of selected assumptions and process risk. Therefore, the fair value of the liabilities will not equal the "expected value of the liability", but rather the expected value plus a reward for the risk. This reward is defined here as the market value margin. The market value margin is derived from the market's view of a risk within the company and the premium for that risk charged by the market. If the market were to become more risk-averse while the actual risks remain the same, the market value margins would increase. It is, however, very difficult to separate the effect of a more risk-averse market from an outright increase in risk itself.

Calculation of market value margin's using a Cost of Capital approach is straightforward given that the majority of the calculation is prescribed under the standard Solvency Capital Requirement. This means that implementation of this approach is straightforward and therefore can be used by both small and large ship. The calculation of market value margin's may require relatively comple models that use stochastic projections and risk-neutral decision rules. Such models are being used in many financial institutions to model "value-at-risk" and the probability of ruin. The expected present value of future liability cash flows includes premiums, fees, policyholder claims, expenses and commissions. if the liability cash flows could be matched exactly, the market consistent value of the liabilities will exactly equal the market value of the replicating portfolio. "The market value liability is derived from the cost of managing the risks underlying the business on an ongoing basis, where market values are not available, market consistent techniques should be applied in order to determine. The expected present value of future liability cash flows (Markets & Computations 2011)."

The Market Value Margin (MVM)[32] for non-hedgeable risks[33] calculation in theoretically, Market Value of Liability = PV of expected future cash flow + Ship Market Value (hedgeable financial risks) + Ship Market Value (Non hedgeable financial risk) + Ship Market Value (Non hedgeable risks & Non-financial risks)
The Market Value Margin (MVM) for non-hedgeable risks calculation in practical way, Market Value of Liability = Market Price + Ship Market Value (Non hedgeable risks) Financial risks + Ship Market Value (Non hedgeable risk, Non-financial risks).
Market values should be used where available to value the market value of liability, either for products in their entirety or their constituent parts. Where market values are not available, market consistent techniques should be applied in order to determine:

- The expected present value of future liability cash flows
- The market value margin for non-hedgeable risks

The market value margin is defined as the cost of risk, i.e. a risk margin in addition to the expected present value of future liability cash flows required to manage the business on an ongoing basis. Before calculating the market value margin, it is important to understand the types of risks affecting insurance liabilities. It is estimated by the present value of the cost of future capital requirements for non-hedgeable risks.

In general terms, the cost of hedging is given by the market value of those instruments that the insurer would need to buy in order to fully hedge its position, as this includes expected and unexpected loss costs, transaction fees etc. In theory, it is possible to sell any risk for a price. However, in order to be confident with reasonable certainty that the price accurately represents the market value liability, the price for the risk would need to come from a deep and liquid market. Risks for which a deep and liquid market is not available are referred to as non-hedgeable (It is possible that over time non-hedgeable risks will become hedgeable as deep and liquid markets develop). They are risks for which a

32 The market value margin is the smallest amount of capital which is necessary in addition to the best-estimate of the liabilities, so that a buyer would be willing to take over the portfolio of assets and liabilities.

33 Hegable Risk: A risk associated with an asset or an obligation that can be effectively neutralised by buying or selling a market instrument (or engaging in a contract with a third party in an arm’s length transaction under normal business conditions), whose value is expected to change in such a way as to offset the change in value of the asset or liability caused by the presence of the risk.

market price cannot be observed. In a ship finance insurance, if considering the use of ship finance insurance as parallel to an insurance default (as ship finance insurance costs both time and money), then loss frequency is parallel to the possibility of dispute occurrence, which is also the possibility of ship finance insurance being utilized. For example, in health insurance, loss frequency is related to each customer's unique features such as age, gender, life style, etc., and can be estimated once the insurer knows those characteristics of the insured. In ship finance insurance, the possibility of disputes occurring and ship finance insurance being applied differs with the ship type characteristics, and can be estimated by knowing those characteristics of a particular financing. Based on past experience and statistical data, ship finance participants should be able to identify and weight the possible indicators of dispute occurrence. For example, a medium/small size ship financing may have higher likelihood of disputes arising from problems in communication channels (management process) and changing political environment (external uncertainty).

The role of insurance in ship finance is not as straightforward as one might think. Shipping risks are dynamic and there are no set of rules dictating how these risks should be managed. The insurance industry itself is vulnerable to sudden changes in its attitude towards certain risks and therefore it cannot be taken for granted that the insurance coverage will always be available. In addition, not all operating risks are insurable and the proceeds of insurance may not be sufficient to cover lost revenues or increased expenses. It is therefore important to differentiate between risks for which an insurance solution exists and risks for which there is limited or no insurance solution. In asset-based lending the lender's main concern is that the asset is available if and when needed, whereas in ship lending it is the physical asset that is important that the ship produces a revenue stream sufficient to service its debt. This revenue stream can be frozen by whole range of factors other than the ship as an asset i.e. availability of reserves, availability of a market, price, interest rates etc. Insurance therefore tends to be almost one dimensional in its approach to risk transfer as it focuses only on physical damages and any financial loss must follow actual physical loss. This limitation should however not be seen as a setback as insurance provides one out of many alternatives to managing shipping risk. There is a tendency for the parties to believe that once insurance cover is in place that they could sit back and rela and any losses will be taken care of by the insurance company.

4.3 Estimated Default Exposure

Credit risk indicators are constructed directly from observed book value ship volatility. This information is used to construct four credit risk indicators, the distance-to distress, the default probability, credit spread[34], and expected losses given default. Default is defined as failure to make scheduled principal or interest payments. A shipping firm default when the market value of its assets (the value of the ongoing business) falls below its liabilities payable (the default point) or stop paying the scheduled credit payment on time. There are three key values that determine a shipping firm's estimated default frequency (EDF) credit measure,

- The current market value of the shipping firm, market value of assets
- The level of the shipping firm's obligations default point
- The vulnerability of the market value to large changes asset volatility

Because these are objective, non-judgmental variables, credit measures have consistently outperformed the rating agencies in distinguishing between defaulting and non-defaulting shipping firms. Not only that, they have proven to be a consistent leading indicator of agency rating upgrades and downgrades. The range of variables that may affect bank soundness and the probability of default is wide, especially given the heterogeneity of shipping business models.

Black Scholes–Merton (BSM)[35] based probability of default is a sufficient statistic for forecasting bankruptcy (default). When predicting default, the BSM model can be useful. With information on the market value and volatility of equity and on the value of debt, it is possible to estimate the implied value for assets and assets volatility through the Black-Scholes option formula. With the total value of assets and assets volatility, it is then possible to estimate a set of credit risk indicators exposure at default (EDF), credit spread, distance-to-distress, and expected losses.

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34 A credit spread is the difference in yield between a U.S. Treasury bond and a debt security with the same maturity but of lesser quality. A credit spread can also refer to an options strategy where a high premium option is sold and a low premium option is bought on the same underlying security.

35 It's used to calculate the theoretical value of European-style options using current stock prices, expected dividends, the option's strike price, expected interest rates, time to expiration and expected volatility.

AE = Adjusted Exposure

DPT = Default Point

Lending institutions need to understand the loss that can be incurred as a result of lending to a ship finance that may default, this is known as expected loss (EL). EL can be expressed as a simple formula that EDF is the exposure at default, PD is the probability of default, LGD is the loss given default. Default means that shipping firms' assets less than default point. (Merton Model)

$$EL = PD \ \ LGD \ \ EDF \tag{4.1}$$

The total exposure to credit risk is the amount that the borrower owes to the lending institution at the time of default; the exposure at default (EAD). Generally, EAD will not be larger than the borrowing facility. Probability of default (PD) and loss given default are risk metrics employed in the measurement and management of credit risk. The metrics are used to calculate EL. The probability of default (PD) is the likelihood that a loan will not be repaid and will fall into default. It must be calculated for each borrower. The credit history of the borrower and the nature of the investment must be taken into consideration when calculating PD. External ratings agencies such as Standard and Poor's or Moody's may be used to get a PD; however, banks can also use internal rating methods. We use my own calculation of PD specially designed for shipping companies here. PD can range from 0% to 100%. If a borrower has 50% PD it is considered a less risky company vs. a company with an 80% PD. Estimated default frequency and is a measure of the probability that a shipping firm will default over a specified period of time (typically one year). In shipping finance and credit default issues, estimated default frequency credit measures exhibit a number of characteristic that distinguish them from conventional and other statistical approaches to measuring default risk.

- Estimated default frequency credit measures are a dynamic and forward-looking measure, unlike alternatives that generally rely on accounting data that is essentially historical and backward looking.
- Estimated default frequency credit measures are actual probabilities critical in debt pricing and portfolio management operations, in contrast with alternative products that offer only relative rankings.

- Estimated default frequency credit measure is based on cause and effect model that is not statistically fitted to predict default. This result in performance that is consistent over time. In contrast, the same agency bond rating corresponds to different default rates at different times.

For example; The ratemaking process in ship finance insurance considers each ship's unique features such as year build, type of the ship, market conditions, contract period/style, etc. The insurance company obtains information on a ship's current working status, past operating history, and other indicators of potential future costs or default. Then it estimates the overall risk of default and develops a routine finance structure. Default risk is the uncertainty surrounding a firm's ability to service debts and obligations. Ship's equity can be seen as a call option on the underlying asset. Because at the maturity of debt, financier receive their debts, equity holders take the rest. Let's say, A shipping company takes out a loan for a single ship from Bank ABC for

$15 million (the exposure at default) (EDF).

ship owner pledges $3 million collateral

against this loan (for simplicity, let's say the collateral is cash). The ships' the probability of default (PD) is determined by analyzing their credit risk aspects (evaluate the financial health of the borrower, taking into account economic trends, borrower credit rating, etc.) For shipping company, let's say the PD is 0.618. This means that the Company is very risky; the probability of them defaulting on the loan is 70%. If the shipping company defaults (is unable to pay back the $12 million to Bank ABC), the Bank will be able to recover $3 million (this is the cash-secured collateral). So, the actual loss given default (LGD) is

$$LGD= 1- \text{Recovery Rate (RR)} \quad (4.2)$$

The Recovery Rate (RR) is defined as the proportion of a bad debt that can be recovered. It is calculated as:

$$\text{The Recovery Rate (RR)} = \text{Value of Collateral / Value of the Loan} \quad (4.3)$$

Back to our example,

the recovery rate for Bank ABC = \$3 million / \$15 million = 20%, so

% LGD = 1- 0.20 = 0.80 or 80%.

LGD= 80% of a \$15 million (EAD) loan is equal to \$12 million.

LGD = \$12 million

Expected Loss (EL) is what a bank can expect to lose in the case that their borrower defaults.

It is calculated below:

EL = PD * LGD * EDF

EL= 0.618 * 80% * \$12 million

EL = \$5.933 million

Bank ABC can expect to lose \$5.933 million. Premium amount should be calculated based on EL result instead of the total loan amount.

5 FINANCIAL ANALYSIS OF SHIP EARNING

Ship owners generate income by leasing out their vessels for a defined period in the time charter market or by charging according to specific journey in the voyage charter spot market. In time charter market, a charterer pays the owner a daily lease rate for the life of the contract, typically 6 to 12 months. The owner provides the charterer with the ship and must pay for the crew and maintenance, but the remaining costs, including fuel, are accepted by the charterer.

Low current ship earnings are associated with lower ship prices and earlier higher industry investment; the economic magnitude of return predictability is stable but lower than industry expectations. At the same time, fluctuations in short-term lease rates do not imply anything about the expected returns on shipping capital. Consider a neo-classical benchmark in which the required return on capital is constant over time.
To proceed with the calculation of the distance to default, we had to estimate the daily assets return in such a way that we can after transform it into an annualized value (which will be fixed):

$$r_t = \ln(\frac{V_t}{V_{t-1}}) \quad (5.1)$$

where (r) is the daily ship income return and (V) represent the market value of ship.

$$\sigma_{daily} = \sqrt{\frac{1}{T-1}\sum_{i=1}^{t}(V_t - \text{y})^2} \quad (5.2)$$

then (σ) stands for the involved assets volatility per day, (V) is firm's asset value and y is the mean of the total estimated for a single ship.

$$\sigma_{\text{annual}} = \sigma_{\text{daily}} \ \sqrt{355} \quad (5.3)$$

We multiplied the daily standard deviation by the square root of 355 since the ship earning normally are 355 days throughout the year. Ship owners earn income either by transporting cargo for hire or by leasing out their ships for a defined period of time in the ‘time charter’ market. “In 2007, a 5-year old ‘Panamax[36]’ ship commanded daily lease rates of $25,325 and could be purchased for $44 million. By December 2008, daily lease rates hadn’t grow than one fourth to $6,000, and purchase prices had decreased more than si times to $8 million. By 2014, lease rates and secondhand prices had nearly returned to their 2004 levels. This huge volatility occurred alongside enormous instabilities in industry investment. In December 2007, outstanding orders for new ships amounted to more than 70% of the active fleet. However, by December 2010, outstanding orders for new ships dropped less than 10% of the active fleet (Greenwood & Hanson 2015).”

For example; for a 5-year old Panama ship, approximately 80,000dwt, the owner earns the charter rate for an average of 355 days per year; the boat is for dry dock or maintenance for the remaining 10 days per year. The ship owner must provide a crew, at a daily cost that we estimate to be approximately $7,000 per day, ‘adjusted for inflation’.[37] Thus, annual earnings in year *t* are given by

$$\Sigma_t = 355.\text{Daily Charter/Lease Rate} - 365.\text{Daily Cost}_t \qquad (5.4)$$

in addition to proving the high volatility of ship earnings. Earnings are 85% correlated with earnings in the previous month, but only 60% correlated with earnings 6 months earlier, 20% correlated with earnings 12 months earlier, and uncorrelated after 18 months. It is difficult to evaluate the apparent volatility in ship pricing without first considering a benchmark in which discount rates are constant.

36 Panama are terms for the size limits for ships travelling through the Panama Canal.

37 This estimate is based on Stopford (2009) and conversations with ship owners. CPI potentially overstates the growth of crew costs because globalization has allowed ships to source crews from lower wage countries over time.

5.1 Earning and Future Returns Model

When market value is not available fair value should be computed as a present value of future cash flows. This approach supports a price by answering the question, ‘How much is it worth if it can bring in money over time?’ In the case of a ship, the question becomes, ‘How much would it bring in each month if you chartered it for a period of time, and how much is that series of cash flows worth as a lump sum today?’ The method of most interest for ship valuations is the net present value of all net earnings the ship is presumed to generate during her remaining commercial life plus her scrap value itself. “The present value approach is a reasonable approximation of market value if properly implemented. The present value model is very flexible. In particular, it can be adapted to reflect the value of risk and uncertainty (Babbel 1998).” These are instruments where the fair value cannot be determined directly by reference to market-observable information, and some other pricing technique must be employed. Instruments classified in this category have an element which is unobservable and which has a significant impact on the fair value. The most crucial assumption in modeling earning and future returns model is of course the projection of freight revenue, which in turn is based on assumptions of future market conditions of tonnage supply available vessels to compete for same cargoes, etc., tonnage demand subject to world economic conditions and trade and also trading patterns, and also the chartering strategy of the buyer, spot market, sequence of short-term charters or very long- term charters. The cost and availability of debt finance will be another major input in the earning and future returns model financial modeling.

When a market price exists, it should not be ignored. Even if it cannot be used directly as the fair value, it may provide some guidance, and the difference between any reported fair value and the market price of a similar instrument should be explainable in direction and, preferably, also in amount. Whenever it is possible to dispose of a financial instrument through exchange for cash in a deep, wide, and open market, then the market price is the fair value. When applying this hierarchy to ship finance insurance contract, one often finds method 3 most applicable. Therefore, it is important studying the principles commonly applied when computing present values and making risk adjustments for financial instruments.

a. If there is no risk, discount the cash flows at the risk-free rate.

A major issue in the use of present values is determination of the discount rate. The market for newly issued financial instruments includes a variety of instruments that offer a variety of interest rates. So, what interest rate should be used for fair valuation?

It is generally accepted that the degree of risk affects the interest rate. Higher interest rates are associated with greater risk to the holder of a security. That suggests, of course, that there is a market-determined interest rate that is associated with zero risk. Such an interest rate is called the risk-free rate[38]. The risk- free rate should be used in a present value calculation for cash flows that involve zero risk.

b. If there is risk in the cash flows, the present value estimate should include a risk adjustment to reflect the market price of risk.

When a financial instrument involves more than one kind of risk, each risk can be reflected using a different technique. Different combinations of risks and risk adjustment techniques lead to a wide variety of methods for valuation of financial instruments.

c. Include all cash flows.

The cash flows being valued should include all cash flows associated with the vessel being valued.

For example, a rise in interest rates could cause the fair value of a fully guaranteed vessel insurance contract to fall below its cash surrender value. The main difficulty is to make reasonable adjustment for risk. To be reasonable, an adjustment for risk must reflect a market price for risk in some fashion. The floating of the interest rate and exchange rate of the future market plays a significant role in financing shipping capital and have effect on the capability of the company repaying the loan. 'The risk of the interest rate.' 'The risk of the exchange rate.' Due to possible changes of all the factors of capital cost, the capital cost rate is not a precise value. Change all the net cash flow into present value[39] according to capital cost in the period of the plan and sum them up. The formula for the discounted sum of all cash flows can be rewritten as.

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38 The risk-free interest rate is the theoretical rate of return of an investment with no risk of financial loss, over a given period of time.

39 Net Present Value (NPV) is a formula used to determine the present value of an investment by the discounted sum of all cash flows received from the project.

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - I_0 \tag{5.5}$$

where

n = lifetime of ship

CF_t = Income generated by ship in year t (t= 0, 2…., n)

I0 = Expenditure spent on ship in year t (t=0, 1…, n)

r = Ship owner's cost of capital (assumed constant)

If let total capital cost of shipping investment be I, rate of return on investment r, fixed number of use year n, an annuity is a series of periodic payments (Net Income) that are received at a future date. This formula assumes that the rate does not change, the payments stay the same, and that the first payment is one period away, then we can reduce cash inflow per year;

$$Annuity(A) = \frac{I_0}{\left[\frac{1-(1+r)^{-n}}{r}\right]} \tag{5.6}$$

Total Value Amount = Initial Credit (CR) + Income net (N)

$$NPV = A\,\frac{1-\ (1+r)^{-n}}{r} - I_0 = I_0\,\frac{r}{1-(1+r)^{-n}}\,\frac{1-(1+r)^{-n}}{r} - I_0 \tag{5.7}$$

Above formula has not considered the shipping scrap value. The ship's net scrap value is S_n, then the present value of ship net scrap value

$$P_n = \frac{S_n}{(1+r)^n} \tag{5.8}$$

$$NPV = I_0\,\frac{r}{1-\ (1+r)^{-n}}\,\frac{1-\ (1+r)^{-n}}{r} - I_0 + P_n \tag{5.9}$$

$$NPV = \ I_0\,\frac{r}{1-\ (1+r)^{-n}}\,\frac{1-(1+r)^{-n}}{r} - I_0 + \frac{S_n}{(1+r)^n} \tag{5.10}$$

We construct it as IRR[40]. When NPV=0, according to formula above, we can get:

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = I_0 \tag{5.11}$$

the relationship between price and time is derived from the first derivative of the net present value price function, which equals the sum of present value of all cash flows i.e. all future income and the final face value (scrap) payment.

This key duration relationship shows that the percentage change in a bond price is approximately equal to its duration multiplied by the size of the shift in the yield curve. The chart below shows this relationship. For example, a two-year 6% bond with face value $100, with semi-annual coupon payments, duration is as follows.

Table 5-1 Estimated income rate over the year

Estimated income rate over the year, Payback period is 10 years

Ship Price	Yield		Second hand price at 10 years	
$10,000,000	6%		$3,000,000	
Time	Cash Flow	Present Value	Weight	Time*Weight
0.5	1,000,000.00	971,285.86	0.060499	0.030250
1.0	1,000,000.00	943,396.23	0.058762	0.058762
1.5	1,000,000.00	916,307.42	0.057075	0.085612
2.0	1,000,000.00	889,996.44	0.055436	0.110872
2.5	1,000,000.00	864,440.96	0.053844	0.134610
3.0	1,000,000.00	839,619.28	0.052298	0.156894
3.5	1,000,000.00	815,510.34	0.050796	0.177787
4.0	1,000,000.00	792,093.66	0.049338	0.197351
4.5	1,000,000.00	769,349.38	0.047921	0.215644
5.0	1,000,000.00	747,258.17	0.046545	0.232725
5.5	1,000,000.00	725,801.30	0.045208	0.248646
6.0	1,000,000.00	704,960.54	0.043910	0.263462
6.5	1,000,000.00	684,718.21	0.042649	0.277222

40 The internal rate of return can be defined as discount rate when cash inflow is equal to cash outflow in the period of the plan or when NPV is zero.

7.0	1,000,000.00	665,057.11	0.041425	0.289974
7.5	1,000,000.00	645,960.57	0.040235	0.301765
8.0	1,000,000.00	627,412.37	0.039080	0.312640
8.5	1,000,000.00	609,396.77	0.037958	0.322642
9.0	1,000,000.00	591,898.46	0.036868	0.331812
9.5	1,000,000.00	574,902.61	0.035809	0.340189
10.0	$3,000,000.00	1,675,184.33	0.104343	1.043433
		16,054,550		5.132289
				(823,965)

The weight column is calculated by dividing all the present values by the sum of the PV, which is also the value of the debt rate today. Effectively 5.1322 is the duration of this ship. It means for every 100-basis point increase (1%) in yield, the price of the ship decreases by approximately $823.965.

A long period of time indicates that the ship is more sensitive to changes in interest rates. This also indicates that for a given income rate and yield to maturity, ship with a longer term to scrap are more sensitive to changes in interest rates than corresponding ship with a shorter term to maturity. According to the NPV criterion, the ship or combination of ships that yields the maximum possible NPV is the best alternative for the ship owner. However, the simplicity of this criterion is misleading, mainly because of the significant uncertainties associated with all elements in the NPV formula. For instance,

1. The income stream CF_t is subject to the atmospheres of the markets in which the ship will operate through its lifetime, and also depends on the way the ship will be utilized (which markets or trades it will serve, what cargoes it will carry).
2. The cost stream I0 is also uncertain, as it depends on variables such as fuel prices, which are not known with certainty, but also on uncertainties as regards repairs, maintenance and other costs. It also depends on how the ship will be utilized.
3. The cost of capital CF_t may not be known throughout a ship's lifetime.

The highest care should be exercised to compute all elements of the formula as well as possible, or, if this cannot be done, to perform a comprehensive sensitivity analysis.

5.2 Finding Freight Rate According to NPV

Freight rate risk is caused by the volatility of the earnings of a shipping company from the freight rates. This is the fundamental origin of risk in a shipping company. In 2016, the freight rates market remained very volatile in its various segments. The continuous delivery of newly built large vessels and hesitant demand in the global shipping market put pressure on rates. “Freight rates appear to fluctuate more today than in earlier decades, and the changing structure of operating versus fixed costs is probably one of the reasons for this trend. Price-setting in transport and logistics markets significantly depends on the level of effective competition (Widiantoro & Elvenes 2012).” Competition in the transport markets depends on the size of the market and effective market regulation. There is no relationship between distance and maritime costs. It is known that larger ships will typically have a lower freight rate than smaller ships because of economies of scale, which makes this criterion biased in favor of smaller ships. Also, a constant freight rate is seldom, almost none, experienced by any type of ship, an exception being a ship engaged in a very long term charter in tramp trades. The consideration of freight rate in shipping are important in this respect, make sure to compare ships of similar size.

A ship owner is more interested in what money he or she will make through a ship’ s lifetime than what value a particular ratio will take on. Predicting level of income and expenditures over a ship’s entire lifetime involves significant uncertainties. However, it is clear that both depend on the way the ship is utilized. This can have an important impact on NPV, the required freight rate, IRR and other criteria.

6 THE RESERVE RISK AND BUILDING METHOD IN SHIPPING FINANCE INSURANCE

Insurance risk consists of two aspects: the risks associated with the writing of new business (underwriting risk) and the risks inherent from business already written (reserving risk). "Underwriting risk is the risk associated with the uncertainty of business written in the future, both new business and the renewals of existing policies. This would include catastrophe risks. Reserving risk is the risk associated with the potential inadequacy of claims reserves and provisions for unearned premiums and unexpired risks (Actuary, 2016)."
"Examples of risk factors are:

- the effects of inflation on claims reserves and expenses;
- social changes resulting in an increase in the propensity to claim or to pursue litigation.
- the adequacy of claims reserves;
- the adequacy of provisions for unearned premiums and unexpired risks;
- the frequency and severity of large claims and latent claims;
- changes in the legal system, such as increased court awards or changes in policy wording interpretation;

It has been argued that risks facing all financial institutions can be segmented into three separable types from a management perspective (Santomero & F. Babbel, 1997)." "These are risks that can be eliminated or avoided by standard business practices, risks that can be transferred to other participants, and risks that must be actively managed at the firm level (Actuary, 2016)." Common risk avoidance practices include at least three types of actions. The standardization of process, insurance policies, contracts, and procedures to prevent inefficient or incorrect financial decision is the first of these.
Another is the construction of portfolios on both sides of the balance sheet that benefit from diversification and the application of the law of large numbers and central limit theorem, which reduce the effects of any one loss experience.

Finally, the implementation of incentive compatible contracts with the institution's management to require that employees be held accountable is the third. There are also some risks that can be eliminated, or at least substantially reduced, through the technique of risk transfer. “Markets exist for many of the risks borne by the insurance firm. Actuarial risk can be transferred to reinsurers. Catastrophe risk can be offset somewhat by undertaking a position in catastrophe futures and in catastrophe bonds. Indeed, a number of capital market alternatives for dealing with this kind of risk are currently under consideration (Jaffee et al. 1997).” Insurance risk concerns the inherent uncertainties as to the occurrence, amount, and timing of insurance liabilities. Perhaps one of the most important challenges facing insurers to date is the market valuation of the assets and liabilities in one consistent framework. Risk assessment has so far been overly reliant on hindsight (retrospective analysis). Most tools seek to reduce complexity through statistical analysis of historical data, such as annual reports or evaluations by rating agencies and credit bureaus. “The primary goal of the reserving process is to estimate those which have not yet been paid- unpaid losses. The estimation of loss reserves can materially impact a firm’s financial condition, including its surplus level, reported profit level, ta payments, pricing, capital allocation and financial ratios, which may place the firm under stringent regulatory attentions and affect the strategies that a firm is able to pursue (Anderson, 1971).”

An active market is needed for the assets and liabilities in order to develop a historical profile of changes in value under multiple market conditions. The majority of investments, fixed income assets, were held at amortized value and loss reserves are held at an undiscounted nominal value. The source of differences between the traditional actuarial and the financial view of risk are also driven by the concept of time horizon. Standard actuarial models do not produce results over a discreet time horizon but rather results at “ultimate” or “life of liability basis”. The actuarial methods are focused on the magnitude of the final value not how an estimate may move to its final value. The reason for ignoring time step in actuarial methods is driven by the lack of relevance to their intended use. Current actuarial triangulation or chain ladder methods are used to produce best estimates of loss reserves for financial statement purposes.

6.1 Evaluating the Pricing Risk in Ship Finance Insurance

In a hard market, such as shipping finance, insureds may be more concerned by the size of their insurance premiums and therefore keener to demonstrate good quality risk management to their insurer. In the above term insurance example, the risk premium was held constant for simplicity of illustration. “The reality of markets is that risk premiums do not remain constant. If it is decided that it would be appropriate for this margin to be changed over time, it should be easy to adapt such a feature. In fact, not recognizing a change in the risk premium would be inconsistent with an important concept underlying the measurement of fair values, the use of current estimates and assumptions (Laeven & Goovaerts 2007).” For example, it would reflect recent experience, which has seen large swings in the value of the risk premium in credit instruments and in the ship finance underwriting cycle. While the risk premium in a property & casualty insurance product is likely to fluctuate less than would be the case for credit instruments or ship finance insurance, the insurer still has to assess periodically the appropriateness of its risk premium and update its assumptions accordingly. Market factors that might indicate a change in the risk premium in a line of business include, a change in prices in response to a shift in level of competition, a dramatic fluctuate in the volume ship sold / purchase. “Competition among insurers is one of the primary causes of underwriting cycles in ship finance insurance and is itself affected by factors that drive the cycle, such as the availability of capital and investment returns (Weiss 2007).” There are several methods of pricing products in the market. While selecting the method of fixing prices, a marketer must consider the factors affecting pricing. The pricing methods can be broadly divided into two groups—cost-oriented method and market-oriented method.

6.2 Reserving Calculations

Reserving is concerned with forecasting outstanding liabilities. Reserving risk attempts to capture that uncertainty. There are reserve requirements and capital requirements. The level of collateral is set by the regulators. Not attempting to measure the reserve adequacy, the reserving risk charge in risk-based capital formula serves to measure the vulnerability of loss reserves to adverse developments. The calculations are performed separately by individual companies, line of business, financial reports and statement data. The reserving risk charge is comprised of industry-wide and company-specific components. For each shipping company, the financial ratios are calculated as for each line of shipping business on a certain statement date, individual company ratios are averaged unweighted to determine the average industry-wide ratio. “The insurance business is highly regulated. The purpose of these regulations is to lower the risks for the customers, making sure that the companies do not promise what they cannot keep. The pricing methodology used in insurance industry depends significantly on the variable (product, person, organization, activity) to be priced and the statistical data available (Myhr and Markman 2003).” However, the basic principles of pricing methods are common across many types of insurance. “The process of determining what loss exposure will be insured, for what amount of insurance, at what price, and under what conditions is called underwriting (Myhr and Markman 2003).” For example, ship finance insurers will charge higher premiums to lower grade companies who have a low rating such as B, may offer reduced premiums for safety features such as second ship purchase. There are several factors involved in projecting an insurer’s future loss experience, including the frequency and severity of policyholder losses, catastrophic losses, loss development, payout patterns, and the market cycle phenomenon.

There are three categories of ratemaking methods insurers commonly used for insurance products such as ship finance insurance, pure premium methods, loss ratio methods and judgment methods. Pure premium methods are used to develop rates from past claims experience, it means the amount included in the rate per exposure unit required to pay claims, loss ratio methods are used for modifying existing rates, judgment methods rely heavily on the experience and knowledge of an actuary. “Exposure units are the ship that are insured for a specified period of time, expense loadings include the insurer’s acquisition and operating expenses plus premium ta and possibly loss adjustment expenses (i.e., the administrative costs of handling claims), as well as a provision for profit; Gross premium is the final premium indicated to be paid to the insurance company and equals to pure premium plus expense loading (Dahl 2003).”

Gross Premium = Pure Premium / (1-Expense Loading Factor) (6.1)

where,

Pure Premium = Default Frequency Default Severity (6.2)

Default Severity = Price of the ship – Down payment (6.3)

Xc Default Severity = Price of the ship – Down payment Default Severity = Price of the ship – Down payment Default Severity = Price of the ship – Down payment Default Severity = Price of the ship – Down payment Default Severity = Price of the ship – Down payment

In the ratemaking process, pure premium refers to the total amount of financial obligation due to default that the default is expected to incur over a certain period. The amount of losses which an insurer experiences is a two-dimensional risk: the frequency of defaults per unit of exposure insured (which leads to the number of defaults experienced), and the severity distribution of those defaults that do occur (the size of each default):

$$\text{Losses} = (\text{Frequency per exposure unit} \times \text{Exposures}) \times \text{Severity} \tag{6.4}$$

Fixed-income securities such as ships for insurance companies, pose the risk of default on interest and/or principal. Default rates are a function of both the underlying security (in line with the ratings assigned to the debt) and economic conditions (more volatile interest rates engender a higher level of defaults). "The major components of a default risk measurement framework are the specification of the dynamic process governing several variables including, state of default and loss severity of the assumed instruments, as well as the correlation structure between these variables (Kerdpholngarm 2007)."

6.3 The Model of Default Process

The default risk that a debtor will be unable to pay back its loans. Default risk goes up if a debtor has large number of liabilities and poor cash flow. There are three common methods used to model the default process,

Historical-default models: Historical credit default risk experience over several historic years is used to estimate a probability distribution for counterparty defaults segmented by rating and tenor. Correlations between counterparties are derived using correlations.

Default-intensity models: Counterparty default risk is estimated by tenor and rating by extracting the market's expectations of forward default probabilities from the spreads between corporate bonds and riskless in terms of default assets.

Ship Value or Asset-Pricing Process: Firms use publicly-traded equity price information to develop a model for changes in the market value of counterparty equity and then simulate future firm valuations to determine the probability that firm equity falls below a critical bankruptcy threshold. "Various specific methodologies can be applied to determine this distribution (Branch 1988)."

For example; Suppose that a Handyma size 5 years old ship will be purchased and required to have a ship finance insurance. The insurer, based on ship's characteristics (5-year old, Handymax, charter type, market conditions, past history of owner or ship, etc.). Estimates that she has a 2% chance of becoming default of credit payment during a policy period of one year. Based on past experience of similar ship, the insurer estimate/ actual that the average ship price will be $10Million. Down payment amount of the ship price is 20% of the purchase price. In this case, the estimated Default Frequency (DF) for insureds similar to above ship is 2%,

Default Severity (DS) is $10 Million - $2Million = $8Million

thus, according to Equation (16),

The estimated "Estimate Pure Premium" (EPP) is:

8Million 2%= $160,000.

for our ship finance insurance company, Add an Expense Loading Factor (ELF) of 20% to cover the expenses and the target profits.

Then according to Equation (15),

The indicated Gross Premium (GP) is:

$160.000 / (1- 0.20) = $160.000 / 0.80 = $200.000. Thus, $200.000 is the premium

The insurance company calculates to be an appropriate price for ship to pay for her default to her financier. When the default resolution process starts, the dispute is first turned to Financier of ship (Financial Institutions). Financial criteria include factors like the value of the financed ship, the value of company's fleet and the debt attached to it, the cash flow of the ship and the economical position of the company, as it is depicted in the balance sheet, focusing mainly on cash in banks and on short and long term debt. Financial analysis performed, based on such criteria, contribute to a large extent in finalizing and fine tuning the loan parameters like amount, tenor, margin, repayment schedule and financial covenants. Add an Expense Loading Factor (ELF) of 20% (illustrative value, assumed for this example) to cover the expenses and the target profits of the insurance company, and then according to Equation (15), the Gross Premium (GP) should be:

$200.000/ (1-0.20) =$ 200.000/0.80 = $ 250.000 Thus,

$250.000 is the indicated premium

for the ship owner needed to pay the insurance company for her default payment. Actual premiums in the marketplace may vary and where loss frequency is the average number of defaults per exposure unit, and loss severity is the average cost incurred per default. Because insurance is a mechanism of sharing, or averaging, financial risk across a population of insured, these concepts specifically do not imply that each insured has, or is expected to have, the same number of defaults per year, or that all defaults involve similar costs.

7 UNDERWRITING RISK IN SHIP FINANCE INSURANCE

The underwriting practice refers to the process of accepting or rejecting risk. This is achieved by first looking where insurance fits into the ship financing structure and what the parties want the ship finance insurance. Insurance underwriting risk is the risk that an insurance company will suffer losses due to financial situations or where the accident rate has been changed in violation of the forecast made at the time of a set of premium rates. Ship Finance insurance is an evaluation of the ship owner's payment guarantee by the insurance company, typically the insurance company will give guarantee to the debtor's approved financier. Shipping finance risk can be defined as the deviations of the fair value of ship and debt obligations between expectations and realizations relating to the different factors that affect the value of its cash flow. In a ship finance loan transaction, the borrower is generally required to purchase insurance and thereby becomes the named insured under the policies issued. As the financier wants to protect its collateral and itself as well, the financier should ensure that it has the proper insured status under the policies as well. It is extremely important that a financier protect itself and its ship in any lending transaction, and therefore financiers should always require that borrowers adequately insure their ship and protect themselves against potential liability through purchasing insurance. As part of their due diligence, financiers should conduct a thorough review of the required coverages to ensure that borrowers have purchased the types and amounts of insurance required under the loan documents. Financiers should look to ensure that the appropriate supports are in place to ensure that in the event a loss the financier will be protected. There are several issues that give me cause for concern about ship finance insurance underwriting;

First, what insurer may believe to be secured investments are, in many cases, completely unsecured from a market standpoint.

Second, if the proper security documents are not being used, and/or are not drafted properly, any collateral offered in connection with the deal may be illusory.

Third, unless adequate project control and oversight measures are being included in the underlying loan documents, signs of a project failure may go unnoticed until it is too late.

Finally, the interests of the investors and the other parties are not truly aligned.

7.1 The Concept of Underwriting

Underwriting refers to the structured process used by financial service companies, such as banks, investors, or insurers, to determine and price the risk from a potential client. The underwriting process is a detailed and systematic analysis of a potential borrower's credit-worthiness, including business history, income, financial statements and performance, publicly available information, and independent credit reports. "The underwriting process is intended to determine the credit needs, the quality of the collateral assets to be used to support the borrowing, and the borrower's ability to repay the debt. Upon completion of a formal underwriting process and a summary presented to a credit committee within the Financier, the Financier will either approve or reject the request for a loan (Becker 2010)."

In the insurance industry, the practice of underwriting refers to the process of accepting or rejecting risks. Basically, "underwriting consists of two components; risk assessment and pricing. It is the very heart of insurance and is the first step taken by an insurance company to generate premiums (Mhyr & Markham, 2003)." Originally, insurance and underwriting were synonymous. That is, underwriting referred to the operation of the insurance business. As the insurance industry developed, underwriting took on a more specialized meaning. The process of determining what loss exposure will be insured, for what amount of insurance, at what price, and under what conditions is called underwriting. The process of underwriting involves four basic functions,

1- Origination, Rating, Application,
2- Ship Finance Due Diligence - Underwriting assessment
    - Financial Statement Analysis
    - Commercial Due Diligence
    - Surveying Analysis
    - Strategic Planning
    - Subjective Judgement
3- Contract Negotiation
    - Market Price
    - Fair Value
    - Present Value Estimate of FCF

4- Monitoring - Contract Execution

By performing these four functions the underwriter increases the possibility of securing a safe and profitable distribution of risks. “Risk can be defined as the deviations of the fair value of assets and debt between expectations and realizations relating to the different factors that affect the value of its cash flows (Bianco, 2016).” When an application is received by the insurance company, the underwriter will have the task to assess the risk and classify it according to its likelihood of a loss. Underwriting department will proof if the risk should be accepted and if so how the policy should be issued. Insurance companies cannot assume that every proposed insured object will represent an average likelihood of loss. “Once the risk has been accepted, the underwriter then classifies and rates the policy. Several uncertain classifications are usually assigned before a final decision on classifying the risk is reached. “The purpose of using classifications is to separate risks into similar groups to which rates can be assigned. Insurers may have their own classification and rating system, or they may obtain a system from a rating agency. Besides the borrower’s credit rating, most lending institutions use two primary underwriting requirements to determine whether a borrower will be approved for the requested loan amount. After determining the acceptability of an applicant and assigning the proper classification and rating, the underwriter is ready to issue an insurance policy (Standard et al. 2011).” The underwriter must be familiar with the different types of policies available as well as be able to modify the form to fit the needs of the ship owner. The first three underwriting functions—risk selection, classification and rating, and policy selection—are interdependent. That is, the underwriter determines that a certain risk is acceptable when specified rates and forms are used. In underwriting, selection expense is a factor to be considered. There has to be a balance between the strictness of selection standards and the necessity of having a large volume of risk units to be insured. Underwriting assessment has so far been overly dependent on surveying analysis. Most tools seek to reduce complexity through statistical analysis of historical data, such as annual reports or evaluations by rating agencies and credit bureaus. But in addition to these historical or surveying analyses, risk assessment should also incorporate forward-looking assessments based on a combination of open and confidential documents such as business cases and the ship owner’s strategic plans and the analyst’s individual expertise and experience knowledge of a company and its executives, familiarity with the industry, previous market experience.

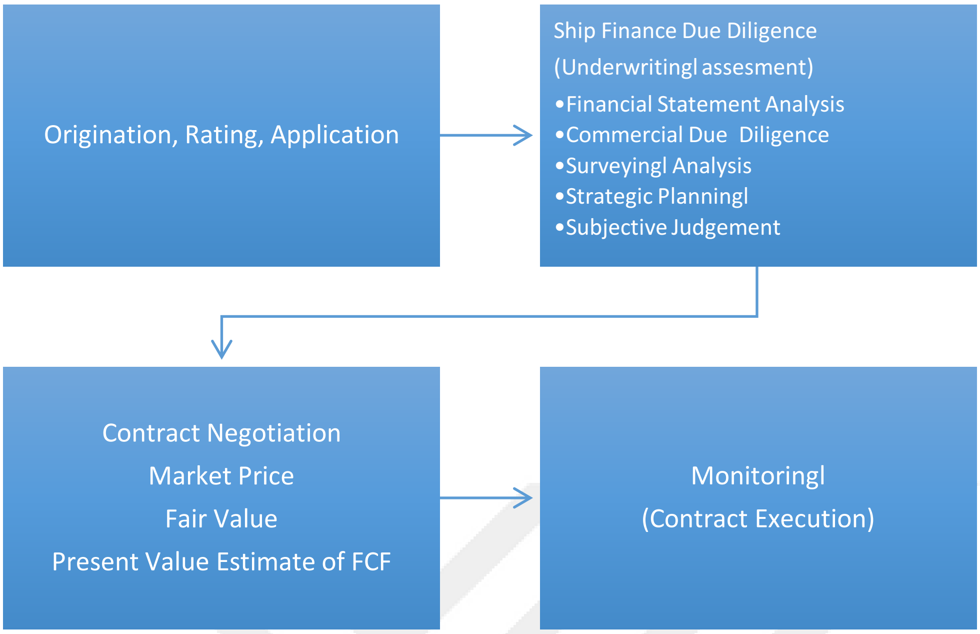


Figure 7-1 Underwriting Process

Whenever it is possible to dispose of a financial instrument through exchange for cash in a deep, wide, and open market, then the market price is the fair value. In some situations, a market may exist, but the market price might not be a fair value. When no market value is available for the exact same instrument, use the market value of similar instruments, adjusted for differences between the instrument to be valued and the similar instruments; whenever insurance risks such as mortality, morbidity, or ship damage are involved, replicating portfolios do not exist in current investment markets. If no market value is available and no suitable similar instruments are available, use a present value estimate of future cash flows. This present value should include an adjustment for risk,

Or, due to considerations mentioned above, does not represent fair value, fair value should be computed as a present value of future cash flows. The present value approach is a reasonable approximation of market value if properly implemented. This is particularly true for financial instruments, where it is generally possible to estimate the future cash flows associated with the instrument.

7.2 Main Questions of Underwriting

Due to the nature of origin of the international shipping market, as well as to the complexity and uncertainty of both internal and external circumstance, shipping enterprises must exercise analysis, evaluation and judgement over the various unmeasurable elements in such situation, so that it can control the process of decision-making and gain the most favorable result from it. This will reduce the risk of ship financing. The uncertain elements political, cultural, financial, taxation and government policy, etc. that may have impact upon macroscopic economical circumstance will affect the business operation of the ship. "Risk in economical circumstance refers to the uncertain elements that exist in economy and influence the profit perspective of shipping enterprise which in normal cases will not be able to control the pattern of change of these risks (Aven 2003)." The most effective way of avoiding risk in financing of ship is to reinforce the work of collecting and analyzing political as well as economical information from other countries, to best forecast future political risk by digesting the information and relying upon experience from the past.

In order to be an effective underwriting, a ship finance insurance model should be capable of producing various types of output, both financial and analytical. Valuation, fundamentally, remains the same no matter what type of firm one is analyzing. There are three groups of firms where the exercise of valuation becomes more difficult and estimates of value. The first group includes firms that have negative earnings. Given the dependence of most models on earnings growth to make projections for the future, analysts have to consider approaches that allow earnings to become positive, at least over time. They can do so by normalizing earnings in the current period or by adjusting margins from current levels to sustainable levels over time or by reducing leverage. The approach used will depend upon why the firm has negative earnings in the first place. The second group of shipping firms where estimates are difficult to make are young shipping firms, with little or no financial history. Here, information on comparable shipping firms can substitute for historical data and allow analysts to estimate the inputs needed for valuation. The third group of shipping firms where valuation can be difficult includes unique firms with few or no comparable firms.

Every asset, financial as well as real, has a value. Ships being investments like any other, the traditional set of criteria used to evaluate investments in any industry can also apply to ships. The key to successfully investing in and managing these assets lies in understanding not only what the value is but also the sources of the value. The value obtained from any valuation model is affected by ship-specific as well as market-wide information. In some cases, new information can affect the valuations of all ships in a sector. It is unrealistic to expect or demand absolute certainty in valuation, since cash flows and discount rates are estimated with error. This also means that you have to give yourself a reasonable margin for error in making recommendations on the basis of valuations. To find out what a ship is worth. The main questions would be 'what is it worth to me?' we will emphasis these questions by first focusing the valuation part of pricing in a complete market setup, and then include also incomplete market based purchasing preferences. Equivalent questions are well known and handled within financial option pricing theory. Hence the market model context of option pricing fits well into the practical nature of shipping finance insurance pricing. To get more hands-on pricing similarities and differences let us therefore outline insurance and option pricing in a parallel approach.

7.3 Moral Hazard

The insurer observes the true risk of loss for each ship financing, losses are due to states of nature beyond the control of the insured, and the insurance contract price reflects the expected default costs of the insured. However, in practice the insured's true risk level is not directly observable by the insurer, and problems of adverse selection and moral hazard arise. “Moral hazard exists when the insured changes behavior in a way which increases the probability or severity of loss after the contract has been written so that the contract price no longer reflects true expected loss costs. That is, adverse selection arises from hidden knowledge and moral hazard arises from hidden action (Riley, 1985).”

7.4 Shipping Finance Underwriting Risk

We will address the risks associated with the insurance process in the following four categories, Operational risk, the risk that the amount or timing of items of cash flow connected with assets will differ from expectations or assumptions as of the valuation date for reasons other than a change in interest rates. Market risk, the risk that the amount or timing of items of cash flow connected with the obligations considered will differ from expectations or assumptions for reasons other than a change in interest rates.

Finance management risks, the risk that the changes in the market value of assets will differ substantially from the changes in the market value of debt primarily due to changes in shifts in the yield curve. It can include internal or external fraud, or employment practices and workplace safety issues, regulatory or legal risks.

Ship is risky asset, ship as risky asset underwriting can be classified into the three main groups.

- The uncertainty with respect to the timing and size of the default to be provided. The timing of the default to be provided by the insurer depends on the terms specified in the contract conditions, and in addition the nature of the covered claim settlement process for ship finance insurance.
- The risks related to the service provided by the insurer. This category of risk relates to the expense level of the company, as well as to expense allowances in the product. The actual level of the expenses is not only a matter of efficiently running the business, but is also affected by external factors such as inflation.
- The willingness or ability of the party to continue to pay the premiums. The continued willingness to pay premiums is reflected in the risk of cancellation, lapse, or paid-up options available prior to the end of the contract term.

Common features for shipping finance insurance include the existence of guarantees as to either the premium rates and/or the default during the contract term. For ship finance insurance contracts, these are reflected in the benefit levels. “Interest rate risk derives from fluctuations in lending rates, which accentuate the financial problems of shipping companies when interest rates increase and firms must refinance their loans at a higher floating rate (Fabozzi et al. 2003).” In parallel, firms may also have exposure to currency risk if the currency of their revenue is other than the denomination of their debt or operating costs. Insurers require capital in order to operate, and providers of capital require compensation for any risk to their capital. The greater the risk, the greater the compensation demanded. They can also include more basic risk such as management failure to execute, deliver and process its client strategy, products and business practices, respectively. These risks can also include legal risks or reputational risk to the insurer. Many of the risks associated with any ship finance insurance leverage of company are highly correlated. For example, investment returns may influence future benefits through crediting rates, which at the same time create a competitive (disadvantage) advantage, influencing ship prices and freight rate of future shipping market.

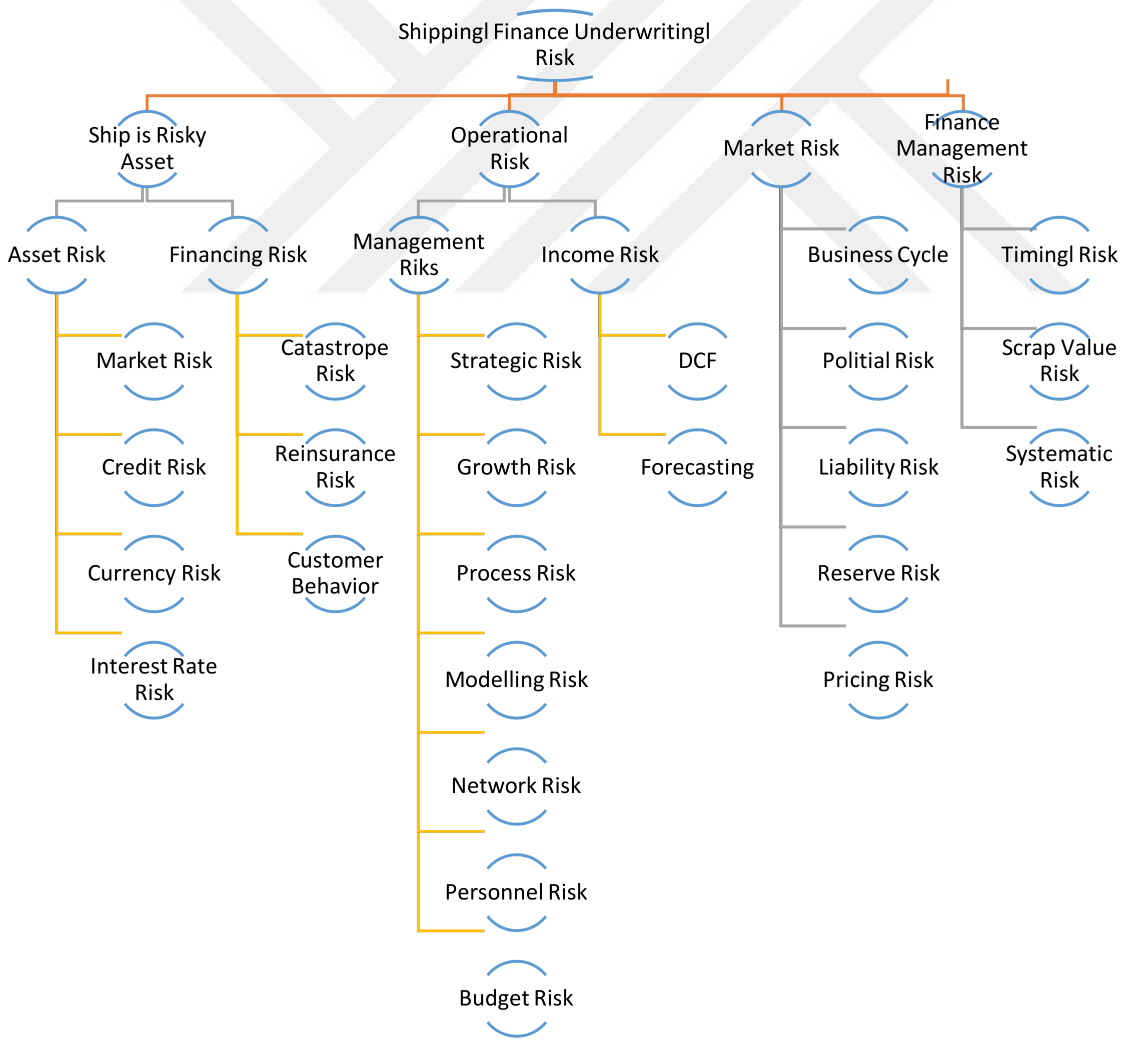


Figure 7-2 Graph of Shipping Finance Underwriting

Any company's business plan components include measures for its growth target. A growth strategy may entail significant risk factors. If the growth opportunity arises from a successful new product, a mutually beneficial strategic alliance, or market penetration in an area about to experience rapid population growth, the growth target may be attainable without a disproportionate increase in risk. For a ship finance insurance company or a company with substantial exposure to catastrophic losses, reinsurance protection is essential. Reinsurance providers, who also desire to write business at a profit, have overhead and marketing costs that need to be included in their price structure. Therefore, reinsurance protection has a net cost, which over time will erode a primary company's profitability especially if the company habitually purchases excessive amounts of reinsurance.

7.5 The Risk of Interest Rate

The conventional types of securities taken for asset based financing are insufficient when the asset is a ship. Due to the ship's movable and international nature, it is susceptible to claims from third parties who are, by law, discussed in rights against the ship itself, as distinct from those against its often-nonconcrete owner. Looking to the ship itself as the collateral for financing should never be sufficient for a prudent financier. In the event of total loss of the ship, and if the ship owner's insurance policies do not respond, or if unpaid liabilities exceed the ship's value, the financier will be left with no alternative security.

The risk of ship finance refers to the chance that any unforeseeable negative elements may occur in the future and its scope of influence on the value of ships. Comparing with risks of financing in other branches of business, shipping financing has its own features in explaining type of risk and risk elements. "The process of risk recognition is in fact a process of picking out the best among various financing possibilities, i.e. choosing the best financier, the best scheme and best loan size to gain the lowest cost and largest profit. This process requires knowledge in management, accounting, finance, statistics, strategy and probabilities (Fabozzi et al. 2003)." The floating of the interest rate and exchange rate of the future market plays a significant role in financing shipping capital and have effect on the capability of the company repaying the loan,

- the risk of the interest rate
- the risk of the exchange rate

Shipping industry is regarded as a trade with characters of capital demanding, high risk and low return, the prospect of ship finance is quite severe. The periodic change in the international shipping market requires the ship investors to precisely catch the opportunity of investment. Whether ship investment capital can be guaranteed greatly depends on long-term and steady cargo source protected by freight service contract between ship and cargo owners. The timing and size of cash flows associated with the ship for an insurance contract typically involves both uncertainty and a long-time horizon. The expertise of an actuary includes the assessment of the relatively complicated expected values of these liabilities, incorporating the various risks and embedded options involved.

The degree to which interest rate risk is an issue and the degree to which these cash flows are fixed or interest sensitive will vary by line of shipping. To the extent that the loss payments are interest sensitive, the economic impact will be reduced, provided that they move in the same direction that interest rates move. Generally, interest rate risk will be more significant for the longer tail lines of business because of the longer duration of the cash flows. The reserve risk is a risk that the actual cost of losses for obligations incurred before the valuation date will differ from expectations or assumptions for reasons other than a change in interest rates, pricing risk has three components;

- the uncertainty that actual losses and expenses will differ from expectations and assumptions.
- the uncertainty regarding pricing parameters, model specifications and assumptions about future loss costs and operating expenses.
- the risk that market premiums will differ from projected expectations of rates.

7.6 Operational Risks

Operating risks (including costs of repairs and maintenance, hull and machinery and protection and indemnity insurance premiums, crewing, provisions, stores, water and lubricating oil) for vessel operators are overall the same, largely independent of routes or locations. Position within shipping networks. Connectivity and developing regional/ sub regional hub ports, as well as upgrading or redeveloping port infrastructure and improving cargo handling with a potential to reduce freight costs, could be considered.

Operational Risk- it is one of the most discussed topics in ship risk management for shipping companies. The risks associated with insurance operations are in the following categories; Event Risk – Risk associated with specific events. By these types of event risks, we are generally referring to external events.
Management Risk – Risk arising from the uncertainty associated with business. It can include internal or external fraud, or employment practices and workplace safety issues, regulatory or legal risks. They can also include more basic risk such as management failure to execute, deliver and process its client strategy, products and business practices, respectively. These risks can also include legal risks or reputational risk.
Ship Financing Risks – Risk associated with economic value added, or the lack of adequate capital surplus to take advantage of new market opportunities.

7.7 Market Risk

The overall shipping industry, dry bulk, containerships, and now offshore assets, have not been doing well; actually, the dry bulk market has been making headline news for setting all-time lows since 2008, with little improvement to show since then. When the overall shipping market crashed after 2008, many institutional investors rushed to invest in shipping via joint-ventures with ship owners and ship managers. Lots of money has been invested in shipping, and not a negligible amount of that investments in newbuilding contracts. The truth of the matter is that many of these investments have been under water and many of these institutional investors have been burned with their shipping investments.

Most shipping banks have been departing the shipping industry at present, for their own reasons. It’s fair to say, that debt finance in the form of ship mortgages for tankers is tough to obtain, especially for tankers older than eight to ten years of age. Thus, another reason for tanker asset prices failing to follow up the freight market has to do with the state of the banking industry, and liability cash flows may also be fixed or may change in response to interest rate changes.

7.8 Asset Risk

Under insurance risk management, asset risks are usually defined by four major risk categories Market risk, Credit risk, Currency risk and Interest Rate risk. Ship price risk reflects the price sensitivity of a ship arising from movement of prices in the general shipping market, or the unique volatility of a particular ship. Credit Risk arises when there is an inability to meet payment obligations or arises from the fact that counterparties may be unwilling or unable to fulfill their contractual obligations. Currency Risk results from imperfect correlations in the movement of currency prices and fluctuations in international interest rates. Interest Rate Risk arises for the movement in the level, or volatility, of interest rate across the yield curve. Interest rate risk includes the portion of market value uncertainty due only to changes in interest rates. The portion of market value uncertainty related to changes in perceived credit or default risk is a component of ship finance risk.

7.9 Financing Risk

The risk that the actual cost of losses for obligations incurred before the valuation date will differ from expectations or assumptions for reasons other than a change in interest rates, Catastrophes risk is the uncertainty regarding the costs of natural disasters and other catastrophes, the uncertainty regarding the cost, value, availability and collectability of reinsurance; and the risk that expenses will differ from those projected. The concentration of insured values in specific geographic areas or legal jurisdictions, Uncertainty regarding the frequency, severity, and nature of default events, Competitive pressures that do not allow the insurer to achieve assumed levels of exposure and/or rate adequacy, Regulatory intervention that restrains premium increases or decreases or requires business to be underwritten that would not be underwritten in the absence of such intervention, Premiums for involuntary business underwritten at premium rates and in volumes that differ from assumptions, Retrospective premiums that differ from assumptions, unanticipated changes in loss costs and exposures from the historical experience period, loss costs for the mi of new policies being underwritten, including the effect of adverse selection, reinsurance risk is a function of changes in the price and availability of desired reinsurance, and of uncertainty regarding the collectability of reinsurance recoverable arising from the financial condition of the reinsurer or uncertainty about the coverage provided.

7.10 Finance Management Risk

Finance management risk is a critical component in many types of valuation regarding the ship finance requirements. Finance management risk objectives include capital management and defensive risk management strategies that place a floor on the net worth of the insurer. These goals are accomplished by management decisions impacting the net match/mismatch between the asset and liability cash flows of the ship.

Ship cash flows may be fixed or may change in response to interest rate changes. If cash flows are fixed an increase in interest rates produces a reduction in market value and possibly a reduction in earnings. If the cash flows are interest sensitive, then both the timing and amount of the flows may change in response to an interest rate change. On the opposite side of the transaction, the insurer would realize an adverse economic impact in the loss of future investment income from the higher yielding asset after reinvestment at the lower principal rates. Net cash flow is the differences in timing and amount between cash inflows and cash outflows produce risks and opportunities with respect to the potential financial loss associated with interest rate changes. The risks include reinvestment risk when cash inflows exceed outflows and disinvestment risk when cash outflows exceed inflows.

Timing risk is the process variance leading to variability in the amount or timing of items of cash flow connected with assets or obligations. Actual cash flows will differ from expectations or assumptions because of changes in interest rates. The international nature of ship finance will normally involve choice of law application. The risk of law refers to risks brought forth by the difference in law of different countries and regions, which often occurs when choosing the law and preparing related documents. A borrower must make sure that he gets the loan and at the same time have control over the risk of law.

7.11 Insurance Underwriting Methods- Rate Making

There are three categories of ratemaking methods insurers should use for underwriting models. First, via a 'Cash-Flow' analysis, one estimates the length of time an insurer will have premium dollars on hand, prior to paying losses and expenses. Second, one estimates how much investment income an insurer will earn on this cash flow and the necessary equity backing up the policies. Finally, one sets the expected return on equity equal to a target return on equity. In theory and often in practice a discounted cash flow can be used to determine the discounted value of expected cash flows. The financial pricing model has replaced traditional assessment techniques for underwriting profit margin and underwriting systematic risk in ship finance insurers. "If there is no active market, the valuation of a liability based on DCF techniques might be perceived to reflect subjective assessments (Waszink 2013)." However, a concern should not arise as long as the valuation is based on a disciplined approach and difficult development of assumptions. The liability value can be estimated by discounting the projected value of all applicable future cash flows. The ship finance value of the debt should represent the amount of money that would have to be transferred in order for an insurer to take over the obligations that give rise to the debt. The process of adjusting the assumptions in order to alter the expected cash flow, in a way that follows what the market would do, is called a market value margin. "The concept of incorporating market value margins in the valuation process is an important and interesting subject. The market value margin can be thought of as the difference between two expected cash flow measures. One is the measure using the true, or realistic, probability distribution and the other is the expectation calculated under the risk-neutral probability distribution. (Risk & Forum 2006)." To project the future expected cash flows, ship purchase/building contracts when determining the true value of the debt, estimates for each source of the cash flows have to be made. If the underlying parameters of the expected value of the cash flows could be determined with 100 % certainty and the parties involved are risk-neutral, then the expected value would equal the market price. However, in practice, uncertainty will exist with regard to the various parameters will not be risk-neutral. "The uncertainty includes but is not limited to the appropriateness of models selected, the distribution functions used in the valuation, future development of selected assumptions and process risk. Therefore, the fair value of the debt will not equal the 'expected value of the liability', but rather the expected value plus a reward for the risk. This reward is defined here as the market value margin. The market value margin is derived from the market's view of a risk within the company and the premium for that risk charged by the market (Strahan 1999)." If the market were to become more risk-averse while the actual risks remain the same, the market value margins would increase. It is, however, very difficult to separate the effect of a more risk-averse market from an outright increase in risk itself. Calculation of market value margin's using a cost of capital approach is straight forward given that the majority of the calculation is prescribed under the standard Solvency capital requirement. This means that implementation of this approach is straightforward and therefore can be used by both small and large ship. The calculation of market value margins may require relatively comple models that use stochastic projections and risk-neutral decision rules. Such models are being used in many financial institutions to model value-at-risk and the probability of ruin. In particular, option valuation models are expected to be a useful starting point for the determination of market value margins. In particular, option valuation models are expected to be a useful starting point for the determination of market value margins. The expected present value of future liability cash flows includes premiums, fees, policyholder defaults, expenses and commissions. if the liability cash flows could be matched exactly, the market consistent value of the debt will exactly equal the market value of the replicating portfolio. "The market value liability is derived from the cost of managing the risks underlying the business on an ongoing basis. Market values should be used where available to value the market value of liability, either for products in their whole or their essential parts (Girard 1998)." Where market values are not available, market consistent techniques should be applied in order to determine:

- The expected present value of future liability cash flows
- The Market Value Margin for non-hedge able risks

The market value margin is defined as the cost of risk, i.e. a risk margin in addition to the expected present value of future liability cash flows required to manage the business on an ongoing basis. Before calculating the market value margin, it is important to understand the types of risks affecting insurance debt. It is estimated by the present value of the cost of future capital requirements for non-hedge able risks. "A hedgeable risk is a risk which can be pooled or hedged using a replicating portfolio. In general terms, the cost of hedging is given by the market value of those instruments that the insurer would need to buy in order to fully hedge its position, as this includes expected and unexpected loss costs, transaction fees etc. In theory, it is possible to sell any risk for a price (Risk & Forum 2006)." However, in order to be confident with reasonable certainty that the price accurately represents the market value liability, the price for the risk would need to come from a deep and liquid market. Risks for which a deep and liquid market is not available are referred to as non-hedgeable (It is possible that over time non-hedge able risks will become hedgeable as deep and liquid markets develop). They are risks for which a market price cannot be observed.

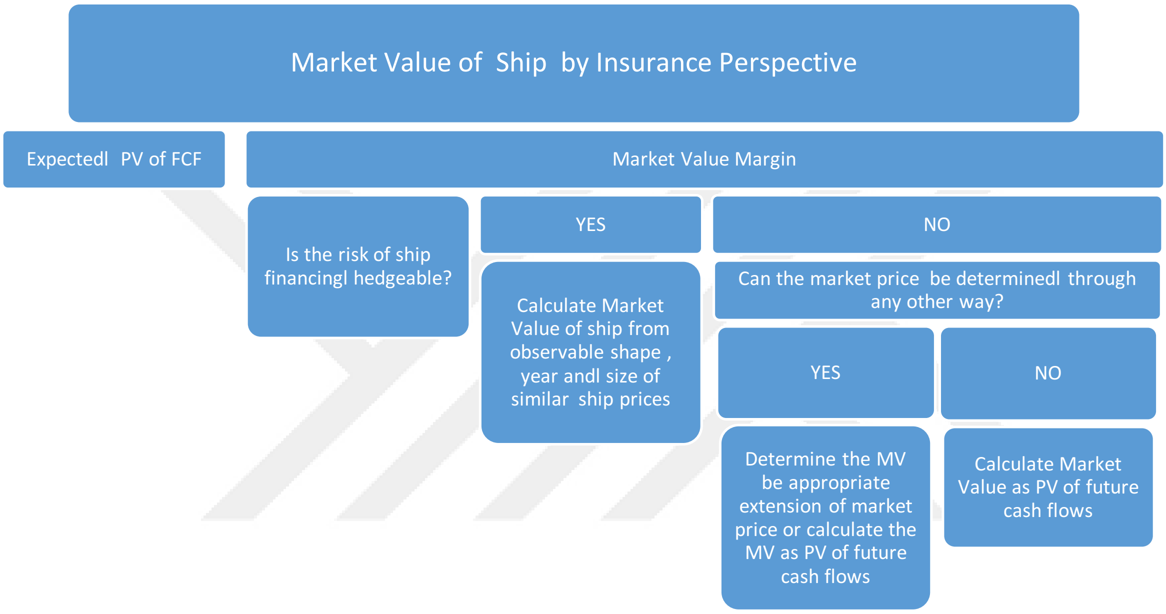


Figure 7-3 Flowchart for determining the method for calculating the Ship Liability.

In a ship finance insurance, if considering the use of ship finance insurance as similar to an insurance default as ship finance insurance costs both time and money, then loss frequency is similar to the possibility of dispute occurrence, which is also the possibility of ship finance insurance being utilized. In health insurance, loss frequency is related to each customer's unique features such as age, gender, life style, etc., and can be estimated once the insurer knows those characteristics of the insured. Meanwhile in ship finance insurance, the possibility of disputes occurring and ship finance insurance being applied differs with the ship type characteristics, and can be estimated by knowing those characteristics of a particular financing. "Based on past experience and statistical data, ship finance participants should be able to identify and weight the possible indicators of dispute occurrence. For example, a medium/small size ship financing may have higher likelihood of disputes arising from problems in communication channels and changing political environment (Stopford

2009).” The role of insurance in ship finance is not as straightforward as one might think. Shipping risks are dynamic and there are no set of rules dictating how these risks should be managed. The insurance industry itself is vulnerable to sudden changes in its attitude towards certain risks and therefore it cannot be taken for granted that the insurance coverage will always be available. In addition, not all operating risks are insurable and the proceeds of insurance may not be sufficient to cover lost revenues or increased expenses. It is therefore important to differentiate between risks for which an insurance solution exists and risks for which there is limited or no insurance solution. In asset-based lending the financier’s main concern is that the asset is available if and when needed, whereas in ship lending it is the physical asset that is important that the ship produces a revenue stream sufficient to service its debt. This revenue stream can be halted by whole range of factors other than the ship as an asset i.e. availability of reserves, availability of a market, price, interest rates etc. Insurance therefore tends to be almost one dimensional in its approach to risk transfer as it focuses only on physical damages and any consequential loss must follow actual physical loss. This limitation should however not be seen as a setback as insurance provides one out of many alternatives to managing shipping risk. There is a trend for the parties to believe that once insurance cover is in place that they could sit back and rela and any losses will be taken care of by the insurance company.

There are several issues that give me cause for concern about ship finance insurance underwriting,

First, what insurer may believe to be secured investments are, in many cases, completely unsecured from a market standpoint.

Second, if the proper security documents are not being used, and/or are not drafted properly, any ‘collateral’ offered in connection with the deal may be illusory.

Third, unless adequate project control and oversight measures are being included in the underlying loan documents, signs of a project failure may go unnoticed until it is too late.

Finally, the interests of the investors and the other parties are not truly aligned.

7.12 Underwriting Problems After the Crisis of Shipping

Prior to the recent financial crisis, numerous banks restored their credit underwriting processes with a focus on speed, costs, efficiency, and customer satisfaction. The one thing they forgot to consider was effectiveness, or risk cost, and many subsequently got burned. Several banks are again re-evaluating their credit processes, now with an emphasis on lower losses and streamlined operations. By focusing jointly on efficiency and effectiveness, banks can draw important lessons from the crisis and accordingly adapt to the new dynamics of credit demand and supply. Assuming relatively competitive markets and informed customers, credit economics will continue to be driven primarily by three dimensions of the credit underwriting process, operational cost and risk cost in combination with pricing revenues. Examples of factors to consider for underwriting risk would be;

- the uncertainty of future defaults experience
- incorrect pricing owing to poor data or an inappropriate method
- the effects of rapid growth in business volumes due to underpricing, or conversely a decline in premium volume due to overpricing
- a lack of underwriting controls, such as inappropriate underwriting strategy or a failure to apply underwriting guidelines and policy wordings
- a potentially catastrophic aggregation of defaults
- the geographical mi of business, including concentrations of risk and lack of diversification
- inappropriate reinsurance programs, lack of availability of suitable reinsurance,

Despite these elements of continuity, the credit business has changed dramatically and will in all likelihood not revert to pre-crisis norms for quite a while, and for good reason.

We expect that higher demand for bank credit in shipping and weaker source of financing will continue to define and shape of the credit business. As the economic recovery continues, demand for credit will rise as ship building investments suspended during the crisis. These projects will be funded mainly through banks, as capital markets' appetite for this type of risk is much lower than in the previous decade. At the same time, the ongoing repercussions of the crisis will generate a wave of risk-related loan prolongations, and banks will need to evaluate these requests against a significant drop in the credit quality of borrowers. Ship owners must reassess their situation. The record profit years of shipping are over and the economic and finance crisis challenged the industry. New forms of shipping financing are sought, some of which demand significant changes and could make huge changes in a firm's course necessary.

7.13 Ship Finance Underwriting Decision Making

For underwriting to achieve its purpose, insurers must minimize the effects of adverse selection. Adverse selection occurs because the individuals and businesses with the greatest probability of loss are those most likely to purchase insurance. Through the underwriting process, the loan designer evaluates a ship owner's circumstances and the condition and value of the ship to determine whether making a particular credit is a wise use of funds. Underwriters analyze information on insurance applications to determine whether a risk is acceptable and will probably not result in an early default to the insurance company. "Underwriting has both objective and individual elements. Such as, income eligibility is an objective factor. On the other hand, analyzing an applicant's credit history and estimating the value of the ship both involve some degree of judgment. Insurers sell a promise to perform sometime in the future. As a result, they are pricing a product today for which the benefits and expense are unknown. So, for insurers, expense risk takes on an additional element of concern (Macedo 2009)." When an insurance company is faced with a series of strategic, tactical options, it is difficult to decide which one to pursue without understanding the impact of various proposed business strategies, tactics or operational planning under a variety of possible future scenarios. Ship Finance Insurance underwriters typically do the following;

- Analyze information stated on insurance applications,
- Evaluating loss exposures- There is a compromise between the need for information and the cost to obtain it.
- Determining and selecting underwriting alternative
- Determine the risk involved in insuring a client
- Screen applicants on the basis of set criteria
- Contact field representatives, superintendents, and others to obtain further information
- Evaluate recommendations from underwriting software
- Decide whether to offer insurance

- Determine appropriate premiums and amounts of coverage
- Monitoring the loss exposures

In any typical ship finance structure, there is always a form of a loan agreement which contains several critical terms which the creditor and its legal advisors must review when conducting pre-enforcement due diligence and/or assessing enforcement options

The major events of default in a shipping loan include,

- Non-payment of any sum payable when due
- Misrepresentation which in effect elevates the importance of the representations and warranties clause,
- Cross default which is an equally important event of default and heavily debated between the parties.
- Material adverse change
- The clause allows the Financier/bank to apply any credit balance of the borrower towards satisfaction of any sum due and payable by the borrower.
- The function of this clause is particularly important in enforcement proceedings and it is aimed to ensure that all notices, demands and letters are sent to the right person through a pre-agreed method of communication so that there is limited room for dispute.
- Breach of covenants or undertakings, particularly insurance covenants, operational covenants and other financial covenants.
- Governing law and Jurisdiction. Regarding the governing law, the majority of the shipping loan agreements are governed by English law.

An arbitrarily large increase in rates is likely to place a company at a competitive disadvantage. However, it does not necessarily follow that a very competitive rate level will denote a competitive advantage position.

In fact, not with standing how competition is compared, very low rates that are unable to cover a company’s costs represent a threat to its financial strength. If the low rates persist, this could grow to become a material threat to solvency.

Competitive positions do not always pose a limitation to pricing strategy. Some scenarios manifest risks that adversely impact all market participants. Under such a scenario, each insurance company will be compelled to take corrective measures and will be able to do so without creating a competitive disadvantage, because competitors are taking similar corrective actions.

8 VALUATION STANDARDS OF AN UNDERWRITING

Ship purchase require the deployment of large lump sums of investments in both nominal and real terms, so setting the ‘right’ price can have multimillion dollar implications. Further, while ship pricing may be a private agreemen between a willing seller and a willing buyer at a point of time, valuation has recently become a concern for banks, insurers. There is no doubt that these are times when correct valuation of ship is vital, however, there is also no doubt that these are times of limited market activity for the sale of ships, especially modern and highly priced ones. The exercise is further complicated by a general dislocation in the freight markets and also the financial markets. Therefore, choosing the appropriate method for the correct pricing of a ship becomes a practical imperative rather than a pure academic or philosophical exercise.

The valuation of ship as an asset requires serious management skills, when determining whether the credit risk on a ship has increased significantly, to consider reasonable and supportable information available, in order to compare the risk of a default occurring at the reporting date with the risk of a default occurring at initial identification of the ship. In order to be an effective valuation, a ship finance insurance model should be capable of producing various types of output, both financial and analytical. Valuation, fundamentally, remains the same no matter what type of firm one is analyzing. There are three groups of firms where the exercise of valuation becomes more difficult and estimates of value noisier. The first group includes firms that have negative earnings. Given the dependence of most models on earnings growth to make projections for the future, analysts have to consider approaches that allow earnings to become positive, at least over time. They can do so by normalizing earnings in the current period or by adjusting margins from current levels to sustainable levels over time or by reducing leverage. The approach used will depend upon why the firm has negative earnings in the first place. The second group of firms where estimates are difficult to make are young firms, with little or no financial history. Here, information on comparable firms can substitute for historical data and allow analysts to estimate the inputs needed for valuation. The third group of firms where valuation can be difficult includes unique firms with few or no comparable firms.

Due to the nature of derivation of the international shipping market, as well as to the complexity and uncertainty of both internal and external circumstance, shipping enterprises must exercise analysis, evaluation and judgement over the various unmeasurable elements in such situation, so that it can control the process of decision-making and gain the most favorable result from it. This will reduce the risk of ship financing. The valuation of ship as an asset requires serious management skills, when determining whether the credit risk on a ship has increased significantly, to consider reasonable and supportable information available, in order to compare the risk of a default occurring at the reporting date with the risk of a default occurring at initial identification of the ship. To find out what a ship is worth. The main questions would be, what is it worth to me? We will emphasis these questions by first focusing the valuation part of pricing in a complete market setup, and then include also incomplete market based purchasing preferences. Equivalent questions are well known and handled within financial option pricing theory. Hence the market model context of option pricing fits well into the practical nature of non-life insurance pricing. To get more hands-on pricing similarities and differences let us therefore outline insurance and option pricing in a parallel approach. The insurer observes the true risk of loss for each individual, losses are due to states of nature beyond the control of the insured, and the insurance contract price reflects the expected loss costs of the insured. However, in practice the ship owner's true risk level is not directly observable by the insurer, and problems of adverse selection and moral hazard arise. “Moral hazard exists when the ship owner changes behavior in a way which increases the probability or severity of loss after the contract has been written so that the contract price no longer reflects true expected loss costs. That is, adverse selection arises from hidden knowledge and moral hazard arises from hidden action (Riley, 1985).” When we try the value of a ship we use all available methods—discounted cash flow, multiples, and other methods. In theory, valuation is a relatively simple process of discounting a firm’s expected cash flows by investors required rates of return. A number of valuation principles come into play when applying this hierarchy to insurance debt. The Shipping finance insurance hierarchy of methods for fair valuation would be:

- Use market value when available- estimated prices for similar ship
- Estimated prices for identical or similar ship in markets that are not active in which, use the market value of similar instruments, adjusted for differences between the instrument

to be valued and the similar instruments -market inputs other than estimated prices such as interest rates.

- If no market value is available and no suitable similar instruments are available, use a present value estimate of future cash flows. This present value should include an adjustment for risk.
- Market inputs derived principally from or corroborated by other observable market data through such techniques as analysis of correlations.

It seems that ship finance banks do not regularly inspect or value ships which they are to finance and even with older tonnage, many financiers do not regard it as necessary to inspect the ship which will form the main security for repayment of the loan. Risk in economical circumstance refers to the uncertain elements that exist in economy and influence the profit perspective of shipping enterprise which in normal cases will not be able to control the pattern of change of these risks (Political, cultural, financial, taxation and government policy, etc.) that may have impact upon macroscopic economical circumstance will affect the business operation of the ship. The most effective way of avoiding risk in financing of ship is to reinforce the work of collecting and analyzing political as well as economical information from other countries, to best forecast future political risk by digesting the information and relying upon experience from the past. In order to be an effective valuation, a ship finance insurance model should be capable of producing various types of output, both financial and analytical. Valuation, fundamentally, remains the same no matter what type of firm one is analyzing. There are three groups of firms where the exercise of valuation becomes more difficult and estimates of value. The first group includes firms that have negative earnings. Given the dependence of most models on earnings growth to make projections for the future, analysts have to consider approaches that allow earnings to become positive, at least over time. They can do so by normalizing earnings in the current period or by adjusting margins from current levels to sustainable levels over time or by reducing leverage. The approach used will depend upon why the firm has negative earnings in the first place. The second group of firms where estimates are difficult to make are new shipping firms, with little or no financial history. Here, information on comparable firms can substitute for historical data and allow analysts to estimate the inputs needed for valuation. The third group of firms where valuation can be difficult includes unique ships or shipping business with few or no comparable firms. Due to the nature of derivation of the international shipping market, as well as to the complexity and uncertainty of both internal and external circumstance, shipping enterprises must exercise analysis, evaluation and judgement over the various unmeasurable elements in such situation, so that it can control the process of decision-making and gain the most favorable result from it. This will reduce the risk of ship financing. "In an effort to provide a uniform set of criteria for the Income Approach method, in early 2009, the Hamburg Shipbrokers Association (Vereinigung Hamburger Schiffsmakler und Schiffsagenten) established the Hamburg Ship Evaluation Standards also known as the Long-Term Asset Value by narrowing the guidelines on the income approach method. In brief, for presently charter-free ships, the estimate for future earnings can be substituted by the historical average earnings and operating expenses of the last 10 years for each type of ship (Schinas et al. 2015)." The most frequently mentioned critique of the Hamburg Method is that relying on 10- year averages for freight rates, financing costs and demolition prices rely heavily on the assumption that history repeats itself, and given that the 10-year historical average incorporates never-seen-before market conditions, valuing ships on such guidelines might resemble driving a car based on the images shown on the rear-view mirror. However, "The accounting and auditing firm Price Waterhouse Coopers (PwC) has recently approved the Long-Term Asset Value method, and therefore can be used for banking purposes (Schinas et al. 2015)."

While these methods are based are open to interpretation and can be used depending on the loan agreement terms between the financiers and the borrowers as per agreed, there is a unique valuation method that the author as come upon recently and is mandated by law. "Such valuations as used for issuing bonds in capital markets and the law stipulates that the value of a ship shall be the least of a) replacement cost -construction cost for a newbuilding, b) present market value of the ship, or c) the average historical value of similar ships in the last 10 years. Since this method stipulates for the least of the three values, it is usually the least generous valuation method (Widiantoro & Elvenes 2012)." The Ship Finance Insurance model relies on a relative assessment of credit risk. The risk of ship finance refers to the chance that any unforeseeable negative elements may occur in the future and its scope of influence on the value of ships. Comparing with risks of financing in other branches of business, shipping financing has its own features in explaining type of risk and risk elements. To avoid risk in shipping financing is in fact to learn how one should recognize, measure and analysis these risks. It is a scientific management that tries to obtain a maximum safety at a minimum cost. The process of risk recognition is in fact a process of picking out the best among various financing possibilities, i.e. choosing the best financier, the best scheme and best loan size to gain the lowest cost and largest profit. This process requires knowledge in management, accounting, finance, statistics, strategy and probabilities.

It might be assumed that a financial institution lending on the security of an asset would take a close interest in the condition of that asset, not least because, in the institution's own interest, the asset itself is its security. A financing on a ship at the bottom of the sea, or on which pollution claimants have a prior lien, is of no value. The lender's interest in those circumstances will center on the insurances on the ship, which will have been assigned to it. Political, cultural, financial, taxation and government policy, etc. that may have impact upon macroscopic economical circumstance will affect the business operation of the ship. The most effective way of avoiding risk in financing of ship is to reinforce the work of collecting and analyzing political as well as economical information from other countries, to best forecast future political risk by digesting the information and relying upon experience from the past. Every asset, financial as well as real, has a value. Ships being investments like any other, the traditional set of criteria used to evaluate investments in any industry can also apply to ships. The key to successfully investing in and managing these assets lies in understanding not only what the value is but also the sources of the value. The value obtained from any valuation model is affected by ship-specific as well as market-wide information. In some cases, new information can affect the valuations of all ships in a sector. It is unrealistic to expect or demand absolute certainty in valuation, since cash flows and discount rates are estimated with error. This also means that you have to give yourself a reasonable margin for error in making recommendations on the basis of valuations. To find out what an asset is worth requires consideration of risk tolerance, sometimes risk tolerance is captured by a utility function, sometimes risk tolerance is captured in an ad hoc way by artificially inflating a “risk- adjusted” discount rate. Fair ship values are estimated on the basis of the results of one or more valuation techniques that make maximum use of market inputs, with as little reliance on unobservable market inputs as possible. A fair value measurement technique should reasonably reflect how the market could be expected to price the asset or liability by incorporating all the factors that market participants would consider in agreeing to a price and be as consistent as possible with accepted economic methodologies. In addition, the inputs tothe valuation technique should reasonably represent market expectations and measures of the risk-return factors inherent in the asset or liability being measured. There are three well-known, generally accepted ship pricing methods. Competition among insurers is one of the primary causes of underwriting cycles in ship finance insurance and is itself affected by factors that drive the cycle, such as the availability of capital and investment returns.

There are three groups of firms where the exercise of valuation becomes more difficult and estimates of value noisier. The first group includes firms that have negative earnings. Given the dependence of most models on earnings growth to make projections for the future, analysts have to consider approaches that allow earnings to become positive, at least over time. They can do so by normalizing earnings in the current period or by adjusting margins from current levels to sustainable levels over time or by reducing leverage. The approach used will depend upon why the firm has negative earnings in the first place. The second group of firms where estimates are difficult to make are new shipping firms, with little or no financial history. Here, information on comparable firms can substitute for historical data and allow analysts to estimate the inputs needed for valuation. The third group of firms where valuation can be difficult includes unique firms with few or no comparable firms. If all three problems come together for the same firm – negative earnings, limited history and few comparable – the difficulty is compounded. It should be noted again that the question is not whether these shipping firms can be valued – they certainly can – but whether we am willing to live with noisy estimates of value. To those who argue that these valuations are too noisy to be useful, our counter would be that much of this noise stems from real uncertainty about the future. As we see it, investors who attempt to measure and confront this uncertainty are better prepared for the volatility that comes with investing in these stocks. While some view multiples as a painless way of analyzing these firms, we have pointed out some of the inherent constraints with coming up with usable multiples and comparable for such firms, and the dangers of trusting the market to be right, on average. The fair value can be determined directly from prices which are quoted in active markets or the fair value can be determined by reference to similar ships trading in active markets.

When we try the value of a ship we use all available methods—discounted cash flow, multiples, and other methods. In theory, valuation is a relatively simple process of discounting a firm's expected cash flows by investors required rates of return. A number of valuation principles come into play when applying this hierarchy to insurance liabilities. The Shipping Finance Insurance hierarchy of methods for fair valuation would be;

- Use market value when available (Quoted prices for similar assets or liabilities)
- Quoted prices for identical or similar assets or liabilities in markets that are not active in which, use the market value of similar instruments, adjusted for differences between the instrument to be valued and the similar instruments. (Market inputs other than quoted prices such as interest rates)
- If no market value is available and no suitable similar instruments are available, use a present value estimate of future cash flows. This present value should include an adjustment for risk.
- Market inputs derived principally from or corroborated by other observable market data through such techniques as analysis of correlations.

To find out what an asset is worth requires consideration of risk tolerance, sometimes risk tolerance is captured by utility function, sometimes risk tolerance is captured in an ad hoc way by artificially inflating a risk- adjusted discount rate. Fair ship values are estimated on the basis of the results of one or more valuation techniques that make maximum use of market inputs, with as little reliance on unobservable market inputs as possible. A fair value measurement technique should reasonably reflect how the market could be expected to price the asset or liability by incorporating all the factors that market participants would consider inagreeing to a price and be as consistent as possible with accepted economic methodologies. In addition, the inputs to the valuation technique should reasonably represent market expectations and measures of the risk-return factors inherent in the asset or liability being measured. There are three well-known, generally accepted vessel pricing methods.

8.1 The Market Value or Comparison Method

Valuation, fundamentally, remains the same no matter what type of firm one is analyzing. Under the Market Approach method, a ship is valued in comparison to the recent sale of a comparable ship, adjusted for age, cargo carrying capacity, ship specifications, etc. In overall efficient markets, or in shipping sectors and shipping assets that are fairly liquid, the ‘last done’ transaction can offer a definite guide for the value of a comparable ship. It supports a price by answering the question, “How much are other things like it selling for?” In the case of the ship, this question becomes, “What have ship like this, in this general area, sold for in the recent past?” The Market Comparison method known as ‘marked to the market’ approach or frequently referred to as ‘last done’ in shipping. The market’s view of the enterprise value of the shipping firm, as determined by the shipping firm’s equity value, equity volatility, and liability structure. The market value approach is extremely useful for setting up risk management systems where one wants to monitor the joint movements of assets and liabilities. In the classical accounting approach of valuing liabilities with a fixed interest rate, it is difficult to quantify reinvestment risk, also the valuation of return guarantees and profit-sharing is not well defined. In the market value approach, insurance contracts are valued using prices of financial instruments that can be observed in the markets. In some situations, a market may exist, but the market price might not be a fair value. The market may not be deep, wide, and open, or each trade may take place under special conditions or involve unique considerations. For example, the volume of shipping activity (for a specific route or competition) might be small relative to the holdings of major players in the market. If so, the market price could be heavily influenced by supply and demand fluctuations unique to the period of trading and not representative of ongoing market conditions. Insurance company cannot completely value liability under its finance contract for payment of cash to a financier. Normally, the insurer is liable for future claims whether or not the ship owner meets its obligations to reimburse the financing company for claim costs.

It supports a price by answering the question, “How much are other things like it selling for?” In the case of the house, this question becomes,” What have houses like this, in this general area, sold for in the recent past?” The Market Comparison method known as ‘marked to the market’ approach or frequently referred to as ‘last done’ in shipping. In a simplified way, (Karatzas, 2009) describes it as: ‘What someone paid recently for a similar asset is a representative way of assessing the price as long as assets as fairly marketable and there is a liquid market. The Income Valuation Method, known as ‘marked to the model’ equates the vessel's value with the present value of the stream of FOpCF (free operating cash flow) generating process. "During inactive markets, the Market Approach faces additional limitations due to continuous uncertainty in the market despite the 'last done' one needs to keep in mind that in illiquid markets a month's lapse since 'last done' can be tantamount to eternity as opposed to a normal market when a month's lapse is just the continuance of the status quo (Risk & Forum 2006)." While the market approach is the tangible proof of what the market would bear for the ship, the critique for this method is equally important during uncertain times weak sellers are keener to sell than stronger players and therefore, the weak players get to write the history book while stronger players can afford not to act if sellers' price ideas are deemed too low.

8.2 The Replacement Cost Method

It is known as 'marked to the cost', equates the ship's value with the estimated required cost to replace the ship. The Replacement Cost method supports a price by answering the question, "How much would it cost to replace?" In the case of the ship, the question becomes "What would it cost to create or construct a ship just like this one?" The Replacement Cost method is mostly applicable to ships that are uniquely suited for certain trades and projects; usually, they have been ships heavily customized for such trades, and therefore there are is a narrow demand in the event of a sale. The obvious critique of such valuation method is that cost to replace the ship is not necessarily the price that a third- party buyer would pay, in short, the historical cost is not necessarily a market number; in the valuation example above, without the military contract, the ship would have limited commercial value, the high replacement value notwithstanding. Applied to most offers of purchasing a ship, replacement cost is typically a cost-plus calculation, such as figuring out how much it cost to buy a new ship, add your desired earnings, and set your price appropriately. "This simple observation raises a serious question from the maritime financial management point of view, if the purpose of investing in the acquisition of a ship is 'value creation', how can one use 'appraisal' methods with different benchmarks in order to identify that value? How can values of the same shipping asset converge when the guiding principles emanate from three distinctly different starting points? From an applied economist's' point of view, the only way to justify this is to accept that the vessel's market is efficient and equates a ships' value with its price (Schroeck 2002)." We do believe that this is a serious concern and should be addressed. Another recent method to estimate the price of a vessel is by using a statistical method, namely regression analysis. Simply, this technique utilizes time series data, such as vessel new-building and second-hand historical prices, vessel age and size along with structural characteristics, freight rates, and calculates the expected mean value of the vessel.

8.3 The Discounted Cash Flow (DEF) / Net Present Value (NPV)

The discounted cash flow method supports a price by answering the question, how much is it worth if it can bring in money over time? In the case of your ship, the question becomes, how much would it bring in each month if you chartered it for a period of time, and how much is that series of cash flows worth as a lump sum today? Charter payments come in every month, which is quite handy if you can use the DCF / NPV formulas to calculate what that series of payments over a certain period of time would be worth if you received it in one lump sum. Assuming you could charter the ship for $100,000 a month for a period of 10 years and you might earn 6% interest on your money by choosing the other cash investment options, and you'll have a supportable estimate of what your ship is worth. DCF / NPV is only used for pricing things that can produce an ongoing cash flow, which makes it a very common way to price entire businesses to sell.

8.4 Income Approach Method

Income approach is typically the optimal way to price your offer, since the value of an offer to a specific group can be quite high, resulting in a much better price. Use the other methods as a baseline, but focus on discovering how much your offer is worth to the party you hope to sell it to, then set your price appropriately. The method of most interest for ship valuations is the value (the net present value, properly) of all net earnings the ship is presumed to generate during her remaining commercial life plus her residual value itself (salvage value). While the Income Approach method is the most academically rigorous method available, and widely accepted as the proper method of determining the value of assets, ships included, arriving at appropriate inputs to the financial model can heavily impact the value of the ship. The most crucial assumption in modeling Income Approach is of course the projection of freight revenue, which in turn is based on assumptions of future market conditions of tonnage supply (available ships to compete for same cargoes, etc), tonnage demand (subject to world economic conditions and trade and also trading patterns), and also the chartering strategy of the buyer (spot market, sequence of short-term charters or very long- term charters). The cost and availability of debt finance will be another major input in the Income Approach financial modeling. Additional assumptions include operating expenses (such as crewing and insurance expenses, bunker fuel expenses), the commercial life of the ship (taking into consideration that regulatory framework and technological innovation can impact the longevity of a ship), and projections on the residual value of the ship (resale value in case of an after-sale or scrap value for demolition). Therefore, while the Income Approach offers a fundamental and well documented approach for the value of the ship, there is a sizeable amount of inputs and assumptions that still can render a ship valuation subjective.

8.5 The Statistical Method

The statistical method is basically regression analysis. Simply, this technique utilizes time series data, such as ship new-building and second-hand historical prices, ship age and size along with structural characteristics, freight rates, and calculates the expected mean value of the ship. The mean estimated value of the ship is known as 'dependent' variable and the 'explanatory' variables such as, historical asset prices, ship age and size, freight rates, etc. are known as 'independent variables'. This method, similar to the three approaches mentioned above, comes with its own set of merits, but also limitations. The regression analysis method works fairly well in estimating the 'price' of a real asset when the second-hand market for that particular asset does not fluctuate widely. The mean price estimation using regression analysis provides a good 'proxy' for pricing the ship. This is because the potential outcomes are fairly close to the estimated mean, since the distribution of prices is fairly tight. It is easily understood that the 'precondition' of low volatility in the case of a ship's market value is not really met. Regression analysis approach is particularly suited for assets where the market price of the asset in the second-hand market is always lower than that of the brand-new asset as a matter of decay and depreciation, and where the second-hand market is not at the mercy of variables other than the original cost and salvage value. Therefore, the regression analysis approach, with its solid statistical foundation, can be more accurately called as 'The Range Pricing Method'.

Advantages as well as drawbacks are associated with each one of these widely-accepted valuation methods in the valuation of shipping assets.

- The Market Comparable Method, known as 'mark to the market' and or 'last done'.
- The Income Valuation Method, known as 'mark to the model'
- The Replacement Cost Method, known as 'mark to the cost'
- The Range Pricing Method, based on the mean estimated price.

Advantages as well as drawbacks are associated with each one of these widely-accepted valuation methods in the valuation of shipping assets. Indifferently, which one of the four is selected versus the others, or, better, if the mean price of the four of them is selected, it needs to be stressed that the decision concerning the outflow required in order to acquire the vessel, or 'the actual transaction price', needs to be evaluated, applying maritime financial management principles. Value creation, as the prime principle of maritime financial management, dictates that the price for acquiring the ship. The decision about a vessel's 'right' price should be under-taken in the context of a value creation framework, which constitutes the core of the Maritime Financial Management discipline (Merikas, Sigalas, Karatzas,, & Drobetz, 2012)."

8.6 Approach of Finding Ship Earning

Ship owners generate income by leasing out their ships for a defined period in the 'time charter' market or by charging according to specific journey in the 'voyage charter' spot market. In time charter market, a charterer pays the owner a daily lease rate for the life of the contract, typically 6 to 12 months. The owner furnishes the charterer with the ship and must pay for the crew and maintenance, but the remaining costs, including fuel, are accepted by the charterer. Low current ship earnings are associated with lower ship prices and earlier higher industry investment; the economic magnitude of return predictability is stable but lower than industry expectations. At the same time, fluctuations in short-term lease rates do not imply anything about the expected returns on shipping capital. To proceed with the calculation of the distance to default, we had to estimate the daily assets return in such a way that we can after transform it into an annualized value (which will be fixed),

$$r_t = \ln(\frac{V_t}{V_{t-1}}) \tag{8.1}$$

where (r) is the daily ship income return and (V) represent the market value of ship.

$$\sigma_{daily} = \sqrt{\frac{1}{T-1}\sum_{i=1}^{t}(V_t - \mathrm{y})^2} \tag{8.2}$$

Then (σ) stands for the involved assets volatility per day, (V) is firm's asset value and y is the mean of the total estimated for a single ship.

$$\sigma_{\text{annual}} = \sigma_{\text{daily}} \text{ x } \sqrt{355} \tag{8.3}$$

We multiplied the daily standard deviation by the square root of 355 since the ship earning normally are 355 days throughout the year. Ship owners earn income either by transporting cargo for hire or by leasing out their ships for a defined period of time in the "time charter" market. Dry bulk shipping is a highly volatile and cyclical industry in which earnings, investment, and returns on capital appear in waves. "In 2007, a 5-year old "Panamax" ship commanded daily lease rates of $25,325 and could be purchased for $44 million. By December 2008, daily lease rates hadn't grow than one fourth to $6,000, and purchase prices had decreased more than six times to $8 million. By 2014, lease rates and secondhand prices had nearly returned to their 2004 levels. This huge volatility occurred alongside enormous instabilities in industry investment. In December 2007, outstanding orders for new ships amounted to more than 70% of the active fleet. However, by December 2010, outstanding orders for new ships dropped less than 10% of the active fleet (Greenwood & Hanson 2015). At the end of 1999 investors could pick up a 5-year-old Panamax bulker for $14m. Trading that vessel at the start year one year timecharter rate for 10 years would have generated estimated earnings of $66.5m (after opex), and then as a 15-year-old unit in

2009 the vessel could have been sold for $12.5m. That's a small loss of $1.5m on the asset but still a total return of $65m, and an impressive internal rate of return (IRR) of 26%.

A few years later, 5-year-old Panamax bulk carrier purchases did perhaps even better. Buying a 5-year-old in 2002, once again at $14m, trading at the time charter rate and selling as a 15-year-old would have generated total returns of $73.2m and an IRR of 41%, whilst the equivalent project in 2003 would have generated $66.1m and an IRR of 44%. These vessels would have generated boom earnings earlier in the project period, subject to a heavier weighting in terms of the internal rate of return calculation. However, not all investors are so lucky. In this example, 5-year-old ships purchased since 2008 (and sold this year, so admittedly with less time to hit upon a period of boom earnings) generated negative returns, and those purchased pre-1995 an average IRR of 7%. Buyers in 2008 would have lost a whopping $82.1m on the asset. Nevertheless, there was clearly a golden period; in the years 1998-2006 investors would have achieved an IRR ranging between 20% and 44%. The ship owner must provide a crew, at a daily cost that we estimate to be approximately $7,000 per day, adjusted for inflation [41]. Thus, annual earnings in year *t* are given by

$$\Sigma_t = 355.\,\text{Daily Charter/Lease Rate} - 365.\,\text{Daily Cost}_t \qquad (8.4)$$

Equation (21) is an approximation, but it is confirmed in case studies of the shipping industry by Stopford (2009)." In addition to proving the high volatility of ship earnings. "Earnings are 96% correlated with earnings in the previous month, but only 61% correlated with earnings 6 months earlier, 24% correlated with earnings 12 months earlier, and uncorrelated after 16 months. This high degree of estimated mean reversion is not sensitive to the time-period in question. (Greenwood & Hanson 2015)." It is difficult to evaluate the apparent volatility in ship pricing without first considering a benchmark in which discount rates are constant.

41 This estimate is based on Stopford (2009) and conversations with ship owners. CPI potentially overstates the growth of crew costs because globalization has allowed ships to source crews from lower wage countries over time.

9 THE SHIP FINANCE INSURANCE CONTRACT MODEL

The main idea behind presenting this thesis is to propose a new dynamic model which can be widely used in ship finance risk management for obtaining probability of default. This thesis gives a new methodology for obtaining probability of defaults (PD) for expected loss of the rating grades which can be further used in internal rating based approach of finance risk in ship finance. Usual bank practices for deriving probability of default values for such exposures often focus on qualitative mapping mechanisms to bank-wide master scales or external ratings. These practices, while widespread in the industry, do not entirely satisfy the desire for a statistical foundation of the assumed PD values. “A core input to modern credit risk modeling and managing techniques are probabilities of default per borrower. As such, the accuracy of the PD estimations determines the quality of the results of ship finance risk models. In a recent paper, Schuermann and Hanson (2004) present a methodology to estimate PDs by means of migration matrices duration method (Jafry and Schuermann, 2004).”

We study and compare two phases of difficulties in estimating a default distribution. If we are going to estimate the default distribution as accurately as possible. We should gather considerably long terms statistics. While economic and social environment will change. As a result, the statistics should be adjusted by a kind of trend value. One of difficulties here is the estimation of that trend value. Another difficulty is the estimation of default distribution as being the stochastic distribution. We are using an actuarial methodology of complexity which will be the base of my model. Mathematically speaking, Complexity is basically an operation on two functions f(x) and g(x) that returns a third function which is actually the modified version of one of the original functions. Here, we are convoluting two probability distributions which return a modified new distribution that forms the cross of those distributions. Complexity has also been used in developing value at risk model but this is the first time that it is being applied for ship finance risk management. Up till now, many practitioners have used different distributions for obtaining probability of default of each grade, but here, we are combining two different probability distributions to get a new modified probability distribution. The results will definitely provide better estimates and the model can be widely used in every kind of portfolio, especially in low default portfolios. My methodology delivers confidence intervals for the probability of defaults of each rating grade. The probability of default range can be adjusted by the choice of an appropriate confidence level. Moreover, by the most prudent estimation principle our methodology yields monotone probability of default estimates.

My model will use simple information from the ship finance insurance portfolio. The model only uses total number of ship owner and total number of defaults in each grade. One of my main concerns is to utilize the weight of default of each grade within the defaulted portfolio which will be obtained simply by applying Bayesian's Theorem.

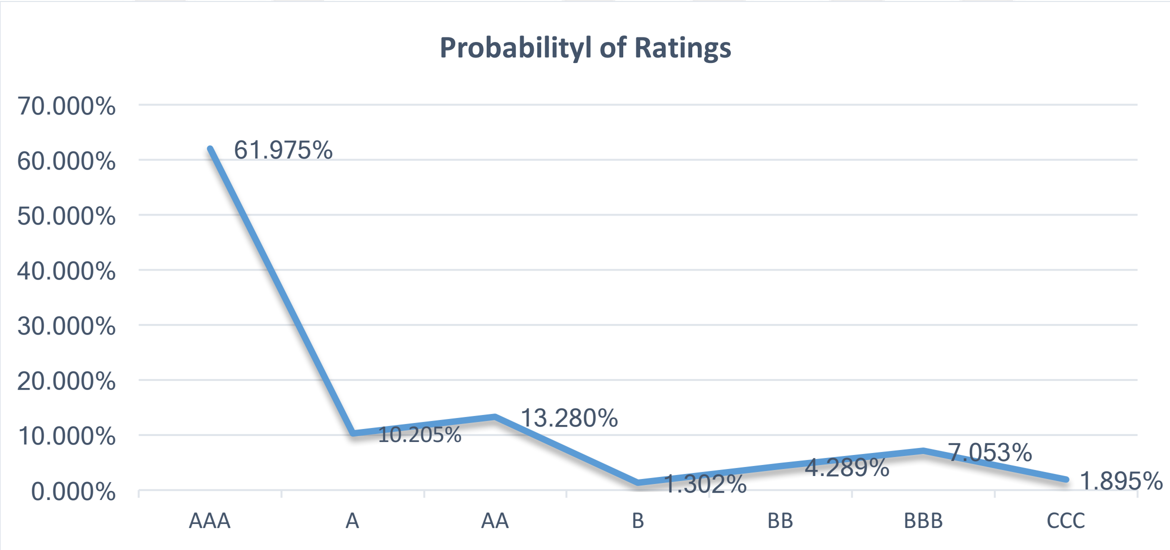


Figure 9-1 Shipping Finance Rating According to Market Cap.

9.1 Data Description

The data sample consists of 298 shipping companies (including shipbuilding) in the period 2011– 2016. The Appendix Table 14-2 provides full list of shipping companies listed in the world in respect to the firms' market capital size. The financial and specific data for the companies were collected from the offering prospect, whereas the industry specific variable for the shipping market was constructed using data collected from Rasyonet, Transportation & Port Industry report. A number of variables were employed and tested in our analysis in order to best predict the probability of default of shipping company at the time of a single year. Ratio analysis evaluates various aspects of an organizations operating and financial performance, e.g. efficiency, liquidity and profitability. For most ratios, an acceptable level is determined by its comparison to ratios of companies in the same industry. Such ratios are generally of two types: comparison of items between years or a comparison between items in the same year. The number of ratios that can be calculated is large and the multiplicity of available ratios means that it is important that the correct ratios are chosen.

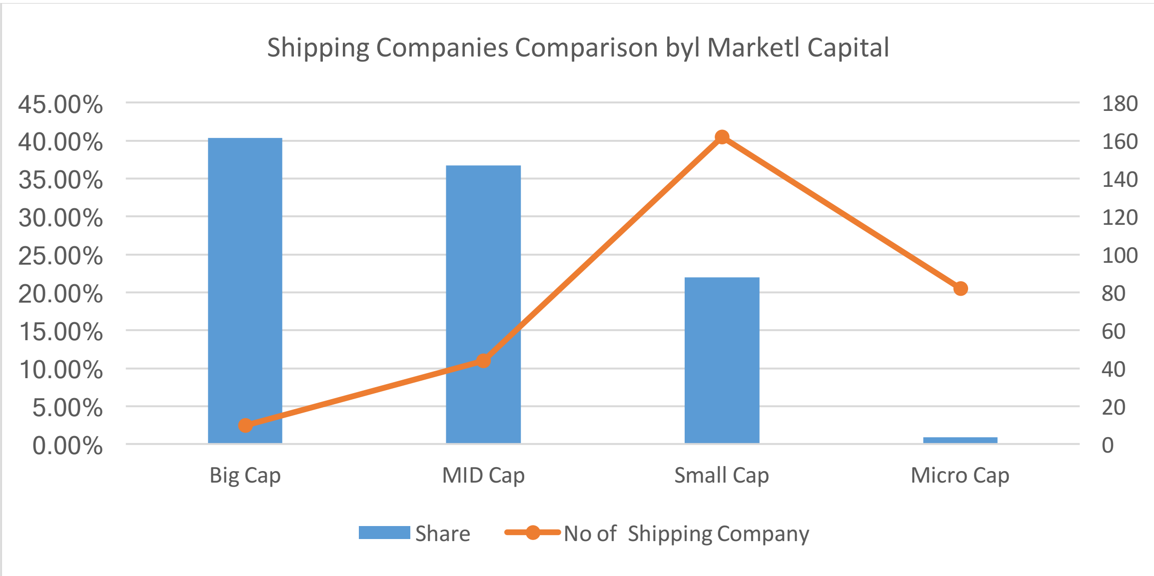


Figure 9-2 Shipping Companies Comparison by Market Capital

The Appendix 14-3 at the end of this thesis provides additional numerical and graphical results for the scaling the number of companies in each credit ratings according to their market capital. Credit rating is scaled from AAA, AA, A, BBB, BB, B to CCC level. Credit Ratings (CR) are meant to be an indication of the likelihood that a company will repay its debt on time. As such, ratings improve the flow of information between institutional financiers (investors) and borrowers (issuers) and they reduce the investor's costs of gathering, analyzing, and monitoring the financial positions of the borrowers.

The financiers are distributed to rating grades AAA, AA, A, BBB, BB, B, and CCC, with frequencies nAAA, nAA, nA, nBBB, nBB, nB, and nCCC. The grade with the highest credit-worthiness is denoted by AAA, the grade with the lowest creditworthiness is denoted by CCC. Below there are some important ratios to analyze for financiers before investing money in shipping companies. All parts are equally important when conducting a financial statement analysis. However, the balance sheet and income statement are of special interest as they are used for financial statement modeling, forecasting future financial statements and valuating of the firm. So, the purpose of the analysis is to forecast future cash flows.

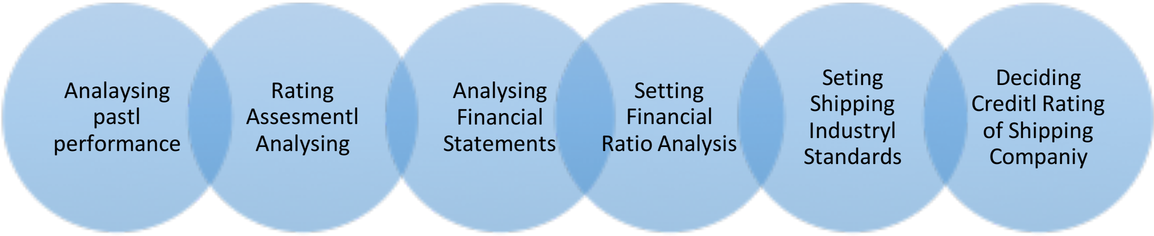


Figure 9-3 Setting Financial Ratios

The industrial rating is used to find the credit premium which is used to calculate the cost of capital. The industrial rating represents the default risk of the firm. Rating of AAA to BBB is considered investment grade, rating of BB to B is considered speculative and CCC and below is considered high risk and in default. The table 9-1 also provides an overview over average key ratios for shipping firms.

9.2 Analysis of Rating

We compute the financial ratios based on the results ending at companies' fiscal year. We have analyzed the financial information of all shipping companies since 2011 till end of 2016, according to their financial statements. Based on a sample of 298 shipping companies, we test whether they follow a target capital structure and examine the dynamics of capital structure adjustments subsequent to distresses in leverage. This ranking of companies by financial performance is a unique application in shipping industry, and as such is relied upon by investors looking for relative earnings power and margin control, Financiers estimating the relative performance of management irrespective of market conditions, and the boards and management of public companies that can use this data to benchmark their own performance.

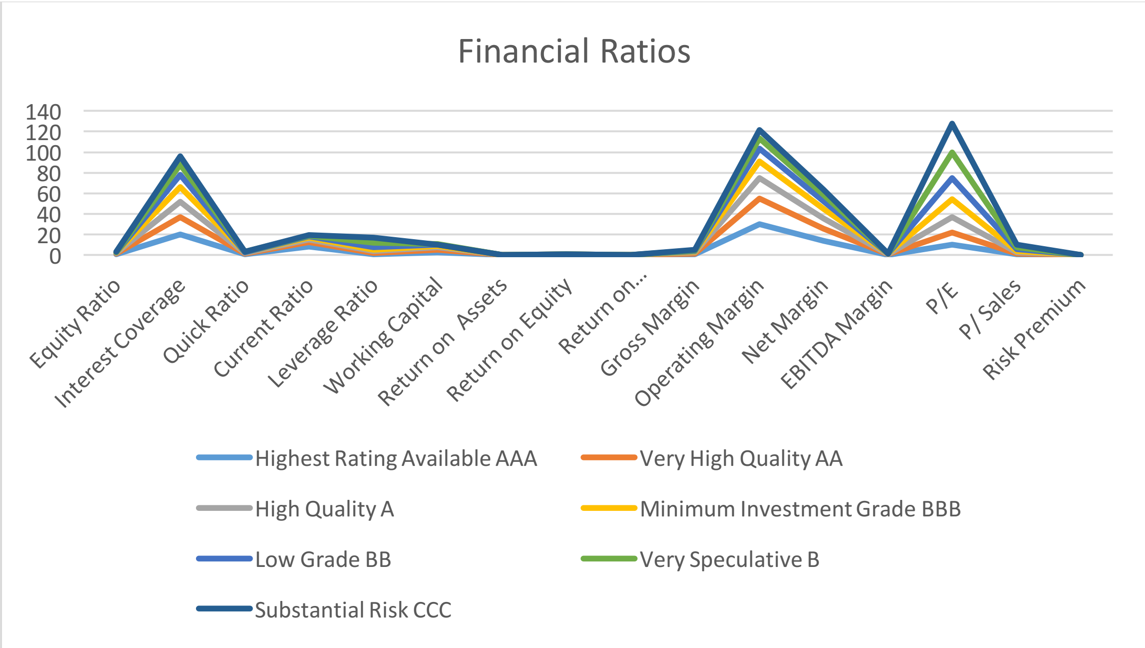


Figure 9-4 Financial Ratios

The Appendix 14-4 provides all numerical results for financial ratios the sample period is from 2011 to 2016 at the end of this thesis. All variables are scrutinized at the upper and lower confidence level. Ratios of profitability provide a view of the profitability in terms of percentages. This may be useful when comparing firms and development over time within an industry. Moreover, these ratios can be adapted to the user of the ratios, either a creditor oriented view or an investor oriented view. The most important strengths of the ship finance insurers will be their ratings skills. As a consequence, they work closely with the rating agencies to preserve them. Capital adequacy and solvency obviously play a key role in the rating agencies' credit assessments. In addition, rating agencies require that all potential transactions be of investment grade quality before any insurance wrap is considered. “According to estimates of ABN Amro (2011), more than 80% of all external funding needs in the shipping industry were traditionally covered by debt finance.” “As financing choices affect a firm’s valuation in the presence of market frictions (such as taxes, distress costs, and information asymmetry), the access of shipping companies to the global capital markets raises novel research questions with regard to their capital structure decisions. However, it is only a phenomenon of the last decade that ship owners took the opportunity to tap the global capital markets (Grammenos et al. 2008).” “De Angelo et al. (2011) suggest that the optimal capital structure from the traditional static point of view –

where financial managers trade off the tax benefits of debt against the distress costs of excessive debt – may not be optimal. The costs of leverage include the opportunity cost of its consequent future inability to borrow and therefore vary with firms' financial conditions and investment needs in the future. Shipping companies operate in a risky environment, most previous studies put their effort on risk management strategies using freight rate derivatives." Country-level variables do not affect the capital structure decisions of shipping companies, supporting the conjecture that shipping is a truly global business with limited local influences. Listed shipping companies exhibit comparatively high leverage ratios and hence higher financial risk. Such AAA ratings provide the issuer with reduced borrowing costs (as the pricing benefits outweigh the cost of the guarantee) and better marketability of the creditor debt. According to my calculations, ship finance insurance target roughly 65% of the available spread as the required insurance premium for AAA ratings. Investors benefit from enhanced security and liquidity of the ship owner credit. They also benefit from the credit monitoring expertise of the guarantor and the comfort that the insurer is sharing the risk by lending its credit quality to the issue.

My results reveal that the standard financial structure variables exert a significant impact on the cross-sectional variation of leverage ratios in the maritime industry. Asset tangibility is positively related to leverage, and its economic impact is more pronounced compared with other industries. Profitability, asset risk, and operating leverage are inversely related to leverage, but there is only weak evidence for market-timing behavior in our sample of shipping companies. Leverage behaves counter-cyclical over the business cycle. "Modigliani and Miller (1958) first began this groundbreaking work on capital structure in the field of Corporate Finance. The main theories of capital structure that attempt to explain firms' financing decisions are the tradeoff theory. According to MM Theorem, in perfect capital markets no impact of leverage can be seen on firm value. This theorem documented that firm's value is not affected by debt-equity ratio." "MM irrelevance theorem says that cost of capital and firm's value should not be affected by firm's financing policy (Jahanzeb et al. 2013)." While the trade-off theory assumes the existence of an optimal leverage ratio based on market imperfections such as taxes, bankruptcy costs, and agency costs into the model, the pecking order theory is based on asymmetric information between firm insiders and outsiders and the resulting adverse selection problems in raising capital. "According to the trade-off theory, capital structure choices are determined by a trade- off between the benefits and costs of debt (Kraus 2008)." "The empirical evidence documents that there exists no comprehensive theory which is capable to explain all time series and cross-sectional patterns of observed leverage ratios (Parson and Titman, 2009; Graham and Leary, 2011)." Any observable leverage factors should be related to capital structure theories because they are assumed to proxy for the underlying forces that drive these theories, such as the costs of financial distress and information asymmetry. However, the expected sign of the relationship is not always unambiguous, and hence it is important to sort out those factors which are reliably signed and economically relevant for explaining corporate leverage.

9.3 Financial Risk Ratios

Financial risk ratios are primarily used to assess a company's capital structure and current risk level as evaluated in relation to the company's debt level. The ability of a company to manage its outstanding debt effectively is critical to the company's financial soundness and operating ability. Debt levels and debt management also significantly impact a company's profitability, since funds required to service debt reduce net profit margin and cannot be invested in growth. Some of the financial ratios are listed below which has also been included in my benchmarking analysis.

The Debt to Capital Ratio; If a shipping company has a high debt to capital ratio, A variety of equity valuation metrics can be utilized to evaluate a company along with the debt to capital ratio to get a more complete picture of the company's capability as a paying its debt. It is possible to do it with financial models that allow us to see how far a company is from falling. The debt to equity ratio can be used as an alternative measure to evaluate a company's debt situation. What is perhaps more important than a company's total debt is its ability to service its outstanding debt. Debt in itself is not problematic as long as the company can make the required payments. Neither the debt to capital ratio nor the debt to equity ratio factor in a company's ability to cover its debt or that companies borrow at different interest rates. The interest coverage ratio accounts for these factors. Instead of looking simply at total debt, the calculation for this metric includes the cost a company pays in interest as it relates to the company's operating income. The debt-to-capital ratio is a

measure of leverage that provides a basic picture of a company's financial structure in terms of how it is capitalizing its operations and an indication of its financial soundness.
The Debt to Equıty Ratio; The debt/equity ratio is a key financial ratio that provides a more direct comparison of debt financing to equity financing. It is also an indicator of a company's ability to meet outstanding debt obligations. Again, a lower ratio value is generally preferred, as this indicates the company is financing operations more through its own financial resources than through taking on debt financing.

The Interest Coverage Ratio; The interest coverage ratio is a basic measure of a company's ability to handle its short-term financing costs. The ratio value reveals the number of times that a company can make the required annual interest payments on its outstanding debt with its current earnings before taxes and interest. A relatively lower coverage ratio indicates a greater debt service burden on the company and a correspondingly greater risk of default or financial insolvency. A lower ratio value means a lesser number of earnings available to make financing payments, and it also means the company is less able to handle any increase in interest rates.

Leverage Ratio; The degree of combined leverage provides a fuller, more complete assessment of a company's total risk by factoring in both operating leverage and financial leverage. This leverage ratio estimates the combined effect of both business risk and financial risk on the company's earnings per share (EPS), given a particular increase or decrease in sales. Calculating this ratio can help management identify the best possible levels and combination of financial and operational leverage for the firm.

Current Ratio; The current ratio is Current Asset/Current Liabilities. Current assets (cash, inventory, accounts receivable) to Current liabilities (obligations due within the next period). The current ratio explains if a firm has enough resources to meet its debt maturing over the next year. A ratio of, 5 and more is often promoted as being sound, but this is also contingent on the type of shipping company. For a supply ship firm with relatively low current assets, a slightly lower ratio may also be sound.

Interest Coverage Ratio; The Interest Coverage Ratio is EBIT/ Interest Expenses. The interest coverage ratio reviews the firm’s ability to meet its interest from pre-debt, pretax earnings (EBIT). A higher ratio is thus preferable, but may fluctuate according to industry and economy.

Debt Ratio; The debt to equity ratio is Debt/Equity. The debt to capital ratio is Debt/Debt +Equity. The debt ratio is used to find out if a firm can repay the principal on its debt. This does not provide an in-depth overview over the default risk of the firm, but rather a simplified view over the financial state of the firm.

Prıce to Book Ratio; The P/B ratio is often used as a valuation multiple, and a P/B value below the industry average may mean the company is undervalued. We believe the P/B ratio demonstrates how efficiently companies utilize invested equity capital to create value. A higher P/B ratio in the same industry reflects a market view of better future performance with the same amount of equity invested, because better performance will lead to greater discounted cash flows and better current valuation. In my ranking method, higher P/B ratios lead to a better performance ranking – of course it all depends at what value ships are put in the book.

Return on Equity Ratio; ROE is an all-time favorite to provide a shortcut performance evaluation metric for equity investors. Return on equity tells us the percent returned for each dollar (or other monetary unit) invested by shareholders. It not only directly measures the earnings returned to equity holders, but also factors in multiple performance metrics like leverage, profit margin and asset turnover. Averaging ROE over the past 5 years can give us a better idea of the historical growth. Return on Equity/Net Income/Shareholder's Equity.

Return on Capital, The Return on Capital (ROC) ratio is EBIT/Book Value of Debt + Book Value of Equity. Return on Capital gives an overview over the profitability of the firm, by comparing return to invested capital. While also used to measure profitability; ROC shows return not only to equity shareholders, but all invested capital including debt.

Return on Net Operating Assets; The Return on Net Operating Assets (RNOA) ratio is Net Operating Profit After Taxes/ Average Net Operating Assets. Return on Net Operating Assets provides an overview over the relationship between operating profit after tax and operating assets invested in the firm. It is thus a measure of the firm's capability to earn positive returns on its operating capital.

The Solvency Ratıo; It is of special interest for companies that invest money in (or lend money to) a shipping company such as banks. For the same reason, we have measured the Net Debt Ratio of the companies analyzed. Maximum requirements for net debt ratios are often included in bank covenants.

EBITDA; Earnings before Interest, Taxes, Depreciation & Amortization (EBITDA) is a very popular, but also controversial measure of operating performance in the bulk shipping industry. In fact, most shipping companies report EBITDA in their earnings report. This ratio is important for credit institutions as it indicates the ability of the company to pay the interest expenses on the debts. EBITDA is a pro-forma accounting figure that measures the operating efficiency of a company, taking into consideration ship operating expenses and administrative overhead. It also measures a company's capacity to service its debt obligations, and is frequently used in loan covenants. EBITDA is an indirect method of calculating a company's operating margin. In that regard, it is similar to the indirect method of calculating the operating cash flow. Another ratio that is often included in bank covenants is EBITDA / Net Finance Cost. This ratio indicates how many times a company's interest expenses can be covered from operating cash earnings (earnings before interest, depreciation and amortization).

Workıng Capıtal; Meeting long term liabilities is only relevant when a company is able to pay its short-term liabilities in the short run. The working capital over total assets ratio (WC/TA) is a measure of the net liquid assets of the firm relative to the total assets. Normally, a firm with negative working capital is likely to experience problems meeting its short-term obligations because there are simply not enough current assets to cover them. As a result, we would expect a higher probability of default to be related to lower values of this ratio.

Current Ratıo; The current ratio indicates the ability of the company to pay its short-term liabilities in the short run and is calculated by dividing the total of current assets by the amount of current liabilities. A low current ratio would reflect possible insolvency problems, as companies need enough liquid assets to meet short-term liabilities. As a rule of thumb, a current ratio of approximately 1.5 is generally deemed to be healthy while current ratios less than 1 are generally deemed to be unhealthy.

Leverage Ratıo; The net debt ratio is calculated as the ratio of interest bearing debt less cash divided by total assets. The higher the ratio the more the company has been financed by interest bearing liabilities. Borrowing capacity of the company decreases when net debt on total assets increases. For this reason, this ratio is usually monitored by banks or other finance providers. It should be minimum approx. 0.5 and more. A higher proportion of debt increases the risk of bankruptcy for a shipping company. On the other hand, too few debts can also raise questions. If a company's operations can generate a higher rate of return than the interest rate on its loans, then the debt is helping to fuel growth in profits. The degree of a firm’s operating leverage is a positive function of the firm’s fixed production costs. The higher a firm’s operating leverage, the higher are its operating risks, and therefore operating leverage and asset risk can be viewed as complementary measures of a firm’s business risks.

Return on Assets; The net income over total assets (NI/TA), the so-called return on assets (ROA) ratio, is a measure of the company’s asset intensity. Companies such as car manufacturers, railroads, and shipping are very asset-intensive, requiring large and expensive machinery, equipment or ships, to operate and generate a profit. (0.20 and more)

Return on Equity; One of the most important profitability metrics is the net income over shareholder’s equity ratio (return on equity – ROE). Generally, it reveals how much profit a company generates with the money its shareholders have invested. It is useful for comparing the profitability of a company to that of other firms in the same industry. The higher a company’s return on equity and return on assets compared to its industry, the better (0.50 and more).

9.4 Global Shipping Industry's Rating

"Shipping companies' leverage is completely a function of a company's demand for debt (Stiglitzand Weiss, 1981)." However, firms are sometimes rationed by financiers based on surveys, Graham and Harvey (2001) report that an important goal of chief financial officers (CFOs) is to maintain financial flexibility. "Therefore, Faulkender and Petersen emphasize that when estimating a firm's target leverage, empirical analyses should not only include the determinants of a firm's preferred leverage-the demand side but also those factors that measure the constraints on its ability to increase leverage-the supply side (Faulkender and Petersen 2006)." They argue that a company's ability to issue public (rated) debt can be interpreted as an indicator of large debt capacity. "Firms with a credit rating have easier access to the debt markets than those without a rating, and hence rated firms will hold more leverage. This result can occur either directly through a quantity channel (Financiers are willing to lend more) or a price channel (firms with access to a cheaper source of capital borrow more). Either way, Faulkender and Petersen document that opening up a new supply of debt capital increases a firm's leverage (Faulkender and Petersen 2006)." Possessing a credit rating involves information collection and processing through the rating agency, and hence firms with a public rating suffer from less pronounced information asymmetry. Accordingly, from a pecking order perspective, firms that have a rating may use less debt and more equity. "As emphasized by Frank and Goyal (2009), however, this effect is ambiguous as lower adverse selection costs increase the frequency with which firms tap the external capital market, potentially resulting in more debt (Frank and Goyal, 2009)."

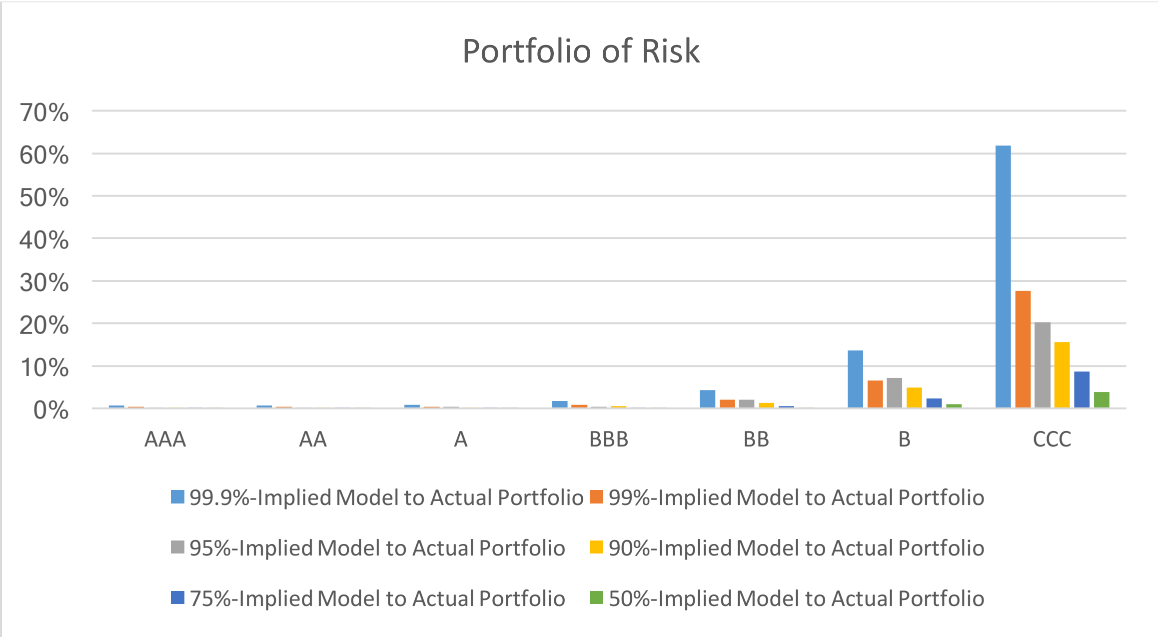


Figure 9-5 Implied model to Actual Portfolio of Shipping Companies in 2017

Shipping earning expectations is negative at the moment in 2016 because EBITDA ratios will worsen, with freight rates likely to remain depressed during sufficient amount of supply. One of the leading example is that South Korean shipping giant. Hanjin Shipping used to be one of the world's top 10 shipping companies. The firm was declared bankrupt by a South Korean court after months of uncertainty at Feb.2017. The firm had a hard time with $5.4bn in debt in August 2016, the company failed to get any more money from its creditors. Hanjin went into receivership and applied for court protection. Stopping the credit line immediately results in an inability to purchase fuel, it immediately results in ships not being able to go to port and it immediately results in all customers going to the competitors. According to Ian Lewis that is Managing Director of Corporate finance division of Moody’s. "We expect that the aggregate EBITDA of Moody's-rated shipping companies will fall by 7%-10% in 2016”. "Such a result is much worse than the low-single-digit percentage decline we forecast in March 2016, when we changed our outlook for the industry to negative from stable (Lewis 2017).” Moody's report says that conditions will remain weak for the dry bulk segment. In particular, freight rates are very low, despite the fact that the high levels of cancellations and scrapings will keep the gap between supply growth and demand growth narrow. The report points out that Moody's will consider changing the outlook for the global shipping industry back to stable if shipping supply growth exceeds demand growth by less than 2%, or demand growth exceeds supply growth by up to 2%, and if aggregate EBITDA growth is within a range of -5% to +10% year-over-year. Moody's will consider a positive outlook for the global shipping industry if the oversupply of ships declines materially and the aggregate year-over-year EBITDA growth for companies that Moody's rates appears likely to exceed 10%.

9.5 Forecasting Distress with Discriminant Analysis

The Shipping Default Rating (SDR) is the output of a credit-strength test that gauges a publicly traded shipping company's likelihood of bankruptcy.

$$Shipping\ Default\ Rating = a_1x_1 + a_2x_2 + a_3x_3 + \cdots + a_nx_n/\text{n} \qquad (9.1)$$

Table 9-1 Sipping Default Rating Score Component Definitions

Variable	Definition Ratio of Shipping Companies	Weighting Factor
x1	Total Debt to Equity	A
x2	Interest Coverage	B
x3	Quick Ratio	C
x4	Current Ratio	D
x5	Leverage Ratio	E
x6	Working Capital	F
x7	Return on Asset	G
x8	Return on Equity	H
x9	Return on Investment	I
x10	Gross Margin	J
x11	Operating Margin	K
x12	Net Margin	L
x13	EBITDA Margin	M
x14	P/E	N
x15	P/Sales	P

SDR = AX1 + BX2 + CX3 + …. +NX14 + PX15/15

The Appendix 14-4 provides additional information on the analytical and numerical results about the shipping default score components.

• Score above 3.0 - “Safe” Zones. The company is considered ‘Safe’ based on the financial figures only.

• Score above 2.2 - “Grey” Zones. There is a good chance of the company going bankrupt within the next 2 years of operations.

• Score below 1.8 - “Distress” Zones. The score indicates a high probability of distress within this time period.

9.6 Utilize the Risk Financing Portfolio

My shipping finance insurance coverage model focuses on a different issue of probability of default estimations and will utilize simple information from the group of shipping companies. As discussed in the earlier sections, the model only uses total number of shipping company and total number of defaults in each grade. One of my main concerns is to utilize the weight of default of each grade within the defaulted group which will be obtained simply by applying Bayesian’s Theorem. This approach uses sequential analysis techniques to include the outcome of earlier experiments in the design of the next experiment. It will produce the probability of default in each grade of the next customer which will be part of the portfolio. Now, as Bayesian Theorem says,

$$P\left(\frac{A}{B}\right) = \frac{P\left(\frac{B}{A}\right) P(A)}{P(B)} \qquad (9.2)$$

where;
A: is percentage of obligors in a ranking
B: is an event of default
For estimating probability of defaults, we use all available company’s financial statements and quantitative information of ratios and rating grades. My model delivers confidence intervals for the probability of defaults of each rating grade. For example, we have the following portfolio: Therefore, my table will provide results for each grade in this way:

Table 9-2 Bayesian Estimate which provides the weights of default in each grade

GRADE	*NUMBER OF SHIPPING CO.*	*NUMBER OF DEFAULTS*	***λ***
AAA	6	1	2.01%
AA	22	1	7.38%
A	92	1	30.87%
BBB	71	1	23.83%
BB	57	1	19.13%
B	28	1	9.40%
CCC	22	1	7.38%
Total	298	7	

The above derives Bayesian Estimate which provides the weights of default in each grade given the total number of defaults of the whole portfolio or simply, the probabilities of each grade given the total number of defaults in that grade. This estimate can only answer the question that given a default, what is the probability that the obligor has a particular grade.

9.7 First Approach- Assumption of No Default

The rating grades sorted by AAA, AA, A, BBB, BB, B, CCC with frequencies nAAA, nAA, nA, nBBB, nBB, nB, nCCC. The AAA is the highest credit worthiness. We assume that the probability of defaults of pAAA of grade AAA, pAA of grade AA, pA of grade A, pBBB of grade BBB, pBB of grade BB, pB of grade B, pCCC of grade CCC reflect the decreasing credit-worthiness of the grades, in the sense of the following difference:

$$nAAA <= nAA <= nA <= nBBB <= nBB <= nB <= nCCC \quad (9.3)$$

The difference implies that we assume the ordinal borrower ranking to be correct. According to (9.3), the probability of default pAAA of grade AAA cannot be greater than the probability of default pCCC of grade CCC. As a consequence, the most prudent estimate of the value of pAAA is obtained under the assumption that the probabilities pAAA and pCCC are equal.

Then, from (9.3) even follows pAAA= pAA= pA= pBBB= pBB= pB= pCCC.

Assuming this relation, we now proceed in determining a confidence region for pAAA at confidence level $\boldsymbol{\gamma}$. This confidence region can be described as the set of all admissible values of pAAA with the property that the probability of not observing any default during the observation period is not less than 1− $\boldsymbol{\gamma}$.

If we have got pAAA = pAA= pA= pBBB= pBB= pB= pCCC, then the seven rating grades AAA, AA, A, BBB, BB, B and CCC do not differ in their respective riskiness.

So, we have to deal with a homogeneous sample of size nAAA+ nAA+ nA+ nBBB+ nBB+nB+nCCC without any default during the observation period. Assuming unconditional independence of the default events, the probability of observing no defaults turns out to be $(1-\text{pAAA})^{\text{nAAA + nAA + nA + nBBB+ nBB+ nB+ nCCC}}$. As a consequence, we have to solve the difference

$$1-\gamma \leq \ (1-\text{pAAA})^{\text{nAAA+nAA+nA+nBBB+nBB+nB+nCCC}} \tag{9.4}$$

for pA in order to obtain the confidence region at level Δ for pA as the set of all the values of pA such that

$$pA \leq 1-(1-\gamma)^{1/(\text{nAAA+nAA+nA+nBBB+nBB+nB+nCCC})} \tag{9.5}$$

According to data collected till 2016 with rating of last 5-year rating average the result is

nAAA = 6, nAA = 22, nA = 92, nBBB = 71, nBB = 57, nB = 28, nCCC =22 (9.6)

Table 9-3 Confidence Level AAA

Upper confidence level ▽AAA of pAAA as a function of the confidence level. No defaults observed, frequencies of obligors in grades given by (25)

$\boldsymbol{\gamma}$	50%	75%	90%	95%	99%	99.90%
▽AAA	0.23%	0.46%	0.77%	1.00%	1.53%	2.29%

In order to above table, there is a strong demand of the upper confidence bound ▽AAA on the confidence level. By difference (9.3), the probability of default pBBB of grade BBB cannot be greater than the probability of default pCCC of grade CCC either. Consequently, the most prudent estimate of pBBB is obtained by assuming pBBB = pCCC. Assuming additional equality with the probability of default pAAA of the best grade AAA would violate the most prudent estimation principle, because pAAA is a lower bound of pAA. If we have got pBBB = pCCC, then BBB and CCC do not differ in their respective riskiness and may be considered a homogeneous sample of size nBBB+nCCC. Therefore, the confidence region at level for pAA is obtained from the difference

$$1 - \gamma \leq (1 - pAA)^{\mathrm{nAA+nA+nBBB+nBB+nB+nCCC}} \tag{9.7}$$

$$pAA \leq 1 - (1 - \gamma)^{1/(n\mathrm{AA+nA+nBBB+nBB+nB+nCCC})} \tag{9.8}$$

We continue the example defined by (9.6), above table displays some values of confidence levels γ with the matching maximum values ▽AA of pAA such that (29) is still fulfilled.

Table 9-4 Confidence Level AA

Confidence bound ▽AA of pAA, ▽A of pA, ▽BBB of pBBB, ▽BB of pBB, ▽B of pB, as a function of the confidence level. No defaults observed, frequencies of obligors in grades given by (28)

γ	50%	75%	90%	95%	99%	99.90%
▽AA	0.24%	0.47%	0.79%	1.02%	1.56%	2.34%
▽A	0.26%	0.51%	0.85%	1.10%	1.69%	2.53%
▽BBB	0.39%	0.78%	1.29%	1.67%	2.55%	3.81%
▽BB	0.65%	1.29%	2.13%	2.76%	4.21%	6.25%
▽B	1.38%	2.73%	4.50%	5.82%	8.80%	12.90%

In order to above table, there is a strong dependence of the upper confidence bound ▽Rating on the confidence level. Intuitively, values of smaller than 95% seem more appropriate for estimating the probability of default by ▽Rating. Appendix 14-5, 14-6, 14-7, 14-8, 14-9, 14-10 shows confidence level of default occurrence from one default to up to 30 default in a single year at 99.9%, 99%, 95%, 90%, 75%, 50%.

For determining the confidence region at level for pCCC we only make use of the observations in grade CCC because by (9.3) there is no obvious upper bound for pCCC. Hence the confidence region at level γ for pCCC consists of those values of pCCC that satisfy the difference,

$$1-\gamma \leq (1-pCCC)^{\text{nCCC}} \qquad (9.9)$$

Table 9-5 Confidence Level

Upper confidence bound ▽CCC of pCCC as a function of the confidence level. No defaults observed, frequencies of obligors in grades given by (9.9).

$\boldsymbol{\gamma}$	50%	75%	90%	95%	99%	99.90%
▽CCC	3.10%	6.11%	9.94%	12.73%	18.89%	26.95%

Equally, the confidence region for pCCC can be described by

$$\text{pCCC} \leq 1-(1-\gamma)^{1/\text{nCCC}} \qquad (9.10)$$

coming back to our example (9.6), Table above lists some values of confidence levels with the corresponding maximum values (upper confidence bounds) ▽CCC of pCCC such that (9.9) is still fulfilled. Relationship of Tables 12-3,4,5 shows that – current sample size is an important driver in the upper confidence bound. The smaller the sample size can be used by the larger upper confidence. This is not an undesirable effect because intuitively credit ratings should be better, the greater the number of debtors in a portfolio without any default observation. So, we have generated probabilities of default by total number of defaults in the portfolio. We have not taken into account the number of shipping companies default frequencies in each grade. We will take into account the above as well and generate a frequency distribution with Poisson distribution being the most suitable one.

Refer to the Table 12-3, we first calculate the parameter of the distribution which is lambda (λ) which will take the impact of number of grade and defaults against them in each grade.

Results are shown in Table 12-7. As we know the probability mass function (pmf) of the Poisson distribution is, where,

λ = frequency of default in each grade

x = number of incremental default in the specific grade

$$p(x, \lambda) = \frac{e^{-\lambda}\lambda^{x}}{x!} \quad \text{for x= 0,1, 2…} \qquad (9.11)$$

Poisson distribution will generate the probabilities of incremental default in every grade and for each confidence level and these results will then be injected to our foundation model, complexity. In our example of confidence level 95%, the results are, the 99.9%,99%, 90%,75%,50% of confidence level based on no defaults provided in Appendix, from Table 14-5 to Table 14-10.

Table 9-6 Based on no Default - 95% Confidence level

The other calculations of confidence levels can be seen at the end of this thesis in section ‘Tables and Figures’

	Poison Dist.	RESULT		Poison Dist.	RESULT		Poison Dist.	RESULT
AAA	λ	1.0529%	AA	λ	1.0744%	A	λ	1.1615%
	n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.98953	0	0	0.98931	0	0	0.98845
1	1	0.01042	1	1	0.01063	1	1	0.01148
2	2	0.00005	2	2	0.00006	2	2	0.00007
3	3	0.00000	3	3	0.00000	3	3	0.00000
4	4	0.00000	4	4	0.00000	4	4	0.00000
5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000
	Poison Dist.	RESULT		Poison Dist.	RESULT		Poison Dist.	RESULT
BBB	λ	1.7567%	BB	λ	2.9062%	B	λ	6.1216%
	n	P(N=n)		n	P(N=n)		n	P(N=n)

0	0	0.98259	0	0	0.97136	0	0	0.94062
1	1	0.01726	1	1	0.02823	1	1	0.05758
2	2	0.00015	2	2	0.00041	2	2	0.00176
3	3	0.00000	3	3	0.00000	3	3	0.00004
4	4	0.00000	4	4	0.00000	4	4	0.00000
5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000
	Poison Dist.	RESULT						
CCC	ג	13.4006%						
	n	P(N=n)						
0	0	0.87459						
1	1	0.11720						
2	2	0.00785						
3	3	0.00035						
4	4	0.00001						
5	5	0.00000						
6	6	0.00000						
7	7	0.00000						
8	8	0.00000						
9	9	0.00000						
10	10	0.00000						
11	11	0.00000						
12	12	0.00000						

When lambda for each class for each security has been estimated, we can fit Poisson, results that will further develop our next step, complexity.

9.8 The Probability of Default of Rating Grades

There are two phases of difficulties in estimating a default distribution. If we are going to estimate the default distribution as correct as possible. We should gather considerably long terms statistics. The default distribution is the distribution of default amount which an insurer paid for a definite period, for example for one year. Therefore, the default distribution should be analyzed by two factors.

- The distribution of frequency
- The distribution of default size.

The Distribution of frequency; the defaults frequency is a number which is calculated from the stand point whether or not default occur in the risk group which an insurer is retaining in a definite term, the logical distribution of default frequency is considered to be a binomial distribution. Assuming that numbers of risks and the average defaults occurrence rate is a risk group are n and p respectively, the distribution is expressed by the following binomial expansion formula.

$$P(X = k) = (^{n}_{k}.)p^{k}q^{n-k} \qquad (9.12)$$

1-p = q, k is probable default number.

The probability of default occurrence is each risk in a risk collective which an insurer is retaining is not always the same. According to a risk collective is separated into many kinds of risk groups with different number of risks and default occurrence rate. Assume the number of risks and default occurrence rate of seven number of risk rating group are, AAA, AA, A, BBB, BB, B, CCC and PAAA, PAA, PA, PBBB, PBB, PB, PCCC respectively the following formula holds.

P= AAAxPAAA+AAxPAA+AxPA+BBBxPBBB+BBxPBB+BxPB+CCCxPCCC / 7

The distribution of default frequency of a risk of financing is accordingly expressed by the following formula

$$\binom{AAA}{k} p^{k}q^{AAA-k} * \binom{AA}{k} p^{k}q^{AA-k} * \binom{A}{k} p^{k}q^{A-k} * \ldots * \binom{CCC}{k} p^{k}q^{CCC-k} \qquad (9.13)$$

where * shows complexity

9.9 The Distribution of Default in Shipping

The first example is the deal with a portfolio without default. For the second example, we change the first example by assuming that the crime has been observed. In another example, we show how the method may be modified to take into account the zero correlation of default. For this purpose, the most suitable binomial distribution that will provide the desired probability for different number of default values for a given class. Such as one default for each grade. We have a total of 7 defaults in my portfolio and we want to know the probability of every possible occurrence of default in grade A. The Binomial Distribution has the probability mass function (pmf):

$$P(X = k) = \binom{n}{k}p^k(1-p)^{n-k} \qquad (9.14)$$

$$P(X = k) = \binom{nAAA + \mathrm{nAA} + \mathrm{nA} + \mathrm{nBBB} + \mathrm{nBB} + \mathrm{nB} + \mathrm{nCCC}A + nB + nC}{k}p^k(1 - p)^{nAAA+\mathrm{nAA}+\mathrm{nA}+\mathrm{nBBB}+\mathrm{nBB}+\mathrm{nB}+\mathrm{nCCC}A+nB+nC-k} \qquad (9.15)$$

where the parameters are defined as,

n = total number of defaults in the portfolio

k = number of defaults in particular grade

p = probability as estimated by Bayesian Theorem

In considering default size, the distribution becomes more and more complex. Assuming that a risk collective is constructed by risk being P_{AAA}, P_{AA}, ……., P_{CCC} of default occurrence rate and confidence level is constructed by C0.5, C0.75, C0.9, C0.95, C0.99, C0.999 and D_{AAA}, DAA, …., $D_{CCC,}$ of default size and AAA, AA….,CCC risk number which are the case of P_{AAA} x D_{AAA}, …P_{CCC} x D_{CCC} respectively the risk collective is expressed by the array of following risk group.

RAAA [AAA, C0.5, PAAA, DAAA],RAAA[AA,C0.75,PAA,DAA],.............RAAA[AAA,C0.999,PAAA,DAAA]

RAA [AA, C0.5, PAA, DAA], RAA[AA, C0.75,PAA,DAA] , …… ……RAA[AA,C0.999,PAA,DAA]

RA [A, C0.5, PA, DA], RA[A,C0.75,PA,DA] , ……………………..RA[A,C0.999,PA,DA]

⋮ ⋮ ⋮

RCCC [CCC, C0.5, PCCC, DCCC], RCCC[AAA, C0.75,PCCC,DCCC] , …. RCCC [CCC, C0.999, PCCC, DCCC],

In the case of each risk being independent stochastically, the default distributions of each rating are shown by the following formula,

B_{AAA} ($D_{AAA.}$k, AAA, C0.5,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

B_{AAA} ($D_{AAA.}$k, AAA, C0.75,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

B_{AAA} ($D_{AAA.}$k, AAA, C0.90,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

B_{AAA} ($D_{AAA.}$k, AAA, C0.95,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

B_{AAA} ($D_{AAA.}$k, AAA, C0.99,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

B_{AAA} ($D_{AAA.}$k, AAA, C0.999,P_{AAA}) = $\binom{AAA}{k} p^k q^{AAA-k}$

⋮ ⋮

B_{CCC} ($D_{CCC.}$k, CCC,C0.999,P_{CCC}) = $\binom{CCC}{k} p^k q^{CCC-k}$

Since a default distribution of a risk collective is a compound function of default distribution of these risk rating, while compound function of binomial distribution is not always a binomial distribution, a default distribution of a risk collective is not always a binomial distribution. Accordingly, we describe the distribution function of a risk collective as Q (D.k, Rating, C, P).

Q (D_{AAA}k; AAA, P) = B_{AAA} (D_{AAA}k; AAA, PAAA) * B_{AA} (D_{AA}k; A, P_{AAA})* B_A(D_Ak; A,P_A)* B_{BBB}(D_{BBB}k; BBB,P_{BBB})* B_{BB}(D_{BB}k; A,P_{BB})* B_B(D_Bk; A,P_B)* B_{CCC}(D_{CCC}k; A,P_{CCC})

This is the logical model for default distribution which may occur in a risk collective. By doing so we are able to get the results for each grade (AAA, AA, A, BBB, BB, B, CCC in the following tables) in the form which is shown in Table 5. Hence the estimated probabilities of default of different occurrences are generated through Binomial Distribution as,

Table 9-7 Probability of Estimate through Binomial Distribution

Probability of Estimate	AAA GRADE	AA GRADE	A GRADE	BBB GRADE	BB GRADE	B GRADE	CCC GRADE
x	P(X=x)	P(X=x)	P(X=x)	P(X=x)	P(X=x)	P(X=x)	P(X=x)
0	0.8672935	0.5845878	0.0754322	0.1488220	0.2262588	0.5012247	0.5845878
1	0.1247477	0.3261830	0.2358171	0.3258350	0.3745944	0.3638520	0.3261830
2	0.0076899	0.0780003	0.3159492	0.3057394	0.2657911	0.1131984	0.0780003
3	0.0002634	0.0103624	0.2351725	0.1593796	0.1047724	0.0195652	0.0103624
4	0.0000054	0.0008260	0.1050285	0.0498500	0.0247802	0.0020290	0.0008260
5	0.0000001	0.0000395	0.0281436	0.0093551	0.0035165	0.0001262	0.0000395
6	0.0000000	0.0000010	0.0041897	0.0009753	0.0002772	0.0000044	0.0000010
7	0.0000000	0.0000000	0.0002673	0.0000436	0.0000094	0.0000001	0.0000000

We think again the portfolio of 'First method' with frequencies nAAA, nAA nA nBBB, nBB, nB, and the nCCC. Unlike previous assumption, this time we guess during the last period, a standard observed in grade AAA, was one of the standard observed in grade AA, was a standard observed in grade A, a standard observed in grade BBB, a standard observed as BB, a standard observed in grade B and a standard observed in grade CCC (Total default is 7). As in First Approach, we determine a most prudent confidence region for the PD pA of A. Also, we do so by assuming that the PDs of the four grades are equal. This allows me to consider the entire portfolio as a homogeneous sample of size nA+nB+nC+nD. Then the probability of observing not more than seven defaults is given by the expression

$$\sum_{i=0}^{7} \binom{nAAA + n\mathrm{AA} + \mathrm{nA} + \mathrm{nBBB} + \mathrm{nBB} + \mathrm{nB} + \mathrm{nCCC}A + nB + nC}{i} pAAA^{i}(1 - pAAA)^{nAAA + n\mathrm{AA} + \mathrm{nA} + \mathrm{nBBB} + \mathrm{nBB} + \mathrm{nB} + \mathrm{nCCC} - i} \quad (9.16)$$

(9.15) follows from the fact that the number of defaults in the portfolio is binomially distributed as long as the default events are independent. As a consequence of (9.16), the confidence region at level $\boldsymbol{\gamma}$ for pAAA is given as the set of all the values of pAAA that satisfy the dissimilarity

$$1-\gamma \le \sum_{i=0}^{7} \binom{nAAA + nAA + nA + nBBB + nBB + nB + nCCCA + nB + nC + nD}{i} pAAA^{i} (1 - pAAA)^{nAAA+nAA+nA+nBBB+nBB+nB+nCCC-i} \tag{9.17}$$

The tail distribution of a binomial distribution can be expressed in terms of an appropriate beta distribution function. Thus, difference (9.6) can be solved analytically for pAAA. Table above shows maximum solutions ∇AAA of (9.17) for different confidence levels $\boldsymbol{\gamma}$**.**

Table 9-8 Upper Confidence Level AAA

Upper confidence bound ∇AAA of pAAA as a function of the confidence level

γ	50%	75%	90%	95%	99%	99.90%
∇AAA	0.23%	0.46%	0.77%	1.00%	1.53%	2.29%
PAAA	3.208%	4.252%	5.835%	7.141%	10.352%	14.992%

In grade AAA defaults have been observed, the seven defaults that occurred during the observation period enter the calculation. They effect the upper confidence bounds, which are higher than those in Table 12-7. This is a consequence of the precautionary assumption pAAA = pAA= pA = pBBB = pBB= pB = pCCC. In order to determine the confidence region at level for pAA, we assume that pAA takes its greatest possible value according to (9.17). In complete analogy to (9.18), the probability of observing no more than three defaults in one period then can be written as

$$\sum_{i=0}^{7} \binom{nAA + nA + nBBB + nBB + nB + nCCC}{i} pAA^{i} (1 - pAA)^{nAA+nA+nBBB+nBB+nB+nCCC-i} \tag{9.18}$$

Table 9-9 Upper Confidence level AA

Upper confidence bound ▽AA of pAA as a function of the confidence level. One default observed in grade AA, one defaults observed in grade A, one default observed in grade BBB, one default observed in grade BB, one default observed in grade B one default observed in grade CCC, frequencies of obligors in grades given by (9.18).

$\boldsymbol{\gamma}$	50%	75%	90%	95%	99%	99.90%
▽AA	0.24%	0.47%	0.79%	1.02%	1.56%	2.34%
pAA	3.273%	4.338%	5.951%	7.283%	10.553%	15.275%

Table 9-10 Upper Confidence Level A

Upper confidence bound ▽A of pA as a function of the confidence level. One default observed in grade A, one default observed in grade BBB, one default observed in grade BB, one default observed in grade B one default observed in grade CCC, frequencies of obligors in grades given by (9.18).

$\boldsymbol{\gamma}$	50%	75%	90%	95%	99%	99.90%
▽A	0.26%	0.51%	0.85%	1.10%	1.69%	2.53%
PA	3.535%	4.683%	6.421%	7.852%	11.362%	16.412%

By analytically or numerically solving (9.19) for pA. Hence, the confidence region at level for pAA turns out to be the set of all the admissible values of pA which satisfy the difference.

$$1-\gamma \leq \sum_{i=0}^{7} \binom{\mathrm{nA}+\mathrm{nBBB}+\mathrm{nBB}+\mathrm{nB}+\mathrm{nCCC}}{i} pA^{i}(1-pA)^{\mathrm{nA}+\mathrm{nBBB}+\mathrm{nBB}+\mathrm{nB}+\mathrm{nCCC}-i} \tag{9.19}$$

From the given numbers of defaults in the different grades it becomes clear that a stand-alone treatment of grade BBB would yield still much higher values for the upper confidence bounds.

$$1-\gamma \leq \sum_{i=0}^{7} \binom{\text{nBBB}+\text{nBB}+\text{nB}+\text{nCCC}}{i} pBBB^{i}(1 - pBBB)^{\text{nBBB+nBB+nB+nCCC}-i} = (1-pBBB)^{\text{nBBB+nBB+nB+nCCC}} + nBBBpBBB(1-pBBB)^{\text{nBBB+nBB+nB+nCCC}-1} \tag{9.20}$$

To determine the confidence region at level γ for pCCC, with the same logic as CCC must be regarded as an independent portfolio. According to the assumption made at the beginning of this section, happened a standard among NCCC debtors in CCC. Therefore, we see that confidence in the region for pC is the set of all allowable values of pCCC fulfilling difference

$$1-\gamma \leq \sum_{i=0}^{7} \binom{\text{nBB}+\text{nB}+\text{nCCC}}{i} pBB^{i}(1-pBB)^{\text{nBB+nB+nCCC}-i} = (1-pC)^{\text{nBB+nB+nCCC}} + nBBpBB(1-pBB)^{\text{nBB+nB+nCCC}-1} \tag{9.21}$$

so far, we have described how to generalize the methodology to the case where non-zero default frequencies have been recorded. In the following section, we investigate the impact of non-zero default correlation on the PD estimates that are effected by applying the most prudent estimation methodology.

Table 9-11 Upper Confidence Level BBB, BB, B, CCC

Upper confidence bound ▽BBB of pBBB as a function of the confidence level. One default observed in grade BBB, one default observed in grade BB, one default observed in grade B one default observed in grade CCC, frequencies of obligors in grades given by (9.21).

▽BBB	0.39%	0.78%	1.29%	1.67%	2.55%	3.81%
PBBB	5.316%	7.020%	9.578%	11.668%	16.719%	23.809%

▽BB	0.65%	1.29%	2.13%	2.76%	4.21%	6.25%
pBB	8.697%	11.413%	15.429%	18.653%	26.242%	36.389%

∇B	1.38%	2.73%	4.50%	5.82%	8.80%	12.90%
PB	17.753%	22.894%	30.171%	35.737%	47.876%	62.021%

∇CCC	3.10%	6.11%	9.94%	12.73%	18.89%	26.95%
pCCC	36.127%	44.818%	55.912%	63.474%	77.276%	88.925%

in a sense, the Poisson process a coherent version of the Bernoulli trials process. To see this, suppose we think of every success in Bernoulli trials process a random point in discrete time. Since the Bernoulli trials process, Poisson process, has a strong renovation residence at any fixed time and at each arrival process 'start over' independent of the past. The interatrial times have independent geometrical distributions in the Bernoulli trials process; they have independent Poisson Exponential.

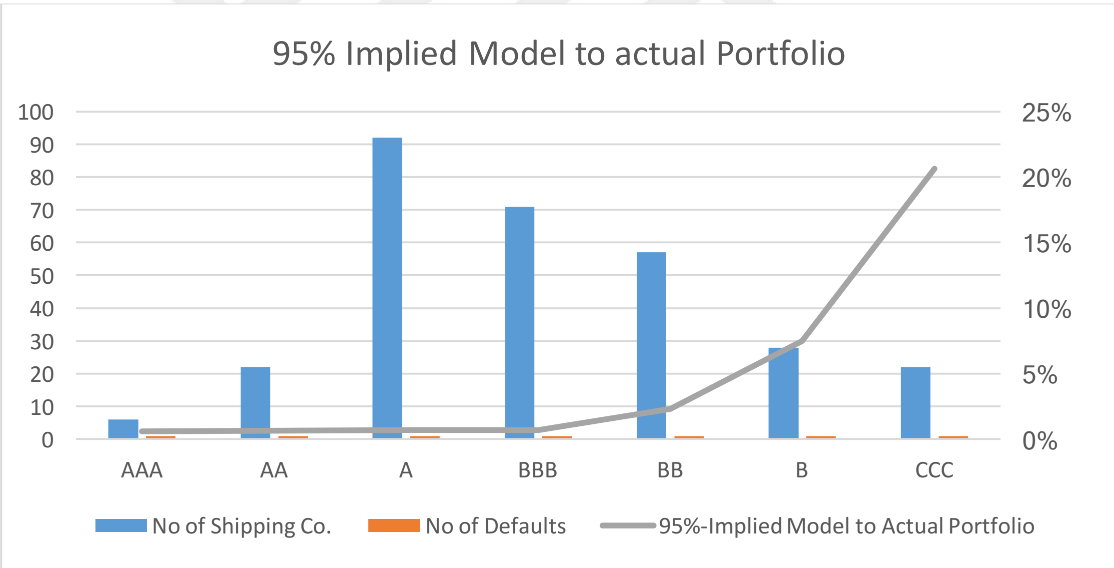


Figure 9-6 95% Implied model to Actual Portfolio of 7 Defaults

The idea is that the time of occurrence of default cannot be predicted with certainty. However, to calculate probabilities. It is needed a mathematical model to find out default probability depends on the previous year default rates. Here are the basic ideas:

1. The number of default in each grade should be counted.
2. The probability distribution of the number of default counted in previous year totally depend on a period of single year.
4. Default cannot be synchronized.

With these assumptions, it is found that the probability distribution of the number of standards in each time interval is Poisson distribution with parameter θ, where θ = λ xw, where w> 0 is the length of the interval, and λ> 0 is a function of the process, often called its speed.

We have presented the Poisson process that occurs depending on the size of shipping companies' rating in a single year. A Poisson process by speed can be seen as a result of performing independent. Bernoulli trials with success probability p = t in each small-time interval of length t, and place a point where the corresponding investigation is a success (no joke otherwise). Automatically, this will give a point process with stationary and independent steps, one Poisson. Number Bernoulli trials that can fit into any interval depends only on the length of the interval, and thus the distribution of the number of standards in this area will only depend on the length, stationary step follows. We first calculate the parameter of the distribution which is lambda 'λ' which will take the impact of number of obligors and defaults against them in each grade. Results are shown in below

Table 9-12 Poison Distribution Results

Grade	**Number of Shipping Companies**	**Number of Defaults**	**-**	***λ* 90% Conf.**
AAA	6	1		0.30%
AA	22	1		0.31%
A	92	1		0.36%
BBB	71	1		0.81%
BB	57	1		2.10%
B	28	1		8.20%
CCC	22	1		29.21%
Total	**298**	**7**		

Once the lambda for each grade has been estimated, we can fit the Poisson distribution, results of which will be further included in our next step, complexity calculation.
X is a Poisson random variable with parameter λ if it takes on the values 0, 1, 2, ... according to the probability distribution

$$p(x,\lambda) = e^{-\lambda}\lambda^{x}/x! \tag{9.22}$$

where,

λ = frequency of default in each grade

x = number of incremental default in the specific grade

By convention, 0! = 1

Poisson distribution will generate the probabilities of incremental default in every grade and these results will then be injected to our foundation model, complexity.

10 THE COMPLEXITY OF TWO MIXED POISSON RANDOMS

10.1 The Distribution Approximation

Until now we have generated the probability of default by simply using the total actual number of defaults in the portfolio. Next take account of the above as well and generating a frequency distribution with a Poisson distribution as the most suitable.

Consider the sum of two independent discrete random variables X and Y whose values are limited to non-negative integer. Let fX (i) represents the probability distribution of X and FY (i) represents the probability distribution of Y. The distribution of their sum Z = X + Y is given by the formula discrete complexity.[42]

Theorem Discrete Complexity Formula. The random variable Z = X + Y has probability distribution fZ(i) given by

$$Fz(z) = f_{x+y}(z) = P(Z = z) = \sum_{x=0}^{z} f_x(x) f_y(z - x) \tag{10.1}$$

for z= 0,1,2, …

By the discrete complexity formula, Z= x1 + x2 has probability distribution

$$P(x1 + x2 = z) = f_z(z) = \sum_{x=0}^{z} f_{x1}(x) f_{x2}(\mathrm{z} - x) \tag{10.2}$$

so

$$f_z(z) = \sum_{x=0}^{z} \frac{\lambda_1^x}{x!} e^{-\lambda_1} \frac{\lambda_2^{z-x}}{(z-x)!} e^{-\lambda_2} \tag{10.3}$$

---

42 In mathematics (and, in particular, functional analysis) complexity is a mathematical operation on two functions (f and g); it produces a third function, that is typically viewed as a modified version of one of the original functions, giving the integral of the pointwise multiplication of the two functions as a function of the amount that one of the original functions is translated. Complexity is similar to cross-correlation.

$$= e^{-(\lambda_1+\lambda_2)} \sum_{x=0}^{z} \frac{\lambda_1^x}{x!} \frac{\lambda_2^{z-x}}{(z-x)!} \quad (10.4)$$

Use the binomial formula

$$(a+b)^m = \sum_{x=0}^{m} \binom{m}{x} a^x b (1-a)^{m-x} \quad (10.5)$$

Although a certain compound Poisson distributions poison compound is a compound Poisson distribution function defaults actual distributions are not Poisson distribution, because of the second element (DAAA, DAA, ..., DCCC) included. Suppose actual default probability distribution of a collective risk to be so,

AAA= Average default rate, KAAA= Complexity of rating,

CX= Confidence level

AAA = AAA.C0.5. KAAA+ AAA.KAAA C0.75+ AAA.KAAA.C0.90+ AAA.KAAA.C0.95+ AAA.KAAA C.099+ AAA.KAAA.C0.999

AA = AA.K_{AA}.C0.5+ AA.K_{AA} C0.75+ AA.K_{AA}.C0.90+ AA.K_{AA} C0.95+ AA.K_{AA} C.099+ AA.K_{AA}.C0.999

A = A.K_{A} .C0.5+ A. KA C0.75+ A.K_{A}.C0.90+ A.$K_{A.}$ C0.95+ A.K_{A} C.099+ A.K_{A}.C0.999

BBB = BBB.K_{BBB} C0.5+ BBB.K_{BBB}.C0.75+ BBB.K_{BBB}.C0.90+ BBB.K_{BBB}.C0.95+ BBB.K_{BBB} C.099+ BBB.K_{BBB}.C0.999

BB = BB.K_{BB} C0.5+ BB.K_{BB} C0.75+ BB.K_{BB}.C0.90+ BB.K_{BB}.C0.95+ BB.K_{BB}. C.099+ BB.K_{BB}.C0.999

B = B.K_{B}.C0.5+ B.K_{B}.C0.75+ B. KB.C0.90+ B.K_{B}.C0.95+ B.K_{B}.C.099+ B.K_{B}.C0.999

CCC = CCC.K_{CCC}.C0.5+ CCC.K_{CCC}.C0.75+ CCC.K_{CCC}.C0.90+ CCC.K_{CCC}.C0.95+ CCC.K_{CCC}.C.099+ CCC.K_{CCC}.C0.999

Therefore, we suggest using the principle most conservative estimate to derive the "relative" probability of default of the classes of risk and scale down to an appropriate level of confidence in the overall portfolio of shipping finance portfolio.

Results by running complex model provides a matrix for each class. This is the very model of a standard distribution that can occur in a risk group. We observe the behavior of the model event of default only in the lower level grades of CCC as a single standard. Let's see the results first.

Corresponding matrices for each class generated which provided us with the final result of the model. The values in the last column gives the implicit model portfolio actual probabilities for each grade. To get the final probability of default, we have to find out the specifics of probability to the original number of confidence in a particular class, and then the resulting cumulative probabilities is the desired probability of default for that grade. The results are given in the table below,

Table 10-1 Complexity model, 7 Default Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	1.33%	0.00891%	99.9%	0.67109%
AA	22	1	0.34%	7.38%	1.38%	0.00961%	99.9%	0.69731%
A	92	1	0.37%	30.87%	1.59%	0.01287%	99.9%	0.80786%
BBB	71	1	0.56%	23.83%	3.37%	0.05873%	99.9%	1.74172%
BB	57	1	0.93%	19.13%	7.83%	0.33290%	99.9%	4.24940%
B	28	1	2.00%	9.40%	20.99%	2.85426%	99.9%	13.58608%
CCC	22	1	4.55%	7.38%	34.45%	21.31525%	99.9%	61.80710%
TOTAL	298	7						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.63%	0.00198%	99.0%	0.31056%
AA	22	1	0.34%	7.38%	0.66%	0.00214%	99.0%	0.32286%
A	92	1	0.37%	30.87%	0.76%	0.00289%	99.0%	0.37480%
BBB	71	1	0.56%	23.83%	1.68%	0.01388%	99.0%	0.81781%
BB	57	1	0.93%	19.13%	4.27%	0.08742%	99.0%	2.02559%
B	28	1	2.00%	9.40%	15.45%	1.01658%	99.0%	6.51500%
CCC	22	1	4.55%	7.38%	46.93%	13.13303%	99.0%	27.70425%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.30%	0.00088%	95.0%	0.28186%
AA	22	1	0.34%	7.38%	0.31%	0.00096%	95.0%	0.29322%
A	92	1	0.37%	30.87%	0.36%	0.00130%	95.0%	0.34129%
BBB	71	1	0.56%	23.83%	0.81%	0.00289%	95.0%	0.34118%
BB	57	1	0.93%	19.13%	2.10%	0.04336%	95.0%	1.95746%
B	28	1	2.00%	9.40%	8.20%	0.61842%	95.0%	7.16479%
CCC	22	1	4.55%	7.38%	29.21%	6.24844%	95.0%	20.32142%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.20%	0.00039%	90.0%	0.17776%
AA	22	1	0.34%	7.38%	0.21%	0.00042%	90.0%	0.18496%
A	92	1	0.37%	30.87%	0.24%	0.00057%	90.0%	0.21551%
BBB	71	1	0.56%	23.83%	0.54%	0.00289%	90.0%	0.48272%
BB	57	1	0.93%	19.13%	1.42%	0.02002%	90.0%	1.26424%
B	28	1	2.00%	9.40%	5.73%	0.30939%	90.0%	4.86282%
CCC	22	1	4.55%	7.38%	21.84%	3.79075%	90.0%	15.62326%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.10%	0.00011%	75.0%	0.07837%
AA	22	1	0.34%	7.38%	0.11%	0.00012%	75.0%	0.08157%
A	92	1	0.37%	30.87%	0.13%	0.00016%	75.0%	0.09515%
BBB	71	1	0.56%	23.83%	0.29%	0.00082%	75.0%	0.21495%
BB	57	1	0.93%	19.13%	0.77%	0.00588%	75.0%	0.57305%
B	28	1	2.00%	9.40%	3.22%	0.10007%	75.0%	2.33437%
CCC	22	1	4.55%	7.38%	13.36%	1.55605%	75.0%	8.73220%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.06%	0.00004%	50.0%	0.02965%

AA	22	1	0.34%	7.38%	0.06%	0.00004%	50.0%	0.03087%
A	92	1	0.37%	30.87%	0.07%	0.00005%	50.0%	0.03604%
BBB	71	1	0.56%	23.83%	0.16%	0.00027%	50.0%	0.08186%
BB	57	1	0.93%	19.13%	0.44%	0.00196%	50.0%	0.22073%
B	28	1	2.00%	9.40%	1.90%	0.03545%	50.0%	0.93240%
CCC	22	1	4.55%	7.38%	8.39%	0.64643%	50.0%	3.85157%
TOTAL	298	7						

According to the above table and each class has only one standard over the past year, for example, in grade CCC a Handymax five years old ship with value of 10 million in the secondary market will create exposure calculations. Default = Shipping firms' assets less than default point;

EL= Expected loss of credit

AE= Adjusted Exposure

LGD= Loss given default

EDF= Exposure default frequency

DPT: Default Point

Ship Purchase Value:	10M
Estimated Default Frequency (EDF)	10
The ships' the probability of default (PD):	0.61807 (CCC)
Collateral:	3
The exposure at default (EDF):	7

Recovery Rate (RR):

The Recovery Rate (RR) = Value of Collateral / Value of the Loan	0.3
the actual loss given default (LGD):	
%LGD:	0.7
Expected Loss: PD*LGD*EDF	2.53M

Table 10-2 Expected Loss

Grade	Expected Loss: PD*LGD*EDF %99.9	Expected Loss: PD*LGD*EDF %99	Expected Loss: PD*LGD*EDF %95	Expected Loss: PD*LGD*EDF %90	Expected Loss: PD*LGD*EDF %75	Expected Loss: PD*LGD*EDF %50
AAA	79,816.35	51,690.31	49,394.68	41,066.25	33,115.14	29,217.84
AA	81,857.13	52,674.32	50,302.94	41,642.74	33,371.21	29,315.21
A	90,437.30	56,829.86	54,148.98	44,086.35	34,457.96	29,728.74
BBB	161,406.70	92,270.05	54,140.19	65,463.52	44,041.99	33,394.56
BB	339,025.74	188,892.91	183,442.12	127,984.77	72,689.47	44,504.06
B	850,921.19	548,045.50	600,028.66	415,871.35	213,594.99	101,437.36
CCC	2,531,496.18	2,243,185.56	1,652,559.51	1,276,706.76	725,421.71	334,971.13

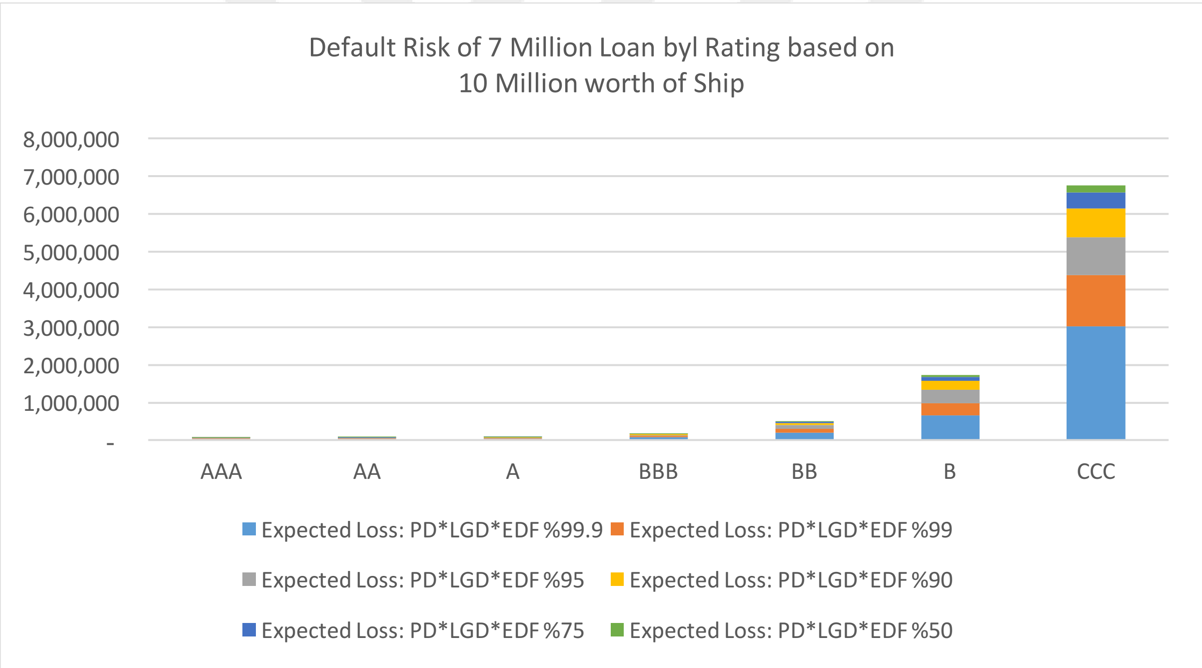


Figure 10-1 Default Risk of 7 Million Loan by Rating based on 10 Million worth of Ship

11 SCENARIOS

In this section, we intend to develop various scenarios and evaluate the model. We believe that the model behavior in different environments, together with the results of the probability of default of a certain class and its impact on the entire portfolio. For example, the number of standard business as a percentage of the total portfolio, convolute the probability distribution gives the probability distribution altered to produce the implied probability of default for each class of each security. On the other hand, when we change the number of bankruptcies to some extent when the primary probability distribution and the next probability distribution both become active, realized the probability of default and Bayesian estimates both change and then convolute with each other to produce modified probability distribution. Finally, the implied probability of default for each class prepared. Let's take the different scenarios and see the results.

11.1 Scenario-1

In first scenario, we have decided only 1 defaults in the total of the portfolio. Table below shows the complete details with different confident level

Table 11-1 Complexity at each confidence level – 1 Default of Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	2.24%	0.02570%	99.9%	0.00000%
AA	22	0	0.00%	7.38%	2.29%	0.02675%	99.9%	0.00000%
A	92	0	0.00%	30.87%	2.47%	0.03116%	99.9%	0.00000%
BBB	71	0	0.00%	23.83%	3.67%	0.06985%	99.9%	0.00000%
BB	57	0	0.00%	19.13%	5.88%	0.18377%	99.9%	0.00000%
B	28	0	0.00%	9.40%	11.35%	0.73018%	99.9%	0.00000%
CCC	22	1	4.55%	7.38%	20.60%	2.73191%	99.9%	0.12405%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	1.05%	0.00667%	99.0%	0.00000%

AA	22	0	0.00%	7.38%	1.07%	0.00571%	99.0%	0.00000%
A	92	0	0.00%	30.87%	1.16%	0.00667%	99.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.76%	0.01516%	99.0%	0.00000%
BB	57	0	0.00%	19.13%	2.91%	0.04101%	99.0%	0.00000%
B	28	0	0.00%	9.40%	6.12%	0.17608%	99.0%	0.00000%
CCC	22	1	4.55%	7.38%	13.40%	0.78190%	99.0%	0.03519%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.85%	0.00725%	90.0%	0.00000%
AA	22	0	0.00%	7.38%	0.87%	0.00755%	90.0%	0.00000%
A	92	0	0.00%	30.87%	0.93%	0.00882%	90.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.41%	0.02010%	90.0%	0.00000%
BB	57	0	0.00%	19.13%	2.31%	0.05464%	90.0%	0.00000%
B	28	0	0.00%	9.40%	4.76%	0.23774%	90.0%	0.00000%
CCC	22	1	4.55%	7.38%	9.89%	1.08846%	90.0%	0.04453%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.62%	0.00381%	75.0%	0.00000%
AA	22	0	0.00%	7.38%	0.63%	0.00396%	75.0%	0.00000%
A	92	0	0.00%	30.87%	0.68%	0.00463%	75.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.02%	0.01059%	75.0%	0.00000%
BB	57	0	0.00%	19.13%	1.69%	0.02895%	75.0%	0.00000%
B	28	0	0.00%	9.40%	3.52%	0.12813%	75.0%	0.00000%
CCC	22	1	4.55%	7.38%	7.51%	0.61018%	75.0%	0.02080%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.46%	0.00215%	50.0%	0.00000%
AA	22	0	0.00%	7.38%	0.47%	0.00224%	50.0%	0.00000%
A	92	0	0.00%	30.87%	0.51%	0.00262%	50.0%	0.00000%
BBB	71	0	0.00%	23.83%	0.77%	0.00600%	50.0%	0.00000%
BB	57	0	0.00%	19.13%	1.27%	0.01646%	50.0%	0.00000%
B	28	0	0.00%	9.40%	2.68%	0.07374%	50.0%	0.00000%
CCC	22	1	4.55%	7.38%	5.83%	0.36130%	50.0%	0.00821%
TOTAL	298	1	4.55%					

11.2 Scenario-2

In the second scenario, we have decided 7 defaults (one default for each grade) of the portfolio.

Table 11-2 Complexity at each confidence level, 7 Default Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	1.33%	0.00891%	99.9%	0.67109%
AA	22	1	0.34%	7.38%	1.38%	0.00961%	99.9%	0.69731%
A	92	1	0.37%	30.87%	1.59%	0.01287%	99.9%	0.80786%
BBB	71	1	0.56%	23.83%	3.37%	0.05873%	99.9%	1.74172%
BB	57	1	0.93%	19.13%	7.83%	0.33290%	99.9%	4.24940%
B	28	1	2.00%	9.40%	20.99%	2.85426%	99.9%	13.58608%
CCC	22	1	4.55%	7.38%	34.45%	21.31525%	99.9%	61.80710%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.63%	0.00198%	99.0%	0.31056%
AA	22	1	0.34%	7.38%	0.66%	0.00214%	99.0%	0.32286%
A	92	1	0.37%	30.87%	0.76%	0.00289%	99.0%	0.37480%
BBB	71	1	0.56%	23.83%	1.68%	0.01388%	99.0%	0.81781%
BB	57	1	0.93%	19.13%	4.27%	0.08742%	99.0%	2.02559%
B	28	1	2.00%	9.40%	15.45%	1.01658%	99.0%	6.51500%
CCC	22	1	4.55%	7.38%	46.93%	13.13303%	99.0%	27.70425%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.30%	0.00088%	95.0%	0.28186%
AA	22	1	0.34%	7.38%	0.31%	0.00096%	95.0%	0.29322%
A	92	1	0.37%	30.87%	0.36%	0.00130%	95.0%	0.34129%
BBB	71	1	0.56%	23.83%	0.81%	0.00289%	95.0%	0.34118%
BB	57	1	0.93%	19.13%	2.10%	0.04336%	95.0%	1.95746%
B	28	1	2.00%	9.40%	8.20%	0.61842%	95.0%	7.16479%
CCC	22	1	4.55%	7.38%	29.21%	6.24844%	95.0%	20.32142%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.20%	0.00039%	90.0%	0.17776%
AA	22	1	0.34%	7.38%	0.21%	0.00042%	90.0%	0.18496%
A	92	1	0.37%	30.87%	0.24%	0.00057%	90.0%	0.21551%
BBB	71	1	0.56%	23.83%	0.54%	0.00289%	90.0%	0.48272%
BB	57	1	0.93%	19.13%	1.42%	0.02002%	90.0%	1.26424%
B	28	1	2.00%	9.40%	5.73%	0.30939%	90.0%	4.86282%
CCC	22	1	4.55%	7.38%	21.84%	3.79075%	90.0%	15.62326%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.10%	0.00011%	75.0%	0.07837%
AA	22	1	0.34%	7.38%	0.11%	0.00012%	75.0%	0.08157%
A	92	1	0.37%	30.87%	0.13%	0.00016%	75.0%	0.09515%
BBB	71	1	0.56%	23.83%	0.29%	0.00082%	75.0%	0.21495%
BB	57	1	0.93%	19.13%	0.77%	0.00588%	75.0%	0.57305%
B	28	1	2.00%	9.40%	3.22%	0.10007%	75.0%	2.33437%
CCC	22	1	4.55%	7.38%	13.36%	1.55605%	75.0%	8.73220%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.06%	0.00004%	50.0%	0.02965%
AA	22	1	0.34%	7.38%	0.06%	0.00004%	50.0%	0.03087%
A	92	1	0.37%	30.87%	0.07%	0.00005%	50.0%	0.03604%
BBB	71	1	0.56%	23.83%	0.16%	0.00027%	50.0%	0.08186%
BB	57	1	0.93%	19.13%	0.44%	0.00196%	50.0%	0.22073%
B	28	1	2.00%	9.40%	1.90%	0.03545%	50.0%	0.93240%
CCC	22	1	4.55%	7.38%	8.39%	0.64643%	50.0%	3.85157%
TOTAL	298	7						

11.3 Scenario-3

In third scenario, we have decided 5% of defaults of the portfolio.

Table 11-3 Complexity at each confidence level 5% of total Portfolio is default - 15 Default Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	4.85%	0.12361%	99.9%	2.54693%
AA	22	1	0.34%	7.38%	5.02%	0.13256%	99.9%	2.63992%
A	92	5	0.37%	30.87%	5.71%	0.17308%	99.9%	15.14013%
BBB	71	4	0.56%	23.83%	10.84%	0.66121%	99.9%	24.38345%
BB	57	3	0.93%	19.13%	20.31%	2.64402%	99.9%	39.01819%
B	28	1	2.00%	9.40%	33.57%	9.75311%	99.9%	29.02120%
CCC	22	1	4.55%	7.38%	36.75%	29.47774%	99.9%	80.13298%
TOTAL	298	15						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	2.49%	0.03030%	99.0%	1.20340%
AA	22	1	0.34%	7.38%	2.59%	0.03263%	99.0%	1.24810%
A	92	5	0.37%	30.87%	2.99%	0.04330%	99.0%	7.17472%
BBB	71	4	0.56%	23.83%	6.29%	0.18538%	99.0%	11.67743%
BB	57	3	0.93%	19.13%	14.67%	0.92410%	99.0%	18.71283%
B	28	1	2.00%	9.40%	42.24%	5.62373%	99.0%	13.17928%
CCC	22	1	4.55%	7.38%	83.86%	26.47760%	99.0%	31.25637%
TOTAL	298	15						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.21%	0.01437%	95.0%	1.13197%
AA	22	1	0.34%	7.38%	1.25%	0.01551%	95.0%	1.17581%
A	92	5	0.37%	30.87%	1.45%	0.02080%	95.0%	6.80142%
BBB	71	4	0.56%	23.83%	3.15%	0.04494%	95.0%	5.42877%
BB	57	3	0.93%	19.13%	7.74%	0.55389%	95.0%	20.39057%
B	28	1	2.00%	9.40%	25.63%	5.00792%	95.0%	18.56119%
CCC	22	1	4.55%	7.38%	65.22%	20.29723%	95.0%	29.56420%
TOTAL	298	15	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.81%	0.00652%	90.0%	0.72353%
AA	22	1	0.34%	7.38%	0.84%	0.00704%	90.0%	0.75198%
A	92	5	0.37%	30.87%	0.98%	0.00948%	90.0%	4.35998%
BBB	71	4	0.56%	23.83%	2.14%	0.04494%	90.0%	7.54953%
BB	57	3	0.93%	19.13%	5.39%	0.27518%	90.0%	13.78186%
B	28	1	2.00%	9.40%	18.93%	2.94023%	90.0%	13.97974%
CCC	22	1	4.55%	7.38%	54.07%	16.00026%	90.0%	26.63197%
TOTAL	298	15	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.43%	0.00187%	75.0%	0.32392%
AA	22	1	0.34%	7.38%	0.45%	0.00203%	75.0%	0.33688%
A	92	5	0.37%	30.87%	0.53%	0.00274%	75.0%	1.95850%
BBB	71	4	0.56%	23.83%	1.17%	0.01344%	75.0%	3.45747%
BB	57	3	0.93%	19.13%	3.01%	0.08810%	75.0%	6.57772%
B	28	1	2.00%	9.40%	11.38%	1.15306%	75.0%	7.59603%
CCC	22	1	4.55%	7.38%	37.86%	9.50995%	75.0%	18.83678%
TOTAL	298	15						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.25%	0.00061%	50.0%	0.12374%
AA	22	1	0.34%	7.38%	0.26%	0.00066%	50.0%	0.12875%
A	92	5	0.37%	30.87%	0.30%	0.00090%	50.0%	0.74976%
BBB	71	4	0.56%	23.83%	0.67%	0.00452%	50.0%	1.33969%
BB	57	3	0.93%	19.13%	1.77%	0.03094%	50.0%	2.61496%
B	28	1	2.00%	9.40%	7.05%	0.46233%	50.0%	3.28004%
CCC	22	1	4.55%	7.38%	26.13%	5.17454%	50.0%	9.90288%
TOTAL	298	15						

11.4 Scenario-4

In fourth scenario, we have increased the number of defaults, doubled the numbers of defaults in each grade in the first scenario to 10%.

Table 11-4 Complexity at each confidence level 10% of total portfolio is default. 30 Default Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	13.52%	1.06502%	99.9%	7.86758%
AA	22	2	0.34%	7.38%	13.89%	1.12829%	99.9%	16.23399%
A	92	9	0.37%	30.87%	15.33%	1.40241%	99.9%	82.23004%
BBB	71	7	0.56%	23.83%	23.81%	3.85355%	99.9%	113.17267%
BB	57	6	0.93%	19.13%	32.61%	8.89112%	99.9%	163.40908%
B	28	3	2.00%	9.40%	36.67%	14.36460%	99.9%	117.38949%
CCC	22	3	4.55%	7.38%	36.79%	30.43566%	99.9%	247.94980%
TOTAL	298	30						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	8.30%	0.31672%	99.0%	3.77628%
AA	22	2	0.34%	7.38%	8.59%	0.33827%	99.0%	7.79350%
A	92	9	0.37%	30.87%	9.80%	0.43446%	99.0%	39.49576%
BBB	71	7	0.56%	23.83%	19.01%	1.48200%	99.0%	54.01410%
BB	57	6	0.93%	19.13%	38.24%	4.82777%	99.0%	75.00095%
B	28	3	2.00%	9.40%	77.53%	12.27650%	99.0%	47.02618%
CCC	22	3	4.55%	7.38%	98.83%	30.20844%	99.0%	90.78480%
TOTAL	298	30						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	4.21%	0.17012%	95.0%	3.83576%
AA	22	2	0.34%	7.38%	4.37%	0.18267%	95.0%	7.94316%
A	92	9	0.37%	30.87%	5.02%	0.23976%	95.0%	40.81440%
BBB	71	7	0.56%	23.83%	10.27%	0.48436%	95.0%	31.35678%
BB	57	6	0.93%	19.13%	22.73%	4.06663%	95.0%	101.98303%
B	28	3	2.00%	9.40%	57.37%	17.30142%	95.0%	85.95446%
CCC	22	3	4.55%	7.38%	93.30%	28.96872%	95.0%	88.49103%

TOTAL	298	30	9.09%					
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	2.89%	0.08092%	90.0%	2.52319%
AA	22	2	0.34%	7.38%	3.00%	0.08707%	90.0%	5.23177%
A	92	9	0.37%	30.87%	3.45%	0.11525%	90.0%	27.02369%
BBB	71	7	0.56%	23.83%	7.22%	0.48436%	90.0%	42.26389%
BB	57	6	0.93%	19.13%	16.63%	2.32676%	90.0%	75.54982%
B	28	3	2.00%	9.40%	46.35%	12.89852%	90.0%	75.13868%
CCC	22	3	4.55%	7.38%	87.11%	27.38613%	90.0%	84.88743%
TOTAL	298	30	9.09%					
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.58%	0.02460%	75.0%	1.16700%
AA	22	2	0.34%	7.38%	1.64%	0.02653%	75.0%	2.42329%
A	92	9	0.37%	30.87%	1.90%	0.03547%	75.0%	12.59193%
BBB	71	7	0.56%	23.83%	4.08%	0.15980%	75.0%	20.55905%
BB	57	6	0.93%	19.13%	9.88%	0.88210%	75.0%	40.17962%
B	28	3	2.00%	9.40%	31.29%	7.00257%	75.0%	50.35589%
CCC	22	3	4.55%	7.38%	73.06%	23.08064%	75.0%	71.07703%
TOTAL	298	30						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.92%	0.00835%	50.0%	0.45481%
AA	22	2	0.34%	7.38%	0.95%	0.00902%	50.0%	0.94527%
A	92	9	0.37%	30.87%	1.11%	0.01214%	50.0%	4.92994%
BBB	71	7	0.56%	23.83%	2.42%	0.05715%	50.0%	8.26604%
BB	57	6	0.93%	19.13%	6.06%	0.34517%	50.0%	17.09184%
B	28	3	2.00%	9.40%	20.98%	3.53218%	50.0%	25.25340%
CCC	22	3	4.55%	7.38%	58.11%	17.59006%	50.0%	45.40927%
TOTAL	298	30						

11.5 Scenario-5

In fifth scenario, we have increased the number of defaults, doubled the numbers of defaults in each grade in the first scenario to 15%. Tables below shows that as the number of defaults increase, the probabilities of default also increase.

Table 11-5 Complexity at each confidence level, 45 Default Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	21.42%	2.99297%	99.9%	13.96060%
AA	22	3	0.34%	7.38%	21.84%	3.13449%	99.9%	43.00993%
A	92	13	0.37%	30.87%	23.47%	3.72120%	99.9%	205.91180%
BBB	71	11	0.56%	23.83%	31.12%	7.73446%	99.9%	273.08635%
BB	57	9	0.93%	19.13%	35.87%	12.53488%	99.9%	314.19236%
B	28	5	2.00%	9.40%	36.78%	15.08572%	99.9%	204.84990%
CCC	22	3	4.55%	7.38%	36.79%	30.45029%	99.9%	248.06891%
TOTAL	298	45						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	15.94%	1.07638%	99.0%	6.68631%
AA	22	3	0.34%	7.38%	16.45%	1.14023%	99.0%	20.58869%
A	92	13	0.37%	30.87%	18.54%	1.41676%	99.0%	98.33026%
BBB	71	11	0.56%	23.83%	33.34%	3.88421%	99.0%	126.85911%
BB	57	9	0.93%	19.13%	58.81%	8.93192%	99.0%	135.32605%
B	28	5	2.00%	9.40%	92.42%	14.37784%	99.0%	77.01043%
CCC	22	3	4.55%	7.38%	99.93%	30.43627%	99.0%	90.45898%
TOTAL	298	45						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	8.47%	0.65751%	95.0%	7.37754%
AA	22	3	0.34%	7.38%	8.76%	0.70213%	95.0%	22.83598%
A	92	13	0.37%	30.87%	9.99%	0.90112%	95.0%	111.38791%
BBB	71	11	0.56%	23.83%	19.35%	1.69869%	95.0%	91.73945%
BB	57	9	0.93%	19.13%	38.79%	9.87453%	95.0%	217.64236%
B	28	5	2.00%	9.40%	78.12%	24.73951%	95.0%	150.42466%
CCC	22	3	4.55%	7.38%	98.92%	30.22718%	95.0%	87.09180%

TOTAL	298	45	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	5.91%	0.32891%	90.0%	5.00910%
AA	22	3	0.34%	7.38%	6.12%	0.35235%	90.0%	15.53649%
A	92	13	0.37%	30.87%	7.01%	0.45810%	90.0%	76.41408%
BBB	71	11	0.56%	23.83%	14.01%	1.69869%	90.0%	120.01820%
BB	57	9	0.93%	19.13%	29.70%	6.42386%	90.0%	175.19818%
B	28	5	2.00%	9.40%	67.69%	21.19884%	90.0%	140.92715%
CCC	22	3	4.55%	7.38%	96.91%	29.79832%	90.0%	83.01708%
TOTAL	298	45	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	3.31%	0.10603%	75.0%	2.40179%
AA	22	3	0.34%	7.38%	3.44%	0.11402%	75.0%	7.46699%
A	92	13	0.37%	30.87%	3.96%	0.15052%	75.0%	37.07833%
BBB	71	11	0.56%	23.83%	8.21%	0.62060%	75.0%	62.32530%
BB	57	9	0.93%	19.13%	18.68%	2.87048%	75.0%	103.73848%
B	28	5	2.00%	9.40%	50.36%	14.51395%	75.0%	108.08266%
CCC	22	3	4.55%	7.38%	89.79%	28.09746%	75.0%	70.40600%
TOTAL	298	45						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	1.95%	0.03735%	50.0%	0.95692%
AA	22	3	0.34%	7.38%	2.03%	0.04026%	50.0%	2.97930%
A	92	13	0.37%	30.87%	2.34%	0.05367%	50.0%	14.88181%
BBB	71	11	0.56%	23.83%	4.99%	0.23690%	50.0%	26.10184%
BB	57	9	0.93%	19.13%	11.91%	1.25434%	50.0%	47.40503%
B	28	5	2.00%	9.40%	36.26%	8.88491%	50.0%	61.25591%
CCC	22	3	4.55%	7.38%	78.75%	24.93898%	50.0%	47.50048%
TOTAL	298	45						

11.6 Scenario-6

Under this scenario, we try to find the relationship between implied probabilities of default and all the other inputs if the number of defaults increase with accelerating level. We have increased the number of defaults, 5% default in grade AAA, AA, A, 5% default in Grade BBB, BB, B and 10% default rate in grade CCC.

Table 11-6 Complexity at each confidence level- 17 default

Table below shows the complete details with different confident level, Mix- Default- 5%-AAA, AA, A, 10%-BBB, BB, B, 20%-CCC Default of Portfolio

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	5.93%	0.18693%	99.9%	3.15053%
AA	22	2	0.34%	159.36%	6.13%	0.20014%	99.9%	3.26354%
A	92	3	0.37%	57.16%	6.95%	0.25962%	99.9%	3.73400%
BBB	71	3	0.56%	74.07%	12.82%	0.94789%	99.9%	7.38885%
BB	57	1	0.93%	30.75%	22.84%	3.48587%	99.9%	15.24662%
B	28	3	2.00%	187.82%	34.69%	10.93275%	99.9%	31.48008%
CCC	22	4	4.55%	318.72%	36.77%	29.88963%	99.9%	81.19656%
TOTAL	298	17						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	3.11%	0.04700%	99.0%	1.49396%
AA	22	2	0.34%	159.36%	3.23%	0.05055%	99.0%	1.54847%
A	92	3	0.37%	57.16%	3.72%	0.06680%	99.0%	1.77564%
BBB	71	3	0.56%	74.07%	7.75%	0.27756%	99.0%	3.54525%
BB	57	1	0.93%	30.75%	17.71%	1.30412%	99.0%	7.28973%
B	28	3	2.00%	187.82%	48.40%	6.86324%	99.0%	14.03794%
CCC	22	4	4.55%	318.72%	88.39%	27.73058%	99.0%	31.05946%
TOTAL	298	17						
Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	1.52%	0.02265%	95.0%	1.41889%
AA	22	2	0.34%	159.36%	1.58%	0.02443%	95.0%	1.47325%
A	92	3	0.37%	57.16%	1.82%	0.03268%	95.0%	1.70160%

BBB	71	3	0.56%	74.07%	3.92%	0.06997%	95.0%	1.69617%
BB	57	1	0.93%	30.75%	9.51%	0.81986%	95.0%	8.19363%
B	28	3	2.00%	187.82%	30.27%	6.63178%	95.0%	20.81007%
CCC	22	4	4.55%	318.72%	71.60%	22.57827%	95.0%	29.95882%
TOTAL	298	17	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	1.02%	0.01033%	90.0%	0.91018%
AA	22	2	0.34%	159.36%	1.06%	0.01116%	90.0%	0.94568%
A	92	3	0.37%	57.16%	1.23%	0.01499%	90.0%	1.09522%
BBB	71	3	0.56%	74.07%	2.68%	0.06997%	90.0%	2.34878%
BB	57	1	0.93%	30.75%	6.66%	0.41510%	90.0%	5.60543%
B	28	3	2.00%	187.82%	22.65%	4.04294%	90.0%	16.06231%
CCC	22	4	4.55%	318.72%	60.63%	18.56760%	90.0%	27.56114%
TOTAL	298	17	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	0.55%	0.00299%	75.0%	0.40916%
AA	22	2	0.34%	159.36%	0.57%	0.00324%	75.0%	0.42544%
A	92	3	0.37%	57.16%	0.66%	0.00437%	75.0%	0.49423%
BBB	71	3	0.56%	74.07%	1.47%	0.02119%	75.0%	1.08383%
BB	57	1	0.93%	30.75%	3.76%	0.13588%	75.0%	2.71270%
B	28	3	2.00%	187.82%	13.85%	1.66262%	75.0%	9.00298%
CCC	22	4	4.55%	318.72%	43.73%	11.84272%	75.0%	20.31209%
TOTAL	298	17						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	292.16%	0.31%	0.00099%	50.0%	0.15670%
AA	22	2	0.34%	159.36%	0.33%	0.00107%	50.0%	0.16301%
A	92	3	0.37%	57.16%	0.38%	0.00145%	50.0%	0.18974%
BBB	71	3	0.56%	74.07%	0.85%	0.00718%	50.0%	0.42190%
BB	57	1	0.93%	30.75%	2.22%	0.04839%	50.0%	1.08765%
B	28	3	2.00%	187.82%	8.67%	0.68802%	50.0%	3.96779%
CCC	22	4	4.55%	318.72%	30.83%	6.83428%	50.0%	11.08371%
TOTAL	298	17						

12 CONCLUSION

Shipping finance risk is dynamic, and there are no set rules for how these risks are managed. The insurance industry itself is exposed to sudden changes in their approach to certain risks and therefore cannot be taken for granted that the insurance coverage will always be available. In addition, not all running risks are insurable and the proceeds of insurance may not be sufficient to cover lost revenues or increased expenses. It is therefore important to differentiate between risks for which an insurance solution exists and risks for which there is limited or no insurance solution. In ship-based lending the financier's main concern is that the ship is available if and when needed, whereas in ship lending it is the physical asset that is important that the ship produces a revenue stream sufficient to service its debt.

In this thesis, we introduced a new model to calculate the probability of default of ship financing for low default portfolio in the insurance sector. It is examined how shipping credit defaults can be predicted at the time of the issue by using a combination of financial ratios and industry specific variables. The key financial variables that are associated with the probability of default are: Equity ratio, Interest coverage, quick ratio, current ratio, leverage ratio, working capital, return on assets, return on equity, return on investment, gross margin, operating margin, net margin, EBITDA, P/E ratio, risk premium and an industry specific
variable that captures the shipping market conditions at the time of coverage. The methodology is based on confidence intervals using the most traditional estimates and is based on an analysis mechanism called complexity. We calculated Bayesian probability, Binomial distribution, Poisson distribution, Probability Mass distribution, Complexity and realized the probability of each scenario on expectation. Besides that, we have developed different scenarios to see the behavior of the model. The model justified its performance well. This model is very practical and related organizations can use this model accordingly. The estimation results of the actual complexity portfolio model indicate that higher gearing levels are associated with higher probabilities of default. Similarly, when companies increase leverage ratio that exceeds their total equity by 60% or more, then the probability of default will also be very high, additionally, the working capital, EBITDA margin, current

ratio and the interest coverage over total assets ratio are also negatively related to the probability of default.

In the extreme case of no defaults in the entire portfolio, this information consists solely of the absolute numbers of counter-parties per rating grade. The lack of defaults in the entire portfolio stops reliable quantitative statements on both the absolute level of average probability of defaults per rating grade as well as on the relative risk increase from rating grade to rating grade. My expected default estimates might seem rather low at first sight. However, given the amount of information that is actually available, the results do not appear out of range. We believe that the choice of moderate confidence levels is appropriate within most applications. The results have implications for investors, insurers and ship owners. By retaining simply accessible and calculable variables at the time of coverage, insurers can classify which issues have a high likelihood to default, thus, assisting their investment decisions. It is important to mention at this stage that there are several external and internal factors affecting the maritime sectors that are difficult to evaluate and utilize in the quantifying analysis.

As this is a very new mechanism for calculating probability of default for shipping companies, therefore there are few limitations which need to be discussed. In my future studies, we will come up with further workings including, the first is the decision to select the type of the shipping, liner and tramp shipping distributions. As per my decision, Binomial and Poisson distributions were very sophisticated as per the portfolio and the mechanism. However, we can use other distributions as well. The second is the practice to cumulate the probability of defaults of credit ratings with the specific ratings' probability of defaults. According to my calculations, every grade should have a relation with the performance of other rating / ratings. It means, if the probability of defaults of a better grade increases then it should impact its comparative lower grade in such a way that the probability of defaults for lower grades are increased as well.

Listed shipping companies exhibit comparatively high leverage ratios and hence higher financial risk. Such AAA ratings provide the issuer with reduced borrowing costs and better marketability of the creditor debt. According to my calculations, ship finance insurance target around over 40% of the available spread as the required insurance premium for AAA ratings. Investors benefit from enhanced security and liquidity of the ship owner credit. They also benefit from the credit monitoring expertise of the guarantor and the comfort that the insurer is sharing the risk by lending its credit quality to the issue.

13 REFERENCES

Actuary, T. (2016, September). The magazine of the actuarial profession. Retrieved from The Actuary: http://www.theactuary.com/archive/old-articles/part-5/stress-and-scenario-testing

Ahlgrim, K. C., D'Arcy, S. P., & Gorvett, R. (n.d.). Incorporating a Regime-Switching Process for Equity Returns into a Dynamic Financial Analysis Model.

Ahlgrim, K. C., D'Arcy, S. P., & Gorvett, R. W. (n.d.). Asset-Liability Modeling for Insurers.

Anderson, D. R. (1971). Anderson, Dan R. 1971. Effects of under and Overevaluations in Loss Reserves. The Journal of Risk and Insurance 38 (4).

Ang, A., & Ngeow, J. (2010, March). Insurance protection in financing of ships.

Appellant, J.W., Wallace, J. & Jj, M., 1997. United Grain Growers Limited Intim.

Aven, T., 2003. Foundations of Risk Analysis Foundations of Risk Analysis,

Avenhuis, J.O., 2013. Testing the generalizability of the bankruptcy prediction models of Altman, Ohlson and Zmijewski for Dutch listed and large non-listed firms. Available at: http://essay.utwente.nl/64326/.

Babbel, D.F., 1998. Components of Insurance Firm Value and the Present Value of Liabilities.

Baranoff, E.G., 2012. The Financial and Economic Attributes of Insurers. The Geneva Papers on Risk and Insurance Issues and Practice, 37(3), pp.401–404. Available at: http://www.palgrave-journals.com/ doifinder/ 10.1057/gpp.2012.28.

Barniv, R. Et al., 1999. Confidence Intervals for the Probability of Insolvency in the Insurance Industry. The Journal of Risk and Insurance, 66(1), pp.125–137.

Becker, D., 2010. Credit underwriting after the crisis. (Mckinsey & Company Inc.Work'ng papers on Risk, Number 21)

Beenstock, M., & Vergottis, A. (1993). Econometric Modelling of World Shipping. London, UK: Chapman & Hall.

Berman, N. Et al., 2012. Time to Ship during Financial Crises. NBER International Seminar on Macroeconomics, 9(1), pp.225–260. Available at: http://www.jstor.org/stable/info/10.1086/669587.

Bianco, D. (2016, August 20). Reference for Business. Retrieved from http:// www. Reference for business.com / encyclopedia/Thir-Val/ Underwriting-Insurance.html

Cerchiara, R.R., 2009. A dynamic analysis of the underwriting cycle in non-life insurance. , pp.1–12.

Chiang, S., The Valuation of Deposit Insurance Allowing for the Interest Rate Spread and Early-Bankruptcy Risk Ming-Shann Tsai.Conference, I.I. et al., 2013.

Consiglio, A. & De Giovanni, D., 2008. Evaluation of insurance products with guarantee in incomplete markets. Insurance: Mathematics and Economics, 42(1), pp.332–342.

Conway, T., & McCluskey, M. (2008). Evolution of Loss Reserve Risk.

Cummins, J.D. & Danzon, P.M., 1997. Price, Financial Quality, and Capital Flows in Insurance Markets. Journal of Financial Intermediation, 6, pp.3–38.

Cummins, J.D. & Outreville, J.F., 1987. An International Analysis of Underwriting Cycles in Property-Liability Insurance. The Journal of Insurance and Economic Security, 54(2), pp.246–262.

Cummins, J.D.2001, Asset Pricing Models and Insurance Ratemaking. , 20(2).

Damadaran, A. (2001). Corporate Finance: Theory and Practice (Vol. Second Edition). (Second Edition, Ed.) New York.: John Wiley and Sons, .

Derrig, R.A., 2007. The Impact of Rate Regulation on Claims Evidence from Massachusetts Automobile Insurance By Opal Consulting , LLC Richard@derrig.com And Sharon Tennyson Department of Policy Analysis and Management Cornell University The Impact of Rate Regulation on Claim.

Dickinson, G.M., 1997. Some Issues in Risk-Based Capital. The Geneva Papers on Risk and Insurance, 22(82), pp.76–85.

Doherty, N. A. (1995). Price regulation in property- liability insurance. Journal of Finance 41.

Doherty, N., & Kang, H. (1988). Interest Rates and Insurance price cycles. The Journal of Banking and Finance, pp. 199-214.

EIOPA (2014). The underlying assumptions in the standard formula for the Solvency Capital Requirement calculation. Frankfurt : EIOPA-14-322.

Eling, M., 2015. Under Pressure – How the Environment Affects Productivity and Efficiency of European Life Insurance Companies, (July).

Eling, M., Parnitzke, T., & Schmeiser, H. (2006). Management Strategies and Dynamic Financial Analysis. Casualty actuarial society.

Fabozzi, F.J., Mann, S. V & Choudhry, M., 2003. Interest Rate and Credit Risk, Finance, S., 2012. Ship Finance 1. , (1), pp.1–6.

Fitzpatrick, S. (2004). A Behavioral Guide to Underwriting Cycles. Connecticut Insurance Law Journal, 255-275.

Forte, S., Pirra, M., & Latenti, M. (2007). A reserve risk model for a non-life insurance company.

Fsa, B.J.M., 2014. Down but not Out : A Cost of Capital Approach to Fair Value Risk Margins. , pp.1–22.

Fu, L., 2008. Optimal Growth for P & C Insurance Companies. , 6(1).

Girard, L. (2002). An Approach to Fair Valuation of Insurance Liabilities Using the Firm's Cost of Capital. North American Actuarial Journal.

Girard, L.N., 1998. XX Market Value of Insurance Liabilities : Reconciling the. , pp.261–281.

Golbeck, S. & Linetsky, V., 2013. Asset financing with credit risk. Journal of Banking and Finance, 37(1), pp.43–59. Available at: http://dx.doi.org/10.1016/j.jbankfin.2012.08.010.

Grammenos, C., & Marcoulis, N. (1996). Shipping initial public offerings: a cross-country analysis. . (M. (. In: Levis, Ed.) Elsevier, , 379-400.

Grammenos, C., & Papapostolou, N. (2012). Shipping initial public offerings: Do prospectus and market information matter?, 48(1), 276-295.

Grammenos, C.T., Nomikos, N.K. & Papapostolou, N.C., 2008. Estimating the probability of default for shipping high yield bond issues. Transportation Research Part E: Logistics and Transportation Review, 44(6), pp.1123–1138.

Greenwood, R. & Hanson, S.G., 2015. Waves in ship prices and investment. Quarterly Journal of Economics, 130(1), pp.55–109.

Gwilliam, K.M. & Molenaar, H.J., 1993. Current Issues in Maritime Economics, ISBN 978-94-015-8153-0

Haider, J.J., Ou, Z. & Pettit, S., 2008. ANALYSING RISK IN SHIP FINANCE. , pp.1–8.

Hans, S. & Bull, J., 2005. Insuring the ship mortgage Assignment , co-insurance , and mortgagee ' s interest insurance Table of Contents, (September).

Harrington, S.E., 2004. Tort Liability, Insurance Rates, and the Insurance Cycle. Brookings-Wharton Papers on Financial Services, 2004(1), pp.97–138. Available at: http://muse.jhu.edu /content/ crossref/ journals/ brookings-wharton_papers_on_financial_services/v2004/2004.1harrington.html.

Harrington, S.E., 2005. Capital Adequacy in Insurance and Reinsurance. Capital Adequacy beyond Basel: Banking, Securities, and Insurance.

Ho, T.S.Y., President, E.V. & Summary, E., Market Valuation of Liability : Transfer Pricing , Profit Release and Credit Spread. , 10004(212).

Hodes, D., Feldblum, S., & Neghaiwi, A. (1999). The Financial Modeling of Property-Casualty Insurance Companies,. North American Actuarial Journal 3, , 41—69. Industry From the Property-Liability. , 75(4), pp.893–919.

Ingersoll, J. (1987). Theory of Financial Decision Making. Totowa, N J: Rowman & Littlefield.

Ivashina, V. & Scharfstein, D., 2008. Bank Lending During the Financial Crisis of 2008. October.

Jean-Marc Bourgeon, P.-A. J. (1995). European Economic Review. Elseier, vol 39(8), pages 1487-1509, October.

Jing Haider, J., Ou, Z., & Pettit, S. (2013). Analysing risk in ship finance, Cardiff University, Cardiff, UK.

Karatzas, B. (2009, Nov/Dec). Marine Money. Retrieved from www.marinemoney.com

Kerdpholngarm, C., 2007. Analysis of Pricing and Reserving Risks with Applications in Risk-Based Capital Regulation for Property / Casualty Insurance Companies.

Laeven, R.J.. & Goovaerts, M.J., 2007. Premium calculation and insurance pricing. Encyclopedia of Quantitative Risk Analysis and Assessment, pp.1–22.

Laitinen, E.K., 2006. Partial least squares regression in payment default prediction. Investment Management and Financial Innovations, 3(1), pp.64–77.

Liebenberg, A.P. & Sommer, D.W., 2013. Effects of Corporate Diversification : Evidence from the Property: Liability Insurance Industry Evidence Effects of Corporate Diversification: Insurance

List, Lloyd's, 2016. (n.d.). Baltic Dry Index. Retrieved August 12, 2016, from Lloyds List Intelligence: https://www.lloydslist.com/ll/marketdata/drycargo/drycargopage.htm

Mango, D. (2006). Applying Actuarial Techniques in Operational Risk Modeling. Submitted to 2006 ERM Symposium .

Manistre, B. J. (2014, June 27). Down but not Out: A Cost of Capital Approach to Fair Value Risk Margins.

Manzonetto, S., Harreis , H., & Becker , D. (2010). Credit Underwriting After the Crisis. Mckinsey Working Papers on Risk.

Marek, S.D. & Eling, M., 2010. Do Underwriting Cycles Matter ? An Analysis Based on Dynamic Financial Analysis. , 6(2), pp.131–142.

Markets, I. & Computations, A., 2011. Market value of insurance liability and life insurance securitization in a CDO framework. , 2(3), pp.25–30.

Meier, S., 2007. A survey of economic theories and field evidence on pro-social behavior. Economics and Psychology: A Promising New Cross-Disciplinary Field, (6), pp.51–87. Available at: http://www.bos.frb.org/economic/wp/wp2006/wp0606.pdf.

Meier, U. & Outreville, J.F., 2003. The Reinsurance Price and the Insurance Cycle.European Group of Risk and Insurance, pp.1–17. Available at: http://www.acrobatplanet.com/ go/The Reinsurance Price.pdf.

Meier, U., & Outreville, J. (2003). The Reinsurance Price and the Insurance Cycle. Seminar of the European Group of Risk and Insurance Economists (EGRIE). Zurich.

Meier, U.B. & Outreville, J.F., Business Cycles in Insurance and Reinsurance : Is the US insurance market setting the price ?

Merikas, A., Sigalas, C., Karatzas,, B., & Drobetz, W. (2012, April/May). Marine Money. Retrieved from Valuation Models: A Practical Appraisal: www.marinemoney.com

Mhyr , A., & Markham , J. (2003). Insurance Operations, Regulation, and Statutory Accounting. (S. Edition, Ed.)

Milevsky, M.A. & Salisbury, T.S., 2006. Financial valuation of guaranteed minimum withdrawal benefits. Insurance: Mathematics and Economics, 38(1), pp.21–38.

Neil A. Doherty, J.R.G., 1995. Insurance Cycles.

Risk, C. & Forum, O., 2006. A market cost of capital approach to market value margins, Discussion paper − The Chief Risk Officer Forum, (March), pp.1–31.

Rothschild, M., & Stiglitz, J. (1970). Increasing Risk l : A definition. Journal of Economic. Journal of Economic Theory 2.

Saito, M. A., Goepfert, T.J. & Ritt, J.T., 2008. Some thoughts on the concept of colimitation, Three definitions and the importance of bioavailability. Limnology and Oceanography, 53(1), pp.276–290.

Santomero , A., & F. Babbel , D. (1997). Financial Risk Management by Insurers. The Journal of Risk and Insurance, , Vol. 64, 231-270.

Schinas, O., Grau, C. & Johns, M., 2015. Handbook on Ship Finance, Springer.

Schroeck, G. (2002). Risk management and in financial institutions. New Jersey: John Wiley & Sons, Inc.

Schroeck, G., 2002. Value Creation in Financial Institutions, John Wiley & Sons, Inc. Available at: http://www.arabictrader.com/arabictrader_storage_server/application/2009/07/24/pdf/v202/05A68509-8EC7-F77C-BCAE-C986D721C6DF.pdf.

Service, C. & Publications, S.T., High Risk. 1988.

Sharpe, W.F., 1964. Capital asset prices: A theroy of market equilibrium under conditions of risk. The Journal of Finance, 19(3), pp.425–442.

Standard, A. Et al., 2011. Risk Classification (for All Practice Areas). , 2011(12).

Stopford, M. (2009). Maritime Economics (Vol. 3rd). London: Taylor & Francis Group.

Strahan, P.E., 1999. Borrower Risk and the Price and Nonprice Terms of Bank Loans. Working Paper, (October), pp.1–36.

Sætersdal, L. Et al., 2003. Health R isk A ssessment and H ealth M onitoring. , 66(April), p.83996.

Tamari, M. (2003). Financial ratios. 182. The Banker's Guide to Insurance Aspects of Ship Financing.

Tapiero, C.S., 2010. Risk Finance and Asset Pricing, Available at: http://doi.wiley.com /10. 1002 /9781118268155.

Vaughn, T.R., 1996. Property/Liability Insurance Risk Management and Securitization. Cas.

Waszink, H., 2013. Considerations on the Cost of Capital Approach for the Risk Margin v6, pp.1–19.

Weiss, M.A., 2007. Underwriting Cycles : A Synthesis and Further Directions. Journal of Insurance Issues, 30(1), pp.31–45.

Widiantoro, D.M. & Elvenes, V., 2012. Managing Risk In Financial Market In Shipping., pp.32–49.

Xie, X., 2010. Are publicly held firms less efficient? Evidence from the US property-liability insurance industry. Journal of Banking and Finance, 34(7), pp.1549–1563.

14 APPENDIX

TABLE 14-1 298 LISTED SHIPPING COMPANIES

The table shows the distribution of shipping firm- size observation in our sample with respect to the firms' market capital size. The sample consists of 298 listed shipping companies. All the data based on Rasyonet database. The sample period is from 2011 to including 3rd quarter of 2016.

	Security Code	Region	Country	Market Cap (m USD)
BIG CAP				
A. P. MOLLER MAERSK A/S (A)	MAERSKA:DK	Europe	Denmark	16,956.39
KONINKLIJKE VOPAK NV	VPK:NL	Europe	Netherlands	5,949.38
CHINA MERCHANTS PORT HOLDINGS CO LTD	00144:HK	Asia and Pacific	Hong Kong	6,823.91
MISC BHD	3816:MY	Asia and Pacific	Malaysia	7,422.20
INTERNATIONAL CONTAINER TERMINAL SERVICES INC	ICT:PH	Asia and Pacific	Philippines	6,412.59
DALIAN PORT (PDA) CO LTD	601880:CNA	Asia and Pacific	China, People's Republic of	5,331.09
COSCO SHIPPING DEVELOPMENT CO LTD	601866:CNA	Asia and Pacific	China, People's Republic of	7,042.71
CHINA SHIPBUILDING INDUSTRY CORP	601989:CNA	Asia and Pacific	China, People's Republic of	20,119.90
SHANGHAI INTERNATIONAL PORT (GROUP) CO LTD	600018:CNA	Asia and Pacific	China, People's Republic of	17,486.78
ADANI PORTS & SPECIAL ECONOMIC ZONE LTD	532921:INM	Asia and Pacific	India	8,946.91
MID CAP				
DFDS A/S	DFDS:DK	Europe	Denmark	2,833.26
HAPAG-LLOYD AG	HLAG:DEX	Europe	Germany	2,981.03
HAMBURGER HAFEN UND LOGISTIK AG	HHFA:DEX	Europe	Germany	1,407.26
OCEAN YIELD ASA	OCY:NO	Europe	Norway	1,079.32
ALEXANDRIA CONTAINERS AND GOODS	ALCN:EG	Middle East	Egypt	1,477.86
QINGDAO PORT INTERNATIONAL CO LTD	06198:HK	Asia and Pacific	Hong Kong	2,564.82
ORIENT OVERSEAS (INTERNATIONAL) LTD	00316:HK	Asia and Pacific	Hong Kong	3,120.89
COSCO SHIPPING ENERGY TRANSPORTATION CO LTD	01138:HK	Asia and Pacific	Hong Kong	2,273.55
COSCO SHIPPING PORTS LTD	01199:HK	Asia and Pacific	Hong Kong	2,993.35
WESTPORTS HOLDINGS BHD	5246:MY	Asia and Pacific	Malaysia	3,277.01
HYUNDAI MIPO DOCKYARD CO LTD	010620:KR	Asia and Pacific	South Korea	1,066.26
HYUNDAI MERCHANT MARINE CO LTD	011200:KR	Asia and Pacific	South Korea	1,103.80
WAN HAI LINES LTD	2615:TW	Asia and Pacific	Taiwan	1,173.45
EVERGREEN MARINE CORP (TAIWAN) LTD	2603:TW	Asia and Pacific	Taiwan	1,319.28
PANOCEAN CO LTD	AZY:SG	Asia and Pacific	Singapore	1,746.32

SHENZHEN CHIWAN WHARF HOLDINGS LTD	000022:CNE	Asia and Pacific	China, People's Republic of	1,792.36
SHENZHEN YAN TIAN PORT HOLDINGS CO LTD	000088:CNE	Asia and Pacific	China, People's Republic of	2,035.53
BEIBU GULF PORT CO LTD	000582:CNE	Asia and Pacific	China, People's Republic of	2,282.51
CHANG JIANG SHIPPING GROUP PHOENIX CO LTD	000520:CNE	Asia and Pacific	China, People's Republic of	1,157.28
CHINA MERCHANTS ENERGY SHIPPING CO LTD	601872:CNA	Asia and Pacific	China, People's Republic of	3,930.01
ZHONGCHANG BIG DATA CORP LTD	600242:CNA	Asia and Pacific	China, People's Republic of	1,025.45
ZHANGJIAGANG FREETRADE SCIENCE AND TECHNOLOGY CO LTD	600794:CNA	Asia and Pacific	China, People's Republic of	1,126.71
COSCO SHIPPING SPECIALIZED CARRIERS CO LTD	600428:CNA	Asia and Pacific	China, People's Republic of	2,017.06
YINGKOU PORT LIABILITY CO LTD	600317:CNA	Asia and Pacific	China, People's Republic of	3,293.76
JINZHOU PORTCO CO LTD	600190:CNA	Asia and Pacific	China, People's Republic of	1,238.84
LANHAI MEDICAL INVESTMENT CO LTD	600896:CNA	Asia and Pacific	China, People's Republic of	1,516.16
RIZHAO PORT CO LTD	600017:CNA	Asia and Pacific	China, People's Republic of	1,836.25
TIANJIN TIANHAI INVESTMENT CO LTD	600751:CNA	Asia and Pacific	China, People's Republic of	3,726.02
TIANJIN PORT HOLDING CO LTD	600717:CNA	Asia and Pacific	China, People's Republic of	2,479.13
TANGSHAN PORT GROUP CO LTD	601000:CNA	Asia and Pacific	China, People's Republic of	2,681.96
GUJARAT PIPAVAV PORT LTD	533248:INM	Asia and Pacific	India	958.51
QATAR GAS TRANSPORT CO LTD (NAKILAT) QSC	QGTS:QA	Middle East	Qatar	3,581.38
QATAR NAVIGATION QSC	QNNS:QA	Middle East	Qatar	2,980.87
FRONTLINE LTD	FRO:USY	America	United States	1,226.02
KIRBY CORP	KEX:USY	America	United States	3,524.81
TEEKAY LNG PARTNERS LP	TGP:USY	America	United States	1,209.49
SHIP FINANCE INTERNATIONAL LTD	SFL:USY	America	United States	1,383.87
MATSON INC	MATX:USY	America	United States	1,533.69
GASLOG LTD	GLOG:USY	America	United States	1,348.32
GOLAR LNG LTD	GLNG:USN	America	United States	2,462.38
GOLAR LNG PARTNERS LP	GMLP:USN	America	United States	1,410.67
NEPTUNE ORIENT LINES LTD	NPTOF:USP	America	United States	2,473.03
NMTP	NMTP:RUM	Europe	Russian Federation	2,120.65
NATIONAL SHIPPING COMPANY OF SAUDI ARABIA	4030:SA	Middle East	Saudi Arabia	4,457.25
SMALL CAP				
DAMPSKIBSSELSKABET NORDEN A/S	DNORD:DK	Europe	Denmark	727.63

TORM PLC (A)	TRMDA:DK	Europe	Denmark	584.47
SLOMAN NEPTUN SCHIFFAHRTS AG	NEP:DEH	Europe	Germany	137.30
GENCO SHIPPING & TRADING LTD	GNU1:DEB	Europe	Germany	275.23
BREMER LAGERHAUS-GESELLSCHAFT	BLH:DEF	Europe	Germany	73.04
EUROKAI GMBH & CO KGAA (PR)	EUK3:DEF	Europe	Germany	260.37
JINHUI SHIPPING AND TRANSPORTATION LTD	JIN:NO	Europe	Norway	77.12
ODFJELL SE (A)	ODF:NO	Europe	Norway	224.88
AMERICAN SHIPPING CO ASA	AMSC:NO	Europe	Norway	177.16
BONHEUR ASA	BON:NO	Europe	Norway	371.43
TEAM TANKERS INTERNATIONAL LTD	TEAM:NO	Europe	Norway	257.52
STOLT-NIELSEN LTD	SNI:NO	Europe	Norway	878.36
SAGA TANKERS ASA	SAGA:NO	Europe	Norway	97.72
AURORA LPG HOLDING ASA	AURLPG:NO	Europe	Norway	54.79
SOLVANG ASA	SOLV:NO	Europe	Norway	75.45
SIEM SHIPPING INC	SSI:NO	Europe	Norway	63.70
FLEX LNG LTD	FLNG:NO	Europe	Norway	163.88
CONCORDIA MARITIME AB (B)	CCORB:SE	Europe	Sweden	71.29
PIRAEUS PORT AUTHORITY SA	PPA:GR	Europe	Greece	351.35
THESSALONIKI PORT AUTHORITY SA	OLTH:GR	Europe	Greece	196.63
ATTICA HOLDINGS SA	ATTICA:GR	Europe	Greece	182.07
MINOAN LINES SHIPPING SA	MINOA:GR	Europe	Greece	281.48
TOUAX	TOUP:FR	Europe	France	75.08
VIKING LINE ABP	VIK1V:FI	Europe	Finland	239.66
EXMAR NV	EXM:BE	Europe	Belgium	443.57
D'AMICO INTERNATIONAL SHIPPING SA	DIS:IT	Europe	Italy	152.46
EIMPSKIPAFELAG ISLANDS	EIM:IC	Europe	Iceland	545.88
TALLINK GRUPP AS	TAL1T:EE	Europe	Estonia	644.16
AS LATVIJAS KUGNIECIBA	LSC1R:LV	Europe	Latvia	98.70
TRENCOR LTD	TRE:ZA	Africa	South Africa	385.90
PRECIOUS SHIPPING PCL	PSL:TH	Asia and Pacific	Thailand	370.16
REGIONAL CONTAINER LINES PCL	RCL:TH	Asia and Pacific	Thailand	124.56
ZHUHAI HOLDINGS INVESTMENT GROUP LTD	00908:HK	Asia and Pacific	Hong Kong	221.08
QINHUANGDAO PORT CO LTD (H)	03369:HK	Asia and Pacific	Hong Kong	193.81
CIG YANGTZE PORTS PLC	08233:HK	Asia and Pacific	Hong Kong	176.74
CHU KONG SHIPPING ENTERPRISES (GROUP) CO LTD	00560:HK	Asia and Pacific	Hong Kong	278.71
COSCO INTERNATIONAL HOLDINGS LTD	00517:HK	Asia and Pacific	Hong Kong	696.26
PYI CORP LTD	00498:HK	Asia and Pacific	Hong Kong	91.55
SINOTRANS SHIPPING LTD	00368:HK	Asia and Pacific	Hong Kong	803.57
ASIA ENERGY LOGISTICS GROUP LTD	00351:HK	Asia and Pacific	Hong Kong	73.21
NEW CENTURY GROUP HONG KONG LTD	00234:HK	Asia and Pacific	Hong Kong	102.18
JINHUI HOLDINGS CO LTD	00137:HK	Asia and Pacific	Hong Kong	67.74
COSCO SHIPPING HOLDINGS CO LTD (H)	01919:HK	Asia and Pacific	Hong Kong	939.01
TIANJIN PORT DEVELOPMENT HOLDINGS LTD	03382:HK	Asia and Pacific	Hong Kong	945.55
XIAMEN INTERNATIONAL PORT CO LTD (H)	03378:HK	Asia and Pacific	Hong Kong	185.88
PACIFIC BASIN SHIPPING LTD	02343:HK	Asia and Pacific	Hong Kong	662.99
NOBLE CENTURY INVESTMENT HOLDINGS LTD	02322:HK	Asia and Pacific	Hong Kong	403.68
GREAT HARVEST MAETA GROUP HOLDINGS LTD	03683:HK	Asia and Pacific	Hong Kong	153.82

PELAYARAN TEMPURAN EMAS TBK	TMAS:ID	Asia and Pacific	Indonesia	128.49
HUMPUSS INTERMODA TRANSPORTASI TBK	HITS:ID	Asia and Pacific	Indonesia	395.17
PT TRADA MARITIME TBK	TRAM:ID	Asia and Pacific	Indonesia	113.24
PT SOECHI LINES TBK	SOCI:ID	Asia and Pacific	Indonesia	174.89
PT WINTERMAR OFFSHORE MARINE TBK	WINS:ID	Asia and Pacific	Indonesia	66.09
SHIN YANG SHIPPING CORP BHD	5173:MY	Asia and Pacific	Malaysia	76.43
SURIA CAPITAL HOLDINGS BHD	6521:MY	Asia and Pacific	Malaysia	127.52
CENTURY LOGISTICS HOLDINGS BHD	7117:MY	Asia and Pacific	Malaysia	73.07
YINSON HOLDINGS BHD	7293:MY	Asia and Pacific	Malaysia	709.51
BINTULU PORT HOLDINGS BHD	5032:MY	Asia and Pacific	Malaysia	644.59
EA TECHNIQUE (M) BHD	5259:MY	Asia and Pacific	Malaysia	73.78
MALAYSIAN BULK CARRIERS BHD	5077:MY	Asia and Pacific	Malaysia	165.38
KSS LINE LTD	044450:KR	Asia and Pacific	South Korea	156.46
EUSU HOLDINGS CO LTD	000700:KR	Asia and Pacific	South Korea	131.57
SEJIN HEAVY INDUSTRIES CO. LTD.	075580:KR	Asia and Pacific	South Korea	102.53
KOREA LINE CORP	005880:KR	Asia and Pacific	South Korea	342.30
HEUNG-A SHIPPING CO LTD	003280:KR	Asia and Pacific	South Korea	135.38
ASIAN TERMINALS INC	ATI:PH	Asia and Pacific	Philippines	442.60
SHIH WEI NAVIGATION CO LTD	5608:TW	Asia and Pacific	Taiwan	119.05
TAIWAN NAVIGATION CO LTD	2617:TW	Asia and Pacific	Taiwan	163.27
EASTERN MEDIA INTERNATIONAL CORP	2614:TW	Asia and Pacific	Taiwan	156.63
CHINESE MARITIME TRANSPORT LTD	2612:TW	Asia and Pacific	Taiwan	211.94
YANG MING MARINE TRANSPORT CORP	2609:TW	Asia and Pacific	Taiwan	471.15
EVERGREEN INTERNATIONAL STORAGE & TRANSPORT CORP	2607:TW	Asia and Pacific	Taiwan	439.24
U-MING MARINE TRANSPOST CORP	2606:TW	Asia and Pacific	Taiwan	662.60
SINCERE NAVIGATION CORP	2605:TW	Asia and Pacific	Taiwan	353.10
FIRST STEAMSHIP CO LTD	2601:TW	Asia and Pacific	Taiwan	83.68
CSBC CORP TAIWAN	2208:TW	Asia and Pacific	Taiwan	320.02
WISDOM MARINE LINES CO LTD	2637:TW	Asia and Pacific	Taiwan	492.54
FIRST SHIP LEASE TRUST	D8DU:SG	Asia and Pacific	Singapore	70.74
SAMUDERA SHIPPING LINE LTD	S56:SG	Asia and Pacific	Singapore	64.59
SINGAPORE SHIPPING CORP LTD	S19:SG	Asia and Pacific	Singapore	74.67
SINWA LTD	5CN:SG	Asia and Pacific	Singapore	60.71
PACC OFFSHORE SERVICES HOLDINGS LTD (S)	U6C:SG	Asia and Pacific	Singapore	430.00
COURAGE MARINE GROUP LTD	ATL:SG	Asia and Pacific	Singapore	72.72
PACIFIC RADIANCE LTD	T8V:SG	Asia and Pacific	Singapore	69.72
SHENZHEN CHIWAN PETROLEUM SUPPLY BASE CO LTD	200053:CNE	Asia and Pacific	China, People's Republic of	774.35
NANJING PORT CO LTD	002040:CNE	Asia and Pacific	China, People's Republic of	723.65
XIAMEN PORT DEVELOPMENT CO LTD	000905:CNE	Asia and Pacific	China, People's Republic of	810.59
HAINAN STRAIT SHIPPING CO LTD	002320:CNE	Asia and Pacific	China, People's Republic of	1,004.74
JIANGSU LIANYUNGANG PORT CO LTD	601008:CNA	Asia and Pacific	China, People's Republic of	826.25

JIANGSU WANLIN MODERN LOGISTICS CO LTD (A)	603117:CNA	Asia and Pacific	China, People's Republic of	567.57
BOHAI FERRY CO LTD (A)	603167:CNA	Asia and Pacific	China, People's Republic of	771.76
SHANGHAI YATONG CO LTD	600692:CNA	Asia and Pacific	China, People's Republic of	856.32
CHONGQING GANGJIU CO LTD	600279:CNA	Asia and Pacific	China, People's Republic of	739.28
NINGBO MARINE CO LTD	600798:CNA	Asia and Pacific	China, People's Republic of	843.45
MMA OFFSHORE LTD	MRM:AU	Asia and Pacific	Australia	75.65
MARSDEN MARITIME HOLDINGS LTD	MMH:NZ	Asia and Pacific	New Zealand	103.72
PORT OF TAURANGA LTD	POT:NZ	Asia and Pacific	New Zealand	374.12
SOUTH PORT NEW ZEALAND LTD	SPN:NZ	Asia and Pacific	New Zealand	105.23
BAHRAIN SHIP REPAIRING & ENGINEERING CO BSC	BASREC:BH	Middle East	Bahrain	76.60
DREDGING CORP OF INDIA LTD	523618:INM	Asia and Pacific	India	184.50
FORBES & CO LTD	502865:INM	Asia and Pacific	India	371.49
THE SHIPPING CORP OF INDIA LTD	523598:INM	Asia and Pacific	India	447.57
SHREYAS SHIPPING & LOGISTICS LTD	520151:INM	Asia and Pacific	India	69.04
ESSAR SHIPPING LTD	533704:INM	Asia and Pacific	India	85.30
GREAT EASTERN SHIPPING CO LTD	GESHIP:INN	Asia and Pacific	India	853.08
SUMMIT ALLIANCE PORT LTD	SAPORTL:BD	Asia and Pacific	Bangladesh	143.85
PAKISTAN INTERNATIONAL CONTAINER TERMINAL LTD	PICT:PK	Asia and Pacific	Pakistan	450.79
SALALAH PORT SERVICES CO	SPSI:OM	Middle East	Oman	295.60
PORT SERVICES CORP	PSCS:OM	Middle East	Oman	57.84
SANTOS BRASIL PARTICIPACOES SA	STBP3:BR	America	Brazil	494.21
CIA DOCAS DE IMBITUBA	IMBI3:BR	America	Brazil	123.34
PRUMO LOGISTICA SA	PRML3:BR	America	Brazil	744.95
WILSON SONS LTD (DR)	WSON33:BR	America	Brazil	704.42
GRUPO EMPRESAS NAVIERAS SA	NAVIERA:CL	America	Chile	172.24
COMPANIA MARITIMA CHILENA SA	INTEROCEAN	America	Chile	68.20
NAVARINO SA	NAVARINO:CL	America	Chile	76.19
PUERTO DE LIRQUEN SA	PUERTO:CL	America	Chile	144.10
PORTUARIA CABO FROWARD SA	FROWARD:CL	America	Chile	50.68
SOCIEDAD MATRIZ SAAM SA	SMSAAM:CL	America	Chile	772.58
GENER8 MARITIME INC	GNRT:USY	America	United States	370.41
DANAOS CORP	DAC:USY	America	United States	296.46
TEEKAY OFFSHORE PARTNERS LP	TOO:USY	America	United States	794.05
DIANA SHIPPING INC	DSX:USY	America	United States	304.59
DHT HOLDINGS INC	DHT:USY	America	United States	376.27
TSAKOS ENERGY NAVIGATION LTD	TNP:USY	America	United States	422.46
NAVIOS MARITIME PARTNERS LP	NMM:USY	America	United States	126.28
GLOBAL SHIP LEASE INC	GSL:USY	America	United States	89.33
TEEKAY TANKERS LTD	TNK:USY	America	United States	365.74
SEASPAN CORP	SSW:USY	America	United States	1,089.49
SAFE BULKERS INC	SB:USY	America	United States	130.53

NAVIOS MARITIME ACQUISITION CORP	NNA:USY	America	United States	295.14
SCORPIO TANKERS INC	STNG:USY	America	United States	815.52
NAVIOS MARITIME HOLDINGS INC	NM:USY	America	United States	185.06
NAVIGATOR HOLDINGS LTD	NVGS:USY	America	United States	571.01
NORDIC AMERICAN TANKERS LTD	NAT:USY	America	United States	865.72
NAVIOS MARITIME MIDSTREAM PARTNERS LP	NAP:USY	America	United States	238.65
KNOT OFFSHORE PARTNERS LP	KNOP:USY	America	United States	795.70
ARDMORE SHIPPING CORP	ASC:USY	America	United States	260.21
DYNAGAS LNG PARTNERS LP	DLNG:USY	America	United States	593.04
SCORPIO BULKERS INC	SALT:USY	America	United States	429.23
NORDIC AMERICAN OFFSHORE LTD	NAO:USY	America	United States	58.96
DORIAN LPG LTD	LPG:USY	America	United States	506.16
HOEGH LNG PARTNERS LP	HMLP:USY	America	United States	502.76
OVERSEAS SHIPHOLDING GROUP INC (A)	OSG:USY	America	United States	309.56
INTERNATIONAL SEAWAYS INC	INSW:USY	America	United States	463.31
GOLDEN OCEAN GROUP LTD	GOGL:USN	America	United States	536.18
STAR BULK CARRIERS CORP.	SBLK:USN	America	United States	339.79
CAPITAL PRODUCT PARTNERS LP	CPLP:USN	America	United States	389.32
EAGLE BULK SHIPPING INC	EGLE:USN	America	United States	295.86
PANGAEA LOGISTICS SOLUTIONS LTD	PANL:USN	America	United States	122.63
STEALTHGAS INC	GASS:USN	America	United States	133.58
SIEM INDUSTRIES INC	SEMUF:USP	America	United States	938.66
BW LPG LTD (DR)	BWLLY:USP	America	United States	313.31
ALGOMA CENTRAL CORP	ALC:CAT	America	Canada	382.46
LOGISTEC CORP	LGT_A:CAT	America	Canada	331.54
IRISH CONTINENTAL GROUP PLC	IR5B:IE	Europe	Ireland	910.60
CLARKSON PLC	CKN:GB	Europe	United Kingdom	829.84
OCEAN WILSONS HOLDINGS LTD	OCN:GB	Europe	United Kingdom	433.28
ATLANTSKA PLOVIDBA D.D	ATPL_R_A:HR	Europe	Croatia	56.57
LUKA RIJEKA D.D	LKRI_R_A:HR	Europe	Croatia	91.95
JSSC UKRRICHFLOT	FLOT:UA	Europe	Ukraine	68.10
LUKA KOPER D.D	LKPG:SI	Europe	Slovenia	399.98
MICRO CAP				
GSD DENIZCILIK	GSDDE:IS	Europe	Turkey	16.37
KDM SHIPPING PUBLIC LTD.	KDM:PL	Europe	Poland	2.91
NORDIC SHIPHOLDING A/S	NORDIC:DK	Europe	Denmark	47.92
ERRIA A/S	ERRIA:DK	Europe	Denmark	12.57
GENCO SHIPPING & TRADING LTD	GNU1:DES	Europe	Germany	264.83
HCI HAMMONIA SHIPPING AG	HHX:DES	Europe	Germany	2.29
KOELN-DUESSELDORFER DEUTSCHE RHEINSCHIFFAHRT AG	KDR:DEF	Europe	Germany	18.46
FARSTAD SHIPPING ASA	FAR:NO	Europe	Norway	17.12
I.M. SKAUGEN SE	IMSK:NO	Europe	Norway	6.94
BELSHIPS ASA	BEL:NO	Europe	Norway	20.11
DEEP SEA SUPPLY PLC	DESSC:NO	Europe	Norway	50.21
BERGEN GROUP ASA	BERGEN:NO	Europe	Norway	13.91
PALLAS GROUP AB	PALSB:SE	Europe	Sweden	0.55

VIKING SUPPLY SHIPS AB (B)	VSSABB:SE	Europe	Sweden	53.71
ANEK LINES SA	ANEK:GR	Europe	Greece	11.75
PREMUDA SPA	PR:IT	Europe	Italy	17.46
AS RIGAS KUGU BUVETAVA	RKB1R:LV	Europe	Latvia	4.46
SOCIEDADE COMERCIAL OREY ANTUNES	ORE:PT	Europe	Portugal	9.40
RAJA FERRY PORT PCL	RP:TH	Asia and Pacific	Thailand	38.21
JUTHA MARITIME PCL	JUTHA:TH	Asia and Pacific	Thailand	11.26
BANGPAKONG TERMINAL PCL	BTC:TH	Asia and Pacific	Thailand	15.77
EVER HARVEST GROUP HOLDINGS LTD	01549:HK	Asia and Pacific	Hong Kong	47.87
PT PELAYARAN NASIONAL BINA BUANA RAYA TBK	BBRM:ID	Asia and Pacific	Indonesia	20.03
PT MITRABAHTERA SEGARA SEJATI TBK	MBSS:ID	Asia and Pacific	Indonesia	43.09
PT ICTSI JASA PRIMA TBK	KARW:ID	Asia and Pacific	Indonesia	10.40
HUBLINE BHD	7013:MY	Asia and Pacific	Malaysia	4.66
SEALINK INTERNATIONAL BHD	5145:MY	Asia and Pacific	Malaysia	19.00
PERAK CORP BHD	8346:MY	Asia and Pacific	Malaysia	40.67
KOREA STEEL SHAPES CO LTD	007280:KR	Asia and Pacific	South Korea	45.70
ASIA PACIFIC NO.10 SHIP INVESTMENT CO LTD	083570:KR	Asia and Pacific	South Korea	10.29
HARBOR STAR SHIPPING SERVICES, INC	TUGS:PH	Asia and Pacific	Philippines	34.77
CHINA CONTAINER TERMINAL CORP	2613:TW	Asia and Pacific	Taiwan	41.57
TZE SHIN INTERNATIONAL CO LTD	2611:TW	Asia and Pacific	Taiwan	39.84
JAYA HOLDINGS LTD	BJE:SG	Asia and Pacific	Singapore	5.28
MANHATTAN RESOURCES LTD	L02:SG	Asia and Pacific	Singapore	43.65
SEROJA INVESTMENTS LTD	IW5:SG	Asia and Pacific	Singapore	9.54
RICKMERS MARITIME	B1ZU:SG	Asia and Pacific	Singapore	15.96
ICP LTD	5I4:SG	Asia and Pacific	Singapore	14.25
MARCO POLO MARINE LTD	5LY:SG	Asia and Pacific	Singapore	12.37
VALLIANZ HOLDINGS LTD	545:SG	Asia and Pacific	Singapore	47.64
SWISSCO HOLDINGS LTD	ADP:SG	Asia and Pacific	Singapore	24.50
ATLANTIC NAVIGATION HOLDINGS (SINGAPORE) LTD	5UL:SG	Asia and Pacific	Singapore	34.38
AVIC INTERNATIONAL MARITIME HOLDINGS LTD	O2I:SG	Asia and Pacific	Singapore	11.96
MERCATOR LINES (SINGAPORE) LTD	EE6:SG	Asia and Pacific	Singapore	85.52
CHOWGULE STEAMSHIPS LTD	501833:INM	Asia and Pacific	India	7.47
GLOBAL OFFSHORE SERVICES LTD	501848:INM	Asia and Pacific	India	21.74
SKS LOGISTICS LTD	526508:INM	Asia and Pacific	India	2.30
SEAMEC LTD	526807:INM	Asia and Pacific	India	31.40
LOG-IN LOGISTICA INTERMODAL SA	LOGN3:BR	America	Brazil	14.65
PORTO SUDESTE VM SA (PR)	PSVM11:BR	America	Brazil	0.00
GRUPO TMM SA	TMMA:MX	America	Mexico	31.26
GENCO SHIPPING & TRADING LTD	GNK:USY	America	United States	267.41
EUROSEAS LTD	ESEA:USN	America	United States	15.79
SEANERGY MARITIME HOLDINGS CORP	SHIP:USN	America	United States	36.80
GLOBUS MARITIME LTD	GLBS:USN	America	United States	11.04
RAND LOGISTICS INC	RLOG:USN	America	United States	16.89
DRYSHIPS INC	DRYS:USN	America	United States	92.29
PYXIS TANKERS INC	PXS:USN	America	United States	51.54
TOP SHIPS INC	TOPS:USN	America	United States	13.37
NEWLEAD HOLDINGS LTD	NEWLF:USP	America	United States	0.01

WINLAND OCEAN SHIPPING CORP	WLOLQ:USP	America	United States	3.36
BRITANNIA BULK HOLDINGS INC	BBLKF:USP	America	United States	0.12
INTERNATIONAL SHIPHOLDING CORP	ISHCQ:USP	America	United States	0.10
INTERNATIONAL SHIPHOLDING CORP (PR)	ISHCP:USP	America	United States	0.02
SOVEREIGN EXPLORATION ASSOCIATES INTERNATIONAL INC	SVXA:USP	America	United States	0.00
BOSTON CARRIERS INC	BSTN:USP	America	United States	0.15
JUPITER MARINE INTERNATIONAL HOLDINGS INC	JMIH:USP	America	United States	0.06
ULTRAPETROL BAHAMAS LTD	ULTR:USP	America	United States	11.98
PARAGON SHIPPING INC	PRGNF:USP	America	United States	0.88
BOX SHIPS INC	TEUFF:USP	America	United States	0.38
CAMPER & NICHOLSONS MARINA INV LTD	CNMI:GB	Europe	United Kingdom	11.79
MERCANTILE PORTS AND LOGISTICS LTD	MPL:GB	Europe	United Kingdom	45.51
SUTTON HARBOUR HOLDINGS PLC	SUH:GB	Europe	United Kingdom	34.97
BULGARIAN RIVER SHIPPING AD	5BR:BG	Europe	Bulgaria	13.95
INDUSTRIAL HOLDING BULGARIA AD	4ID:BG	Europe	Bulgaria	43.32
KORABOREM ZAVOD	5ODE:BG	Europe	Bulgaria	29.45
LOSINJSKA PLOVIDBA-HOLDING D.D	LPLH_R_A:HR	Europe	Croatia	19.50
JADROPLOV D.D	JDPL_R_A:HR	Europe	Croatia	9.48
JORDAN NATIONAL SHIPPING LINES	SHIP:JO	Middle East	Jordan	33.64
SOCEP S.A.	SOCP:BS	Europe	Romania	25.48
PRIMORSK. MOR. PAROXOD.	PRIM:RUM	Europe	Russian Federation	16.09
SEVERO-ZAPADNOE PAROKHODSTVO	SZPR:RUM	Europe	Russian Federation	45.64

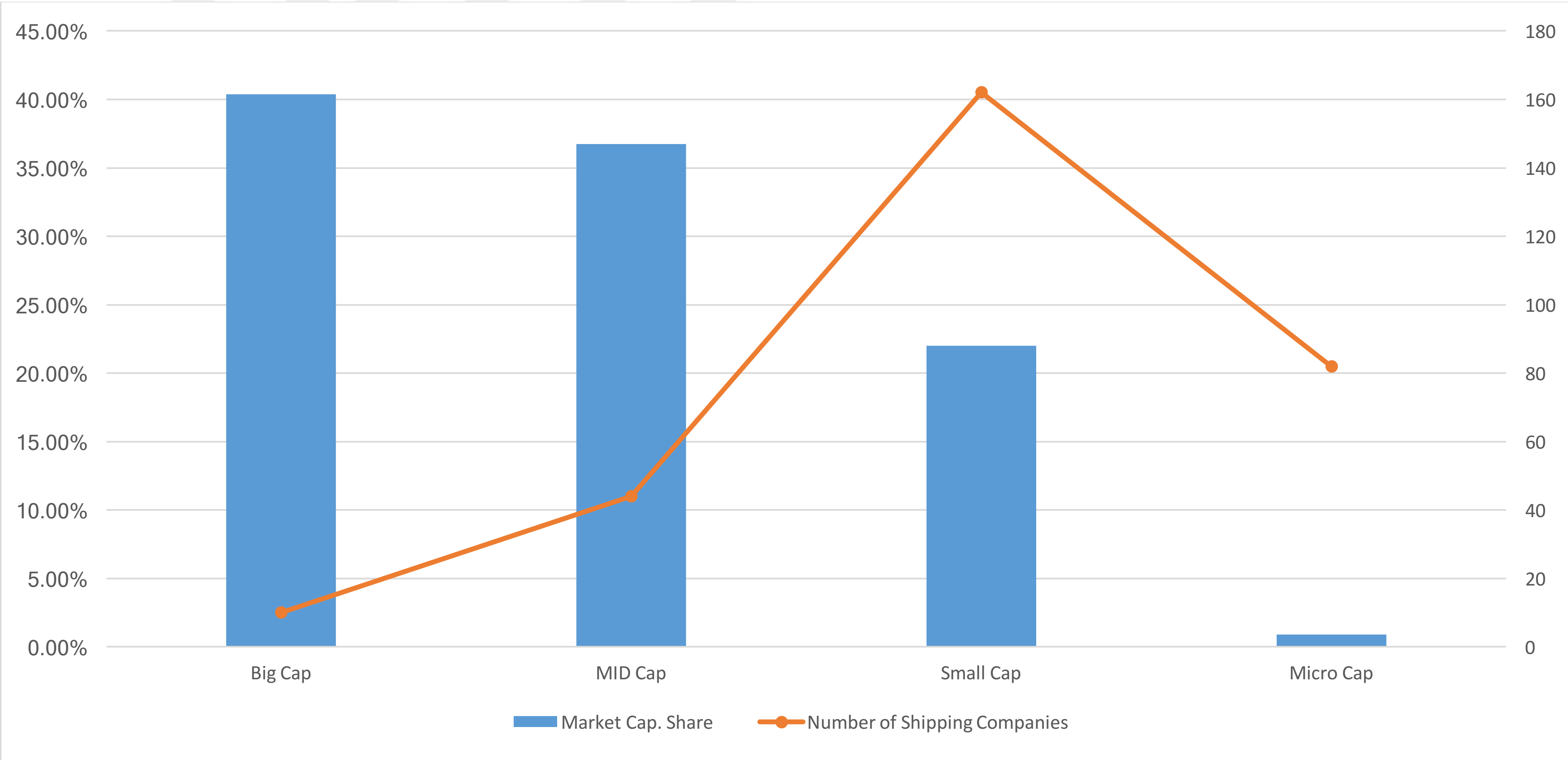


Figure 14-1 Percentage of Market Cap.

Figure 14-2 Market Capitals Based on Ratings

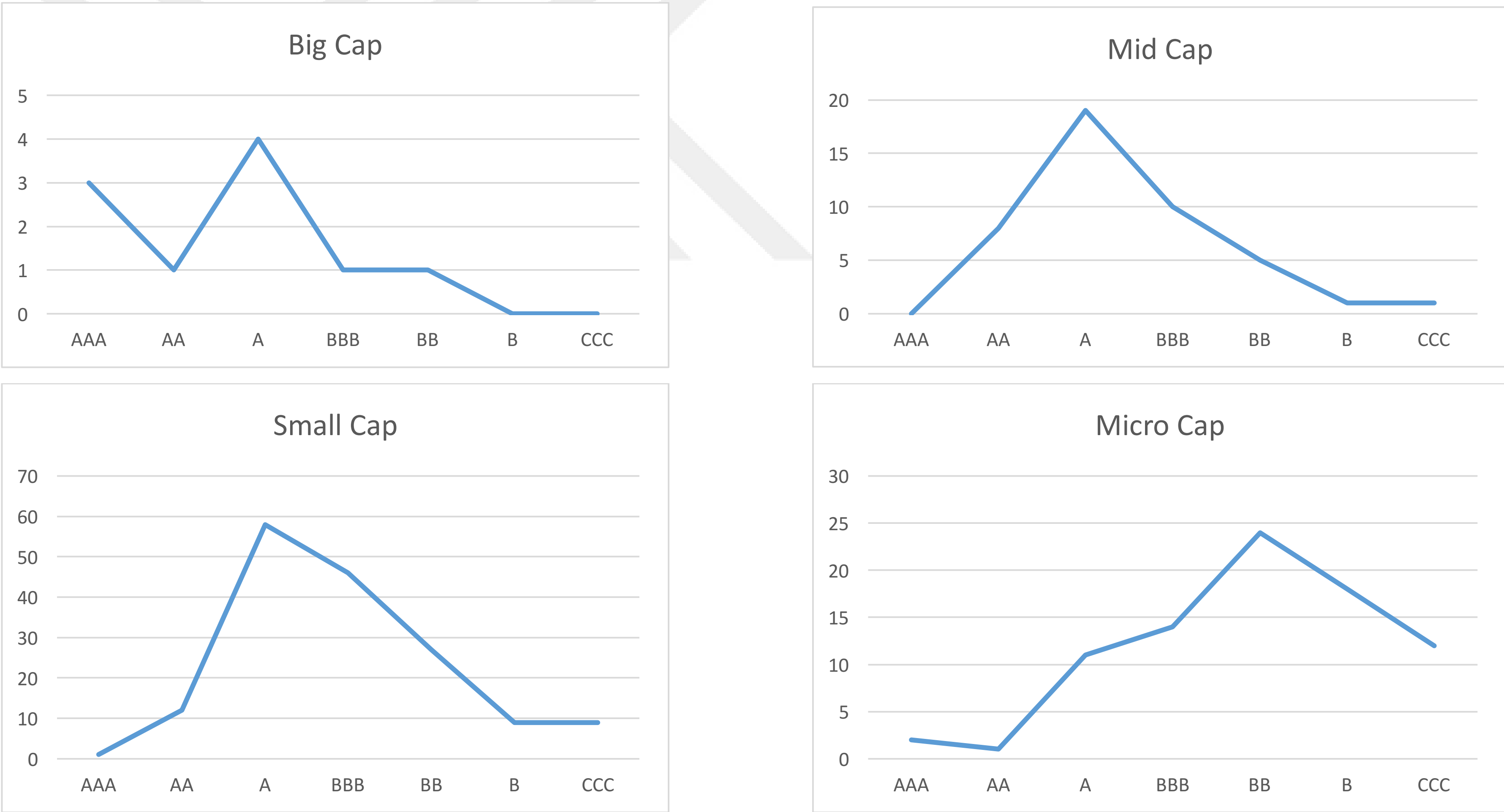


Figure 14-3 Ratio Analysis Standards

Table 14-2 RATIO ANALYSIS STANDARDS

The table consists of 298 listed shipping companies. The sample period is from 2010 to 2016. All variables are scrutinized at the upper and lower confidence level.

Rating	AAA	AA	A	BBB	BB	B	CCC	CC	C
Definition	Highest Rating Available	Very High Quality	High Quality	Minimum Investment Grade	Low Grade	Very Speculative	Substantial Risk	Substantial Risk	Substantial Risk
Equity Ratio	0.9	0.75	0.55	0.4	0.25	0.17	0.1	0.03	-0.1
Interest Coverage	20	17	15	13.92	12	10	8	6	5
Quick Ratio	1	0.75	0.5	0.39	0.3	0.2	0.15	0.1	0.05
Current Ratio	8.5	4.5	2.5	1.75	1.05	0.75	0.55	0.45	0.35
Leverage Ratio	1	1.25	1.5	1.75	2.5	4	5	6	8
Working Capital	3	2.5	2	1.5	1	0.9	-0.5	-1	-10
Return on Assets	8%	7%	6%	5%	4%	3%	2%	1%	1%
Return on Equity	20%	18%	16%	14%	12%	10%	8%	6%	4%
Return on Investment	12%	10%	9%	9%	8%	7%	6%	5%	4%
Gross Margin	90%	85%	80%	75%	70%	60%	50%	40%	20%
Operating Margin	30	25	20	16.2	12	10	8	6	4
Net Margin	14	12	10	8.8	8	6	5	4	3
EBITDA Margin	0.55	0.4	0.25	0.18	0.15	0.12	0.1	0.08	0.05
P/E	10	12	15	17.6	20	25	28	30	32
P/ Sales	0.8	1	1.2	1.3	1.5	2	2.2	2.5	3
Risk Premium	0.1	0.15	0.25	0.4	0.6	1	3	9	27

TABLE 14-3 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 99.9%

99.90%	AAA 99.9% Confidence	Level	AA 99.9% Confidence	Level	A 99.9% Confidence	Level	BBB 99.9% Confidence	Level	BB 99.9% Confidence	Level	B 99.9% Confidence	Level	CCC 99.9% Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.938816505		0.936688451		0.927876195		0.861822183		0.731944547		0.498789996		0.377826439	
1	0.05927244	0.001869266	0.061263727	0.002001369	0.069458043	0.00259616	0.128158486	0.009478921	0.228403833	0.034858726	0.346943652	0.109327476	0.367746407	0.298896261
2	0.001871091	6.08315E-07	0.002003465	6.98466E-07	0.002599711	1.18333E-06	0.009528994	1.66711E-05	0.035636792	0.000257987	0.1206619	0.003682219	0.17896765	0.028092078
3	3.93773E-05	6.66627E-11	4.36786E-05	8.21133E-11	6.48689E-05	1.81956E-10	0.000472341	1.00001E-08	0.003706829	6.65337E-07	0.02797629	4.49392E-05	0.058064324	0.000868641
4	6.21524E-07	3.30091E-15	7.14195E-07	4.36255E-15	1.21397E-06	1.26516E-14	1.756E-05	2.72474E-12	0.00028918	7.86572E-10	0.004864871	2.55915E-07	0.014128807	1.18711E-05
5	7.84802E-09	8.73533E-20	9.34233E-09	1.23878E-19	1.81749E-08	4.70305E-19	5.22258E-07	3.97834E-16	1.80477E-05	5.0067E-13	0.000676772	7.92183E-10	0.002750373	8.51488E-08
6	8.25811E-11	1.37762E-24	1.01839E-10	2.09639E-24	2.26753E-10	1.04211E-23	1.29438E-08	3.46701E-20	9.38635E-07	1.90742E-16	7.84571E-05	1.47611E-12	0.000446166	3.58709E-10
7	7.44826E-13	1.39771E-29	9.5153E-13	2.28243E-29	2.42486E-12	1.48574E-28	2.74976E-10	1.94566E-24	4.18431E-08	4.68775E-20	7.79607E-06	1.78093E-15	6.20375E-05	9.60738E-13
8	5.8781E-15	9.65567E-35	7.7793E-15	1.69203E-34	2.26897E-14	1.44242E-33	5.11134E-12	7.43945E-29	1.63215E-09	7.85889E-24	6.7784E-07	1.46944E-18	7.5478E-06	1.73506E-15
9	4.1235E-17	4.745E-40	5.65336E-17	8.92303E-40	1.88721E-16	9.96217E-39	8.44543E-14	2.02443E-33	5.65903E-11	9.3845E-28	5.23872E-08	8.65159E-22	8.16271E-07	2.21096E-18
10	2.60339E-19	1.71748E-45	3.69755E-19	3.46595E-45	1.41271E-18	5.06803E-44	1.25589E-15	4.05893E-38	1.7659E-12	8.26183E-32	3.6439E-09	3.76041E-25	7.94493E-08	2.06092E-21
11	1.49423E-21	4.71039E-51	2.19852E-21	1.0201E-50	9.61373E-21	1.95366E-49	1.69781E-17	6.16791E-43	5.00956E-14	5.51519E-36	2.30417E-10	1.24061E-28	7.02997E-09	1.44708E-24
12	7.86156E-24	1.00218E-56	1.19828E-23	2.32913E-56	5.99713E-23	5.84243E-55	2.10396E-19	7.27233E-48	1.3027E-15	2.85766E-40	1.3356E-11	3.17939E-32	5.70202E-10	7.8421E-28
13	3.81801E-26	1.68723E-62	6.02868E-26	4.20808E-62	3.45328E-25	1.38257E-60	2.40671E-21	6.78603E-53	3.12698E-17	1.17217E-44	7.14617E-13	6.45438E-36	4.26915E-11	3.34798E-31
14	1.7218E-28	2.28619E-68	2.81645E-28	6.11905E-68	1.84645E-27	2.63329E-66	2.55638E-23	5.09705E-58	6.96984E-19	3.87106E-49	3.55047E-14	1.05547E-39	2.96804E-12	1.14588E-34
15	7.24707E-31	2.53003E-74	1.22806E-30	7.26712E-74	9.21463E-30	4.09629E-72	2.53433E-25	3.12711E-63	1.44996E-20	1.04441E-53	1.6464E-15	1.41064E-43	1.9259E-13	3.192E-38
16	2.85966E-33	2.31622E-80	5.02004E-33	7.13973E-80	4.31113E-32	5.27144E-78	2.35545E-27	1.58724E-68	2.82789E-22	2.3316E-58	7.15744E-17	1.56055E-47	1.17158E-14	7.33297E-42
17	1.06203E-35	1.77409E-86	1.93138E-35	5.86871E-86	1.89834E-34	5.67561E-84	2.06041E-29	6.74083E-74	5.19085E-24	4.35576E-63	2.92853E-18	1.44508E-51	6.70776E-16	1.40549E-45
18	3.72509E-38	1.14832E-92	7.01783E-38	4.07657E-92	7.89467E-37	5.16404E-90	1.7022E-31	2.41936E-79	8.99893E-26	6.8776E-68	1.13167E-19	1.13129E-55	3.62711E-17	2.27078E-49
19	1.23781E-40	6.3376E-99	2.41578E-40	2.41449E-98	3.11038E-39	4.00633E-96	1.33226E-33	7.40431E-85	1.47796E-27	9.26079E-73	4.14292E-21	7.55409E-60	1.85808E-18	3.12109E-53
20	3.90749E-43	3.0065E-105	7.90015E-43	1.2292E-104	1.16417E-41	2.6716E-102	9.90574E-36	1.94787E-90	2.30599E-29	1.07197E-77	1.44085E-22	4.33705E-64	9.04252E-20	3.67966E-57
21	1.17476E-45	1.2349E-111	2.46051E-45	5.4183E-111	4.14982E-44	1.5426E-108	7.01451E-38	4.4369E-96	3.4266E-31	1.07447E-82	4.77243E-24	2.1565E-68	4.19108E-21	3.74896E-61
22	3.37132E-48	4.4207E-118	7.31493E-48	2.0816E-117	1.41201E-46	7.7626E-115	4.74138E-40	8.8087E-102	4.86033E-33	9.38735E-88	1.50889E-25	9.34759E-73	1.85421E-22	3.32318E-65
23	9.25431E-51	1.3876E-124	2.08013E-50	7.012E-124	4.59561E-49	3.4252E-121	3.06554E-42	1.5335E-107	6.59422E-35	7.19187E-93	4.56322E-27	3.55347E-77	7.84672E-24	2.57877E-69
24	2.43447E-53	3.8402E-131	5.66875E-53	2.0826E-130	1.43339E-51	1.3325E-127	1.89944E-44	2.3537E-113	8.57388E-37	4.8583E-98	1.32252E-28	1.19122E-81	3.18224E-25	1.76171E-73
25	6.14805E-56	9.4181E-138	1.48305E-55	5.4812E-137	4.29197E-54	4.594E-134	1.12983E-46	3.2016E-119	1.07019E-38	2.9085E-103	3.67961E-30	3.5393E-86	1.23894E-26	1.06506E-77
26	1.49292E-58	2.0564E-144	3.7307E-58	1.2844E-143	1.23571E-56	1.4101E-140	6.46206E-49	3.8773E-125	1.28444E-40	1.5503E-108	9.84397E-32	9.36377E-91	4.63801E-28	5.72539E-82
27	3.49095E-61	4.0152E-151	9.03722E-61	2.6913E-150	3.42598E-59	3.8703E-147	3.55907E-51	4.1989E-131	1.48449E-42	7.3899E-114	2.53599E-33	2.21548E-95	1.67195E-29	2.74882E-86
28	7.87151E-64	7.0383E-158	2.11099E-63	5.0628E-157	9.15924E-62	9.5372E-154	1.8902E-53	4.0824E-137	1.65441E-44	3.1626E-119	6.29986E-35	4.7066E-100	5.81195E-31	1.18352E-90
29	1.71369E-66	1.1118E-164	4.76097E-66	8.5827E-164	2.36425E-64	2.1178E-160	9.6926E-56	3.577E-143	1.78021E-46	1.2197E-124	1.51103E-36	9.0115E-105	1.95065E-32	4.58727E-95
30	3.60648E-69	1.3007E-137	1.03796E-68	1.0774E-136	5.89937E-67	3.4803E-133	4.8045E-58	2.3083E-115	1.85172E-48	3.42885E-96	3.50343E-38	1.22741E-75	6.32871E-34	1.51E-99

TABLE 14-4 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 99%

99.00%	AAA 99% Confidence	Level	AA 99% Confidence	Level	A 99% Confidence	Level	BBB 99% Confidence	Level	BB 99% Confidence	Level	B 99% Confidence	Level	CCC 99% Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.969336696		0.968198606		0.963439617		0.925420996		0.837688479		0.616302849		0.413171133	
1	0.030188325	0.000469969	0.031290303	0.00050549	0.035883779	0.000668026	0.071726204	0.002775559	0.148362261	0.013041192	0.298301132	0.068632369	0.365199486	0.277305773
2	0.000470082	3.75981E-08	0.000505621	4.35317E-08	0.000668254	7.62869E-08	0.002779626	1.35512E-06	0.013138154	3.22656E-05	0.072191428	0.001171489	0.161398817	0.007276821
3	4.87996E-06	1.00776E-12	5.4469E-06	1.25625E-12	8.29649E-06	2.92165E-12	7.18131E-05	2.23288E-10	0.000775629	2.73356E-08	0.011647296	7.10319E-06	0.047553149	0.000140462
4	3.79945E-08	1.21802E-17	4.40083E-08	1.63487E-17	7.72517E-08	5.04755E-17	1.3915E-06	1.66396E-14	3.43427E-05	1.05372E-11	0.001409373	1.99126E-08	0.010507986	1.27423E-06
5	2.36655E-10	7.8595E-23	2.84453E-10	1.13593E-22	5.75455E-10	4.65657E-22	2.157E-08	6.63005E-19	1.21648E-06	2.17845E-15	0.000136432	3.01916E-11	0.001857589	6.3086E-09
6	1.22837E-12	3.02052E-28	1.53216E-12	4.70087E-28	3.57219E-12	2.55886E-27	2.78636E-10	1.57474E-23	3.59084E-08	2.68945E-19	1.10059E-05	2.74723E-14	0.000273652	1.88474E-11
7	5.46506E-15	7.46523E-34	7.07377E-15	1.25108E-33	1.90068E-14	9.04343E-33	3.08516E-12	2.40664E-28	9.08528E-10	2.13883E-23	7.61007E-07	1.6154E-17	3.45542E-05	3.65181E-14
8	2.1275E-17	1.25596E-39	2.85763E-17	2.26654E-39	8.84898E-17	2.17576E-38	2.98901E-14	2.5046E-33	2.01136E-11	1.15916E-27	4.60426E-08	6.48717E-21	3.81778E-06	4.84429E-17
9	7.36192E-20	1.50286E-45	1.02615E-19	2.92051E-45	3.66205E-19	3.72319E-44	2.57408E-16	1.85434E-38	3.95811E-13	4.47158E-32	2.47615E-09	1.85715E-24	3.74946E-07	4.58926E-20
10	2.29274E-22	1.32437E-51	3.31631E-22	2.77142E-51	1.36395E-21	4.6922E-50	1.99508E-18	1.01127E-43	7.01017E-15	1.27109E-36	1.1985E-10	3.92214E-28	3.31412E-08	3.21155E-23
11	6.49123E-25	8.84236E-58	9.74333E-25	1.99257E-57	4.61827E-24	4.48036E-56	1.40575E-20	4.17897E-49	1.1287E-16	2.73869E-41	5.27359E-12	6.2838E-32	2.66303E-09	1.70666E-26
12	1.68465E-27	4.5795E-64	2.62405E-27	1.11127E-63	1.43341E-26	3.31855E-62	9.07955E-23	1.33971E-54	1.66585E-18	4.57874E-46	2.12709E-13	7.81706E-36	1.96153E-10	7.04768E-30
13	4.03581E-30	1.87665E-70	6.52339E-30	4.90389E-70	4.10678E-29	1.94493E-68	5.41327E-25	3.39865E-60	2.26952E-20	6.05869E-51	7.9196E-15	7.70052E-40	1.33368E-11	2.30607E-33
14	8.97775E-33	6.18923E-77	1.50588E-32	1.74161E-76	1.09257E-31	9.17381E-75	2.99688E-27	6.93932E-66	2.87109E-22	6.45342E-56	2.73802E-16	6.10882E-44	8.42024E-13	6.07967E-37
15	1.86398E-35	1.66706E-83	3.24448E-35	5.05152E-83	2.71288E-34	3.53395E-81	1.54852E-29	1.15721E-71	3.38997E-24	5.61481E-61	8.83498E-18	3.95984E-48	4.96173E-14	1.31024E-40
16	3.62815E-38	3.71442E-90	6.55345E-38	1.21205E-89	6.31515E-37	1.12616E-87	7.50129E-32	1.59645E-77	3.75247E-26	4.04174E-66	2.67268E-19	2.12426E-52	2.74103E-15	2.33768E-44
17	6.64661E-41	6.92406E-97	1.24585E-40	2.43304E-96	1.38359E-39	3.00242E-94	3.41999E-34	1.84264E-83	3.90939E-28	2.43435E-71	7.60953E-21	9.53724E-57	1.42516E-16	3.49161E-48
18	1.14998E-43	1.75049E-06	2.23686E-43	4.1272E-103	2.86292E-42	6.7643E-101	1.47262E-36	1.79731E-89	3.84661E-30	1.23914E-76	2.04619E-22	3.61949E-61	6.9983E-18	4.40946E-52
19	1.88496E-46	1.465E-110	3.80479E-46	5.9695E-110	5.61216E-45	1.2994E-107	6.00726E-39	1.49481E-95	3.58563E-32	5.37853E-82	5.21259E-24	1.17153E-65	3.25566E-19	4.75025E-56
20	2.9352E-49	1.6913E-117	6.14818E-49	7.4214E-117	1.04514E-47	2.1456E-114	2.32801E-41	1.0686E-101	3.17524E-34	2.00679E-87	1.26149E-25	3.25999E-70	1.43883E-20	4.40033E-60
21	4.35294E-52	5.13261E-19	9.46177E-52	7.9883E-124	1.85365E-50	3.0673E-121	8.59219E-44	6.6145E-108	2.67792E-36	6.48325E-93	2.90754E-27	7.85574E-75	6.05606E-22	3.53043E-64
22	6.16203E-55	1.4727E-131	1.38994E-54	7.494E-131	3.13819E-53	3.8218E-128	3.02705E-46	3.5683E-114	2.15584E-38	1.82558E-98	6.39681E-29	1.65014E-79	2.43314E-23	2.46942E-68
23	8.34373E-58	1.125E-138	1.95305E-57	6.1644E-138	5.08188E-56	4.1753E-135	1.02007E-48	1.6879E-120	1.66008E-40	4.5075E-104	1.34616E-30	3.0397E-84	9.35061E-25	1.51491E-72
24	1.08271E-60	8.56946E-34	2.62994E-60	4.4706E-145	7.88655E-59	4.0218E-142	3.29426E-51	7.0398E-127	1.22506E-42	9.813E-110	2.71485E-32	4.93744E-89	3.44373E-26	8.19579E-77
25	1.34877E-63	4.5216E-153	3.39979E-63	2.8732E-152	1.17495E-61	3.4329E-149	1.02131E-53	2.6018E-133	8.67879E-45	1.8932E-115	5.25614E-34	7.1078E-94	1.21756E-27	3.93004E-81
26	1.61558E-66	2.4026E-160	4.22594E-66	1.644E-159	1.68314E-64	2.6089E-156	3.04454E-56	8.5615E-140	5.9119E-47	3.252E-121	9.78485E-36	9.1108E-99	4.13919E-29	1.67814E-85
27	1.8635E-69	5.59345E-50	5.05831E-69	8.4115E-167	2.32183E-67	1.7729E-163	8.73969E-59	2.5191E-146	3.87797E-49	4.9951E-127	1.75409E-37	1.0444E-103	1.35504E-30	6.40854E-90
28	2.0727E-72	4.8693E-175	5.83838E-72	3.8638E-174	3.08849E-70	1.0816E-170	2.41923E-61	6.6548E-153	2.45294E-51	6.8885E-133	3.03217E-39	1.0748E-108	4.27754E-32	2.1975E-94
29	2.22588E-75	1.8717E-182	6.50639E-75	1.5994E-181	3.96663E-73	5.9465E-178	6.46572E-64	1.5842E-159	1.49806E-53	8.5608E-139	5.06077E-41	9.9695E-114	1.30376E-33	6.7913E-99
30	2.31071E-78	3.40059E-67	7.00913E-78	4.9128E-155	4.92464E-76	2.4252E-151	1.67045E-66	2.7904E-132	8.84402E-56	7.8217E-111	8.16499E-43	6.66671E-85	3.84128E-35	1.47554E-69

TABLE 14-5 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 95%

	AAA 95%		AA 95%		A 95%		BBB 95%		BB 95%		B 95%		CCC 95%	
95.00%	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.984949628		0.984368304		0.981922511		0.961568079		0.909320599		0.738786018		0.488722226	
1	0.014936553	0.000226497	0.01550889	0.00024433	0.01791311	0.00032676	0.037683793	0.001476266	0.086437849	0.008198603	0.223665369	0.066317785	0.349906287	0.225782725
2	0.000113255	6.47833E-09	0.000122173	7.54167E-09	0.000163393	1.35116E-08	0.000738413	2.79796E-07	0.004108288	8.98228E-06	0.033857028	0.000694666	0.125259711	0.012036292
3	5.72495E-07	5.50401E-14	6.41617E-07	6.91535E-14	9.9359E-07	1.66041E-13	9.64612E-06	1.58133E-11	0.000130175	2.96007E-09	0.003416706	2.25131E-06	0.029893709	0.000207028
4	2.17044E-09	1.97477E-19	2.52719E-09	2.67793E-19	4.53149E-09	8.61855E-19	9.45077E-08	3.78011E-16	3.09352E-06	4.14051E-13	0.0002586	3.13405E-09	0.005350686	1.559E-06
5	6.58286E-12	3.62945E-25	7.96328E-12	5.31227E-25	1.65335E-11	2.29185E-24	7.4075E-10	4.63252E-21	5.88126E-08	2.97449E-17	1.56581E-05	2.25451E-12	0.000766177	6.12902E-09
6	1.66379E-14	3.86141E-31	2.09105E-14	6.10025E-31	5.02698E-14	3.52812E-30	4.83832E-12	3.28781E-26	9.31764E-10	1.23878E-21	7.90072E-07	9.43577E-16	9.14255E-05	1.41054E-11
7	3.60444E-17	2.58756E-37	4.7064E-17	4.41221E-37	1.3101E-16	3.42101E-36	2.70877E-14	1.47013E-31	1.2653E-11	3.25251E-26	3.41703E-08	2.49534E-19	9.35102E-06	2.05939E-14
8	6.83257E-20	1.16174E-43	9.26876E-20	2.13817E-43	2.98749E-19	2.22255E-42	1.32695E-16	4.4052E-37	1.50346E-13	5.72518E-31	1.29312E-09	4.43093E-23	8.36872E-07	2.02434E-17
9	1.15127E-22	3.66361E-50	1.62257E-22	7.27795E-50	6.05561E-22	1.01423E-48	5.77814E-19	9.2728E-43	1.58795E-15	7.08153E-36	4.34987E-11	5.53472E-27	6.65742E-08	1.40253E-20
10	1.74588E-25	8.42292E-57	2.55638E-25	1.80606E-56	1.10472E-24	3.37427E-55	2.26445E-21	1.42315E-48	1.50947E-17	6.38789E-41	1.31691E-12	5.04583E-31	4.76646E-09	7.10229E-24
11	2.4069E-28	1.45498E-63	3.66147E-28	3.36741E-63	1.83212E-27	8.4347E-62	8.06761E-24	1.64122E-54	1.30442E-19	4.33044E-46	3.62446E-14	3.45918E-35	3.10236E-10	2.70748E-27
12	3.04168E-31	1.93599E-70	4.80726E-31	4.83627E-70	2.78526E-30	1.6241E-68	2.63474E-26	1.45799E-60	1.03329E-21	2.26171E-51	9.14414E-16	1.82787E-39	1.85098E-11	7.96216E-31
13	3.54819E-34	2.02615E-77	5.82609E-34	3.40198E-67	3.90855E-33	2.4597E-75	7.94272E-29	1.01879E-66	7.55556E-24	9.29246E-57	2.12951E-17	7.60083E-44	1.01941E-12	1.84389E-34
14	3.84339E-37	1.69785E-84	6.55651E-37	4.30781E-73	5.09309E-36	2.98271E-82	2.22339E-31	5.70019E-73	5.1301E-26	3.05724E-62	4.60502E-19	2.53169E-48	5.21325E-14	3.42223E-38
15	3.88561E-40	1.15676E-91	6.88659E-40	4.75186E-79	6.19418E-39	2.94075E-89	5.80897E-34	2.59312E-79	3.25103E-28	8.17877E-68	9.29438E-21	6.85839E-53	2.48833E-15	5.16818E-42
16	3.68278E-43	6.4939E-99	6.78121E-43	4.60701E-85	7.06249E-42	2.38906E-96	1.42283E-36	9.72048E-86	1.93147E-30	1.80302E-73	1.75865E-22	1.53135E-57	1.11347E-16	6.43526E-46
17	3.28521E-46	3.0394E-106	6.28466E-46	3.95661E-91	7.57884E-45	1.6181E-103	3.28004E-39	3.03794E-92	1.08001E-32	3.31405E-79	3.13193E-24	2.85129E-62	4.6894E-18	6.68415E-50
18	2.76775E-49	1.1984E-113	5.50088E-49	3.03099E-97	7.68111E-48	9.233E-111	7.14137E-42	7.9986E-99	5.70349E-35	5.13186E-85	5.26768E-26	4.4733E-67	1.86524E-19	5.85137E-54
19	2.20907E-52	4.0178E-121	4.56144E-52	2.0839E-103	7.37504E-51	4.4795E-118	1.473E-44	1.7906E-105	2.85347E-37	6.75728E-91	8.39355E-28	5.96824E-72	7.02863E-21	4.3571E-58
20	1.67501E-55	1.1549E-128	3.59331E-55	1.2931E-109	6.7271E-54	1.8633E-125	2.88634E-47	3.4371E-112	1.35622E-39	7.62886E-97	1.27056E-29	6.82809E-77	2.51612E-22	2.78263E-62
21	1.20958E-58	2.8676E-136	2.69587E-58	7.2781E-116	5.8439E-57	6.6955E-133	5.38644E-50	5.6991E-119	6.13901E-42	7.4404E-103	1.83171E-31	6.74901E-82	8.57829E-24	1.53559E-66
22	8.33772E-62	6.193E-144	1.93063E-61	3.7324E-122	4.84589E-60	2.0925E-140	9.5952E-53	8.219E-126	2.65254E-44	6.3116E-109	2.52066E-33	5.80256E-87	2.79169E-25	7.37216E-71
23	5.49738E-65	1.1705E-151	1.3225E-64	1.7513E-128	3.84361E-63	5.7233E-148	1.63494E-55	1.0373E-132	1.09628E-46	4.6858E-115	3.31792E-35	4.36642E-92	8.6902E-27	3.09812E-75
24	3.47361E-68	1.9471E-159	8.68172E-68	7.5467E-135	2.92161E-66	1.3778E-155	2.66971E-58	1.1523E-139	4.34208E-49	3.0619E-121	4.18538E-37	2.89214E-97	2.59244E-28	1.14614E-79
25	2.10706E-71	2.8656E-167	5.47128E-71	2.9971E-141	2.13194E-69	2.9344E-163	4.18503E-61	1.1326E-146	1.65099E-51	1.7702E-127	5.06845E-39	1.695E-102	7.42434E-30	3.75202E-84
26	1.22897E-74	3.7493E-175	3.31542E-74	1.1005E-147	1.49588E-72	5.556E-171	6.30812E-64	9.8956E-154	6.03612E-54	9.0981E-134	5.90176E-41	8.8314E-108	2.04444E-31	1.0921E-88
27	6.9026E-78	4.3804E-183	1.93463E-77	3.747E-154	1.01071E-75	9.3937E-179	9.15611E-67	7.7206E-161	2.12511E-56	4.1756E-140	6.61756E-43	4.1092E-113	5.42126E-33	2.83889E-93
28	3.73845E-81	4.5888E-191	1.08859E-80	1.1863E-160	6.58509E-79	1.4241E-186	1.28153E-69	5.4012E-168	7.21456E-59	1.7184E-146	7.15517E-45	1.7144E-118	1.38622E-34	6.61768E-98
29	1.95492E-84	4.3267E-199	5.91409E-84	3.5013E-167	4.14245E-82	1.9431E-194	1.73182E-72	3.401E-175	2.36482E-61	6.3651E-153	7.46968E-47	6.4385E-124	3.42234E-36	1.3887E-102
30	9.88199E-88	3.6815E-207	3.10592E-87	9.6467E-174	2.51901E-85	2.3922E-202	2.26234E-75	1.9295E-182	7.49315E-64	2.1167E-159	7.53808E-49	2.1422E-129	8.16755E-38	2.5149E-107

TABLE 14-6 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 90%

90.00%	AAA 90% Confidence	Level	AA 90% Confidence	Level	A 90% Confidence	Level	BBB 90% Confidence	Level	BB 90% Confidence	Level	B 90% Confidence	Level	CCC 90% Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.989834738		0.98943614		0.9877552		0.973544738		0.935525168		0.79729327		0.545354884	
1	0.010113426	0.000103329	0.010507872	0.000111591	0.012169533	0.000149928	0.026102212	0.000699715	0.062350204	0.004150959	0.180613119	0.040429355	0.330658996	0.185676018
2	5.16659E-05	1.34379E-09	5.57971E-05	1.5677E-09	7.49667E-05	2.83313E-09	0.00034992	6.23212E-08	0.002077736	2.25546E-06	0.020457403	0.000242048	0.100242406	0.00726037
3	1.75962E-07	5.18682E-15	1.97523E-07	6.53713E-15	3.07873E-07	1.58951E-14	3.1273E-06	1.65192E-12	4.61585E-05	3.67033E-10	0.001544758	4.44036E-07	0.020259623	9.07193E-05
4	4.49463E-10	8.45181E-21	5.24426E-10	1.1508E-20	9.4828E-10	3.7653E-20	2.09619E-08	1.85052E-17	7.69084E-07	2.53068E-14	8.74846E-05	3.48449E-10	0.003070948	4.94025E-07
5	9.18458E-13	7.05368E-27	1.11389E-12	1.03762E-26	2.33664E-12	4.56859E-26	1.12404E-10	1.06232E-22	1.02515E-08	8.95336E-19	3.96363E-06	1.40992E-13	0.000372395	1.40101E-09
6	1.56403E-15	3.40739E-33	1.97159E-15	5.41525E-33	4.79804E-15	3.20866E-32	5.02287E-13	3.53095E-28	1.13872E-10	1.83541E-23	1.49649E-07	3.31495E-17	3.76317E-05	2.32235E-12
7	2.28287E-18	1.03667E-39	2.99121E-18	1.77998E-39	8.44483E-18	1.41934E-38	1.92387E-15	7.39309E-34	1.08418E-12	2.37126E-28	4.8429E-09	4.92079E-21	3.25954E-06	2.43971E-15
8	2.91559E-21	2.1131E-46	3.97085E-21	3.91986E-46	1.30055E-20	4.20648E-45	6.44773E-18	1.03723E-39	9.03221E-15	2.05341E-33	1.37135E-10	4.90192E-25	2.4704E-07	1.72442E-18
9	3.30994E-24	3.02527E-53	4.68563E-24	6.06309E-53	1.78036E-23	8.75632E-52	1.92081E-20	1.02219E-45	6.68858E-17	1.24932E-38	3.45172E-12	3.43372E-29	1.66428E-08	8.58656E-22
10	3.38186E-27	3.15758E-60	4.97616E-27	6.83698E-60	2.19347E-26	1.32884E-58	5.15E-23	7.34455E-52	4.45776E-19	5.54264E-44	7.81928E-14	1.755E-33	1.00908E-09	3.12389E-25
11	3.14122E-30	2.47617E-67	4.80429E-30	5.79256E-67	2.45677E-29	1.51518E-65	1.25527E-25	3.9651E-58	2.70089E-21	1.84785E-49	1.6103E-15	6.74372E-38	5.56206E-11	8.55323E-29
12	2.67456E-33	1.49572E-74	4.25182E-33	3.78026E-74	2.52236E-32	1.33076E-72	2.80463E-28	1.64894E-64	1.50006E-23	4.74591E-55	3.03987E-17	1.99701E-42	2.81032E-12	1.80621E-32
13	2.10206E-36	7.10631E-82	3.47343E-36	1.94042E-81	2.3905E-35	9.19307E-80	5.78434E-31	5.39373E-71	7.69035E-26	9.58821E-61	5.29716E-19	4.65316E-47	1.31073E-13	3.00312E-36
14	1.5341E-39	2.70327E-89	2.63486E-39	7.97482E-89	2.10371E-38	5.08481E-87	1.10776E-33	1.41266E-77	3.66101E-28	1.55111E-66	8.5713E-21	8.68369E-52	5.67658E-15	4.00114E-40
15	1.04495E-42	8.36083E-97	1.86549E-42	2.66479E-96	1.7279E-41	2.28668E-94	1.98006E-36	3.00822E-84	1.62664E-30	2.0403E-72	1.29445E-22	1.31791E-56	2.29455E-16	4.33711E-44
16	6.67287E-46	2.1307E-104	1.23823E-45	7.3371E-104	1.33052E-44	8.4734E-102	3.31802E-39	5.27845E-91	6.7757E-33	2.2115E-78	1.83273E-24	1.64844E-61	8.69516E-18	3.87592E-48
17	4.01051E-49	4.5271E-112	7.73532E-49	1.6842E-111	9.6427E-48	2.6177E-109	5.23301E-42	7.72195E-98	2.65637E-35	1.99856E-84	2.44219E-26	1.71931E-66	3.1012E-19	2.88913E-52
18	2.27647E-52	8.1031E-120	4.56386E-52	3.2569E-119	6.6001E-51	6.8128E-117	7.79471E-45	9.5166E-105	9.83553E-38	1.52158E-90	3.07354E-28	1.51088E-71	1.04462E-20	1.81494E-56
19	1.22418E-55	1.2332E-127	2.55097E-55	5.3552E-127	4.27978E-54	1.5076E-124	1.09994E-47	9.9725E-112	3.45006E-40	9.85027E-97	3.66451E-30	1.12907E-76	3.33354E-22	9.69747E-61
20	6.25389E-59	1.6092E-135	1.35457E-58	7.5495E-135	2.63643E-57	2.8603E-132	1.47455E-50	8.9599E-119	1.14969E-42	5.4675E-103	4.15066E-32	7.23485E-82	1.0106E-23	4.44378E-65
21	3.04275E-62	1.8138E-143	6.85032E-62	9.1938E-143	1.54675E-60	4.688E-140	1.88261E-53	6.954E-126	3.64873E-45	2.6216E-109	4.47743E-34	4.00509E-87	2.91782E-25	1.7595E-69
22	1.41312E-65	1.7782E-151	3.30685E-65	2.08853E-45	8.6621E-64	1.13528E-44	2.29435E-56	4.6942E-133	1.10535E-47	1.0933E-115	4.61039E-36	1.92851E-92	8.04151E-27	6.06051E-74
23	6.27751E-69	1.5256E-159	1.52691E-68	9.0265E-159	4.64002E-67	8.3367E-156	2.67457E-59	2.7732E-140	3.203E-50	3.9905E-122	4.54089E-38	8.12733E-98	2.11988E-28	1.82725E-78
24	2.67246E-72	1.1521E-167	6.75663E-72	1.31616E-57	2.38195E-70	1.26206E-56	2.98788E-62	1.43995E-51	8.89462E-53	6.52038E-46	4.28609E-40	3.0148E-103	5.35551E-30	4.84965E-83
25	1.09221E-75	7.6968E-176	2.87023E-75	5.3155E-175	1.17386E-73	8.8921E-172	3.20439E-65	6.6335E-155	2.37121E-55	3.6435E-135	3.88376E-42	9.8945E-109	1.29886E-31	1.13894E-87
26	4.2921E-79	4.5714E-184	1.17239E-78	2.72703E-70	5.56249E-77	4.61294E-69	3.30441E-68	9.86969E-63	6.07825E-58	1.21854E-55	3.38384E-44	3.5617E-47	3.02893E-33	2.72344E-42
27	1.62421E-82	2.4245E-192	4.61141E-82	1.9544E-191	2.53822E-80	5.9219E-188	3.28134E-71	9.9072E-170	1.50037E-60	2.0772E-148	2.83908E-46	7.5227E-120	6.80185E-35	4.43485E-97
28	5.92678E-86	1.1529E-200	1.74905E-85	2.25841E-83	1.11685E-83	6.73911E-82	3.14206E-74	2.70388E-74	3.57126E-63	9.1019E-66	2.29695E-48	1.48399E-55	1.47289E-36	1.26197E-49
29	2.08813E-89	4.9348E-209	6.40519E-89	4.6434E-208	4.74486E-87	2.5484E-204	2.90494E-77	9.5612E-185	8.20741E-66	7.6525E-162	1.79425E-50	3.6963E-131	3.07945E-38	1.1163E-106
30	7.11166E-93	3.03861E-97	2.26745E-92	8.54911E-97	1.94862E-90	4.50023E-95	2.5962E-80	3.38594E-86	1.82334E-68	3.10766E-76	1.35486E-52	2.82626E-64	6.22377E-40	2.67293E-57

TABLE 14-7 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 75%

	AAA 75%		AA 75%		A 75%		BBB 75%		BB 75%		B 75%		CCC 75%	
75.00%	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level	Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.994529553		0.994311273		0.993388259		0.985441689		0.9631299		0.87065812		0.645791792	
1	0.005455461	2.99255E-05	0.00567252	3.23613E-05	0.006589839	4.37145E-05	0.014451831	0.00021193	0.036181911	0.001358773	0.120591362	0.016626214	0.282390817	0.118427194
2	1.49629E-05	1.12354E-10	1.61808E-05	1.31407E-10	2.18575E-05	2.39933E-10	0.00010597	5.6699E-09	0.000679623	2.36764E-07	0.008351313	3.81666E-05	0.061741706	0.002502155
3	2.73595E-08	1.25099E-16	3.07703E-08	1.58253E-16	4.8332E-08	3.90624E-16	5.18031E-07	4.50545E-14	8.51047E-06	1.22992E-11	0.000385569	2.65228E-08	0.008999439	1.66109E-05
4	3.75199E-11	5.87846E-23	4.3886E-11	8.04323E-23	8.01551E-11	2.68412E-22	1.89927E-09	1.51185E-19	7.99282E-08	2.70203E-16	1.33509E-05	7.84411E-12	0.000983815	4.76913E-08
5	4.11628E-14	1.41456E-29	5.00737E-14	2.09345E-29	1.06345E-13	9.44522E-29	5.57069E-12	2.59871E-25	6.00533E-10	3.04308E-21	3.69836E-07	1.19305E-15	8.60402E-05	7.10107E-11
6	3.76329E-17	1.97008E-36	4.76115E-17	3.15354E-36	1.17577E-16	1.92368E-35	1.3616E-14	2.58574E-31	3.76004E-12	1.98473E-26	8.53742E-09	1.05278E-19	6.27059E-06	6.16476E-14
7	2.94906E-20	1.72795E-43	3.88032E-20	2.99174E-43	1.11424E-19	2.46745E-42	2.85262E-17	1.6205E-37	2.01791E-14	8.15531E-32	1.68926E-10	5.85966E-24	3.91713E-07	3.38634E-17
8	2.02212E-23	1.01537E-50	2.76714E-23	1.90148E-50	9.23943E-23	2.12036E-49	5.22933E-20	6.80433E-44	9.47583E-17	2.2456E-37	2.92466E-12	2.18724E-28	2.1411E-08	1.25015E-20
9	1.23248E-26	4.19054E-58	1.75405E-26	8.48822E-58	6.81018E-26	1.27976E-56	8.52109E-23	2.00678E-50	3.95532E-19	4.34367E-43	4.50092E-14	5.73836E-33	1.04028E-09	3.24874E-24
10	6.7607E-30	1.26082E-65	1.00068E-29	2.76235E-65	4.51767E-29	5.63104E-64	1.24965E-25	4.31488E-57	1.4859E-21	6.12597E-49	6.23405E-16	1.09811E-37	4.54894E-11	6.16477E-28
11	3.37142E-33	2.85015E-73	5.18987E-33	6.75415E-73	2.72444E-32	1.86157E-71	1.66604E-28	6.97073E-64	5.0746E-24	6.49177E-55	7.84957E-18	1.57944E-42	1.80832E-12	8.80001E-32
12	1.54115E-36	4.95854E-81	2.46734E-36	1.27093E-80	1.50609E-35	4.73551E-79	2.03609E-31	8.6548E-71	1.58865E-26	5.26888E-61	9.06011E-20	1.71368E-47	6.5895E-14	9.06499E-36
13	6.50303E-40	6.7966E-89	1.08278E-39	1.88431E-88	7.68536E-39	9.49423E-87	2.29692E-34	8.49025E-78	4.59083E-29	3.40274E-67	9.65291E-22	1.52612E-52	2.2165E-15	8.39012E-40
14	2.54801E-43	7.45268E-97	4.4123E-43	2.23487E-96	3.6416E-42	1.52251E-94	2.40608E-37	6.65364E-85	1.23188E-31	1.74946E-73	9.5499E-24	1.06555E-57	6.92304E-17	5.82297E-44
15	9.31803E-47	6.6443E-105	1.67814E-46	2.1551E-104	1.61048E-45	1.9851E-102	2.3524E-40	4.23952E-92	3.08521E-34	7.31319E-80	8.81813E-26	6.04978E-63	2.0182E-18	3.28736E-48
16	3.19461E-50	4.8809E-113	5.98358E-50	1.7124E-112	6.67717E-49	2.1326E-110	2.15617E-43	2.2258E-99	7.24388E-37	2.51907E-86	7.63352E-28	2.8306E-68	5.51571E-20	1.52983E-52
17	1.03082E-53	7.5048E-24	2.00801E-53	8.75296E-24	2.60555E-52	1.58004E-23	1.86005E-46	3.44246E-22	1.60077E-39	1.2137E-20	6.21934E-30	1.17661E-18	1.41877E-21	2.8251E-17
18	3.1414E-57	1.5423E-129	6.36425E-57	6.3301E-129	9.60246E-56	1.4412E-126	1.51546E-49	3.5927E-114	3.3409E-42	1.7503E-99	4.78565E-32	3.62952E-79	3.44664E-23	1.94185E-61
19	9.06951E-61	6.7657E-138	1.91094E-60	3.0036E-137	3.35262E-59	9.2462E-135	1.16972E-52	1.1264E-121	6.60566E-45	3.6005E-106	3.48863E-34	1.0144E-84	7.93233E-25	5.40124E-66
20	2.48753E-64	2.5447E-146	5.45093E-64	1.2219E-145	1.11201E-62	5.0859E-143	8.57719E-56	3.0281E-129	1.24077E-47	6.3506E-113	2.41598E-36	2.43093E-90	1.73432E-26	1.28835E-70
21	6.49774E-68	8.2679E-155	1.48083E-67	4.2943E-154	3.51275E-66	2.4166E-151	5.98987E-59	7.0319E-137	2.21963E-50	9.6761E-120	1.59347E-38	5.03262E-96	3.61133E-28	2.65513E-75
22	1.62014E-71	4.63656E-57	3.84004E-71	7.96023E-57	1.05921E-69	6.34476E-56	3.99288E-62	3.29294E-51	3.79022E-53	1.04577E-45	1.0032E-40	2.08663E-38	7.17799E-30	9.4525E-33
23	3.86402E-75	5.7781E-172	9.52493E-75	3.511E-171	3.05498E-73	3.6121E-168	2.54596E-65	2.5104E-152	6.19075E-56	1.4871E-133	6.04129E-43	1.4281E-107	1.36469E-31	7.46888E-85
24	8.83164E-79	1.2577E-180	2.26414E-78	8.2661E-180	8.44409E-77	1.1498E-176	1.55572E-68	3.9054E-160	9.69033E-59	1.518E-140	3.48648E-45	1.9809E-113	2.48645E-33	1.03161E-89
25	1.93783E-82	2.422E-189	5.16675E-82	1.7218E-188	2.24062E-80	3.2383E-185	9.12606E-72	5.3754E-168	1.45615E-61	1.3709E-147	1.93159E-47	2.4311E-119	4.34909E-35	1.26077E-94
26	4.08842E-86	4.1464E-198	1.1337E-85	3.1883E-197	5.71677E-84	8.1077E-194	5.14757E-75	6.5774E-176	2.10396E-64	1.1007E-154	1.02899E-49	2.6524E-125	7.31447E-37	1.3699E-99
27	8.30626E-90	6.56936E-94	2.39545E-89	1.66022E-93	1.40457E-87	5.84294E-92	2.79596E-78	7.22385E-84	2.92739E-67	2.06648E-74	5.27856E-52	8.48649E-62	1.18461E-38	7.25319E-52
28	1.62728E-93	8.6885E-216	4.88072E-93	7.8162E-215	3.32767E-91	3.6336E-211	1.46441E-81	7.0409E-192	3.92762E-70	5.0727E-169	2.61112E-54	2.2576E-137	1.85002E-40	1.1567E-109
29	3.07806E-97	1.0719E-224	9.6015E-97	1.043E-223	7.612E-95	6.5562E-220	7.40556E-85	6.2087E-200	5.0879E-73	2.9351E-176	1.24709E-56	1.7752E-143	2.78957E-42	9.0595E-115
30	5.6282E-101	1.1942E-233	1.8259E-100	1.2568E-232	1.68319E-98	1.0681E-228	3.62017E-88	4.9408E-208	6.37124E-76	1.5303E-183	5.75763E-59	1.2498E-149	4.06606E-44	6.2329E-120

TABLE 14-8 CONFIDENCE LEVEL OF DEFAULT OCCURRENCE AT 50%

50.00%	AAA 50% Confidence	Level	AA 50% Confidence	Level	A 50% Confidence	Level	BBB 50% Confidence	Level	BB 50% Confidence	Level	B 50% Confidence	Level	CCC 50% Confidence	Level
	P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)		P(N=n)	
0	0.996861071		0.996734426		0.996197979		0.991525768		0.978000499		0.916951042		0.734692807	
1	0.003134	9.85286E-06	0.003260238	1.06639E-05	0.003794787	1.44553E-05	0.00843823	7.1811E-05	0.021755732	0.000483899	0.079500806	0.006880241	0.226508014	0.068342804
2	4.92644E-06	1.21604E-11	5.33199E-06	1.42461E-11	7.22768E-06	2.61861E-11	3.59061E-05	6.48288E-10	0.000241979	2.97128E-08	0.00344641	6.2871E-06	0.034916553	0.000741312
3	5.16269E-09	4.44922E-18	5.8135E-09	5.64202E-18	9.1774E-09	1.40642E-17	1.01858E-07	1.73654E-15	1.79429E-06	5.42562E-13	9.96027E-05	1.7259E-09	0.003588293	2.48953E-06
4	4.05771E-12	6.86904E-25	4.75387E-12	9.42871E-25	8.7398E-12	3.18752E-24	2.16712E-10	1.9635E-21	9.97852E-09	4.18579E-18	2.15892E-06	2.00999E-13	0.00027657	3.59229E-09
5	2.55138E-15	5.4303E-32	3.10991E-15	8.06839E-32	6.65845E-15	3.69927E-31	3.68858E-13	1.13702E-27	4.43947E-11	1.65461E-23	3.74362E-08	1.20189E-17	1.70535E-05	2.67897E-12
6	1.33687E-18	2.48447E-39	1.69538E-18	3.99582E-39	4.22731E-18	2.48466E-38	5.23185E-16	3.81096E-34	1.64594E-13	3.78662E-29	5.40961E-10	4.16573E-22	8.76274E-07	1.16248E-15
7	6.00419E-22	7.15846E-47	7.92206E-22	1.24624E-46	2.30042E-21	1.05099E-45	6.3607E-19	8.04457E-41	5.23059E-16	5.45862E-35	6.70029E-12	9.10162E-27	3.8594E-08	3.18753E-19
8	2.35955E-25	1.38178E-54	3.23905E-25	2.60394E-54	1.09537E-24	2.97828E-53	6.76647E-22	1.13769E-47	1.45444E-18	5.27248E-41	7.26154E-14	1.33311E-31	1.48733E-09	5.86882E-23
9	8.24234E-29	1.87332E-62	1.17719E-28	3.8213E-62	4.63616E-28	5.92768E-61	6.39834E-25	1.13008E-54	3.59491E-21	3.57719E-47	6.99538E-16	1.37201E-36	5.09498E-11	7.60146E-27
10	2.59128E-32	1.85146E-70	3.85048E-32	4.08814E-70	1.76604E-31	8.60078E-69	5.44521E-28	8.18347E-62	7.99691E-24	1.76944E-53	6.06509E-18	1.02975E-41	1.5708E-12	7.18601E-31
11	7.40605E-36	1.37482E-78	1.14496E-35	3.28598E-78	6.11574E-35	9.37602E-77	4.21278E-31	4.45244E-69	1.6172E-26	6.5763E-60	4.78046E-20	5.80814E-47	4.40256E-14	5.10845E-35
12	1.9403E-39	7.86343E-87	3.12091E-39	2.03443E-86	1.94138E-38	7.87294E-85	2.98769E-34	1.86596E-76	2.9979E-29	1.88271E-66	3.45393E-22	2.52385E-52	1.1311E-15	2.79915E-39
13	4.69235E-43	3.53749E-95	7.85249E-43	9.90689E-95	5.68863E-42	5.19963E-93	1.95587E-37	6.15072E-84	5.1299E-32	4.23952E-73	2.30354E-24	8.62728E-58	2.68248E-17	1.20702E-43
14	1.05372E-46	1.2742E-103	1.83463E-46	3.8626E-103	1.54782E-45	2.7495E-101	1.18894E-40	1.62331E-91	8.15109E-35	7.64381E-80	1.42657E-26	2.36148E-63	5.90726E-19	4.16904E-48
15	2.20851E-50	3.7314E-112	4.00062E-50	1.2244E-111	3.93072E-49	1.1821E-109	6.74551E-44	3.4833E-99	1.20881E-37	1.12053E-86	8.2457E-29	5.25592E-69	1.21415E-20	1.17118E-52
16	4.33954E-54	9.0039E-121	8.17857E-54	3.1982E-120	9.35824E-53	4.1876E-118	3.58791E-47	6.1588E-107	1.68064E-40	1.35352E-93	4.4682E-31	9.63972E-75	2.33954E-22	2.71177E-57
17	8.02527E-58	1.8113E-129	1.57362E-57	6.9644E-129	2.09694E-56	1.2368E-126	1.79614E-50	9.0787E-115	2.19917E-43	1.3631E-100	2.27882E-33	1.47409E-80	4.24287E-24	5.23603E-62
18	1.40169E-61	3.0698E-138	2.85954E-61	1.2776E-137	4.43768E-60	3.0771E-135	8.4921E-54	1.1274E-122	2.71782E-46	1.1564E-107	1.09765E-35	1.89906E-86	7.26716E-26	8.51863E-67
19	2.31933E-65	4.4235E-147	4.9228E-65	1.9928E-146	8.89701E-64	6.5097E-144	3.80372E-57	1.1904E-130	3.18202E-49	8.3421E-115	5.0088E-38	2.08032E-92	1.1792E-27	1.17861E-71
20	3.64583E-69	5.4651E-156	8.05104E-69	2.6651E-155	1.69456E-67	1.1807E-152	1.61855E-60	1.0777E-138	3.53921E-52	5.1595E-122	2.17135E-40	1.95395E-98	1.81776E-29	1.39833E-76
21	5.4581E-73	5.8326E-165	1.25401E-72	3.0789E-164	3.07382E-71	1.85E-161	6.55925E-64	8.4275E-147	3.74906E-55	2.7566E-129	8.96469E-43	1.5854E-104	2.66867E-31	1.43329E-81
22	7.79979E-77	5.414E-174	1.86445E-76	3.0935E-173	5.32228E-75	2.521E-170	2.53734E-67	5.7321E-155	3.79083E-58	1.281E-136	3.53295E-45	1.1189E-110	3.73982E-33	1.27791E-86
23	1.06615E-80	4.398E-183	2.6515E-80	2.7202E-182	8.81478E-79	3.0065E-179	9.38855E-71	3.412E-163	3.66641E-61	5.2095E-144	1.33179E-47	6.9105E-117	5.01303E-35	9.97225E-92
24	1.3966E-84	3.1445E-192	3.61369E-84	2.1053E-191	1.39908E-82	3.1558E-188	3.32916E-74	1.7876E-171	3.39832E-64	1.8646E-151	4.81116E-50	3.7567E-123	6.43972E-37	6.84974E-97
25	1.75629E-88	1.9891E-201	4.72803E-88	1.4415E-200	2.13179E-86	2.9307E-197	1.13329E-77	8.2856E-180	3.02384E-67	5.9049E-159	1.66853E-52	1.8068E-129	7.94154E-39	4.163E-102
26	2.12367E-92	1.1186E-210	5.94808E-92	8.7748E-210	3.12329E-90	2.4195E-206	3.70951E-81	3.4142E-188	2.58714E-70	1.6624E-166	5.564E-55	7.7257E-136	9.41693E-41	2.2494E-107
27	2.4728E-96	5.6168E-220	7.20581E-96	4.7696E-219	4.40646E-94	1.7837E-215	1.16923E-84	1.2563E-196	2.13153E-73	4.1792E-174	1.78669E-57	2.9499E-142	1.07528E-42	1.0854E-112
28	2.7765E-100	2.529E-229	8.4177E-100	2.3246E-228	5.99479E-98	1.179E-224	3.55377E-88	4.1447E-205	1.69343E-76	9.4202E-182	5.53243E-60	1.0099E-148	1.18398E-44	4.696E-118
29	3.01E-104	1.0249E-238	9.4944E-104	1.0197E-237	7.8744E-102	7.0147E-234	1.04289E-91	1.2308E-213	1.29899E-79	1.9112E-189	1.65403E-62	3.1121E-155	1.2587E-46	1.8289E-123
30	3.1543E-108	3.751E-248	1.0352E-107	4.0399E-247	9.9986E-106	3.7689E-243	2.95845E-95	3.2997E-222	9.63203E-83	3.4976E-197	4.78022E-65	8.6146E-162	1.29354E-48	6.3081E-129

TABLE 14-9 99.9% BASED ON NO DEFAULT

AAA	Poison Dist. λ	RESULT 2.2937%	AA	Poison Dist. λ	RESULT 2.3402%	A	Poison Dist. λ	RESULT 2.5285%	BBB	Poison Dist. λ	RESULT 3.8102%	BB	Poison Dist. λ	RESULT 6.2581%	B	Poison Dist. λ	RESULT 12.9166%	CCC	Poison Dist. λ	RESULT 26.9743%
	n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.97732	0	0	0.97687	0	0	0.97503	0	0	0.96261	0	0	0.93934	0	0	0.87883	0	0	0.76358
1	1	0.02242	1	1	0.02286	1	1	0.02465	1	1	0.03668	1	1	0.05878	1	1	0.11351	1	1	0.20597
2	2	0.00026	2	2	0.00027	2	2	0.00031	2	2	0.00070	2	2	0.00184	2	2	0.00733	2	2	0.02778
3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00001	3	3	0.00004	3	3	0.00032	3	3	0.00250
4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00001	4	4	0.00017
5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00001
6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000

TABLE 14-10 99% BASED ON NO DEFAULT

AAA	Poison Dist. λ	RESULT 1.5490%	AA	Poison Dist. λ	RESULT 1.5805%	A	Poison Dist. λ	RESULT 1.7082%	BBB	Poison Dist. λ	RESULT 2.5798%	BB	Poison Dist. λ	RESULT 4.2551%	B	Poison Dist. λ	RESULT 8.8878%	CCC	Poison Dist. λ	RESULT 19.0777%
	n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.98463	0	0	0.98432	0	0	0.98306	0	0	0.97453	0	0	0.95834	0	0	0.91496	0	0	0.82632
1	1	0.01525	1	1	0.01556	1	1	0.01679	1	1	0.02514	1	1	0.04078	1	1	0.08132	1	1	0.15764
2	2	0.00012	2	2	0.00012	2	2	0.00014	2	2	0.00032	2	2	0.00087	2	2	0.00361	2	2	0.01504
3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00001	3	3	0.00011	3	3	0.00096
4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00005
5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000

TABLE 14-11 90% BASED ON NO DEFAULT

AAA	Poison Dist. λ	RESULT 0.8552%	AA	Poison Dist. λ	RESULT 0.8727%	A	Poison Dist. λ	RESULT 0.9435%	BBB	Poison Dist. λ	RESULT 1.4281%	BB	Poison Dist. λ	RESULT 2.3655%	B	Poison Dist. λ	RESULT 5.0008%	CCC	Poison Dist. λ	RESULT 11.0413%
	n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.99148	0	0	0.99131	0	0	0.99061	0	0	0.98582	0	0	0.97662	0	0	0.95122	0	0	0.89546
1	1	0.00848	1	1	0.00865	1	1	0.00935	1	1	0.01408	1	1	0.02310	1	1	0.04757	1	1	0.09887
2	2	0.00004	2	2	0.00004	2	2	0.00004	2	2	0.00010	2	2	0.00027	2	2	0.00119	2	2	0.00546
3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00002	3	3	0.00020
4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00001
5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000

TABLE 14-12 75% BASED ON NO DEFAULT

AAA	Poison Dist. λ	RESULT 0.6188%	AA	Poison Dist. λ	RESULT 0.6315%	A	Poison Dist. λ	RESULT 0.6828%	BBB	Poison Dist. λ	RESULT 1.0344%	BB	Poison Dist. λ	RESULT 1.7163%	B	Poison Dist. λ	RESULT 3.6460%	CCC	Poison Dist. λ	RESULT 8.1425%
	n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.99383	0	0	0.99370	0	0	0.99319	0	0	0.98971	0	0	0.98298	0	0	0.96420	0	0	0.92180
1	1	0.00615	1	1	0.00628	1	1	0.00678	1	1	0.01024	1	1	0.01687	1	1	0.03515	1	1	0.07506
2	2	0.00002	2	2	0.00002	2	2	0.00002	2	2	0.00005	2	2	0.00014	2	2	0.00064	2	2	0.00306
3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00001	3	3	0.00008
4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000
5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000

TABLE 14-13 50% BASED ON NO DEFAULT

AAA	Poison Dist. λ	RESULT 0.4647%	AA	Poison Dist. λ	RESULT 0.4742%	A	Poison Dist. λ	RESULT 0.5128%	BBB	Poison Dist. λ	RESULT 0.7773%	BB	Poison Dist. λ	RESULT 1.2914%	B	Poison Dist. λ	RESULT 2.7535%	CCC	Poison Dist. λ	RESULT 6.2031%
	n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)		n	P(N=n)
0	0	0.99536	0	0	0.99527	0	0	0.99489	0	0	0.99226	0	0	0.98717	0	0	0.97284	0	0	0.93985
1	1	0.00463	1	1	0.00472	1	1	0.00510	1	1	0.00771	1	1	0.01275	1	1	0.02679	1	1	0.05830
2	2	0.00001	2	2	0.00001	2	2	0.00001	2	2	0.00003	2	2	0.00008	2	2	0.00037	2	2	0.00181
3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00000	3	3	0.00004
4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000	4	4	0.00000
5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000	5	5	0.00000
6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000	6	6	0.00000
7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000	7	7	0.00000
8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000	8	8	0.00000
9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000	9	9	0.00000
10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000	10	10	0.00000
11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000	11	11	0.00000
12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000	12	12	0.00000

TABLE 14-14 1 DEFAULT AT CCC GRADE - DEFAULT OF PORTFOLIO

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	2.24%	0.02570%	99.9%	0.00000%
AA	22	0	0.00%	7.38%	2.29%	0.02675%	99.9%	0.00000%
A	92	0	0.00%	30.87%	2.47%	0.03116%	99.9%	0.00000%
BBB	71	0	0.00%	23.83%	3.67%	0.06985%	99.9%	0.00000%
BB	57	0	0.00%	19.13%	5.88%	0.18377%	99.9%	0.00000%
B	28	0	0.00%	9.40%	11.35%	0.73018%	99.9%	0.00000%
CCC	22	1	4.55%	7.38%	20.60%	2.73191%	99.9%	0.12405%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	1.55%	0.01181%	99.0%	0.00000%
AA	22	0	0.00%	7.38%	1.58%	0.01229%	99.0%	0.00000%
A	92	0	0.00%	30.87%	1.71%	0.01434%	99.0%	0.00000%
BBB	71	0	0.00%	23.83%	2.58%	0.03242%	99.0%	0.00000%
BB	57	0	0.00%	19.13%	4.26%	0.08672%	99.0%	0.00000%
B	28	0	0.00%	9.40%	8.89%	0.36068%	99.0%	0.00000%
CCC	22	1	4.55%	7.38%	19.08%	1.49091%	99.0%	0.06709%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	1.05%	0.00548%	95.0%	0.00000%
AA	22	0	0.00%	7.38%	1.07%	0.00571%	95.0%	0.00000%
A	92	0	0.00%	30.87%	1.16%	0.00667%	95.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.76%	0.01516%	95.0%	0.00000%
BB	57	0	0.00%	19.13%	2.91%	0.08672%	95.0%	0.00000%
B	28	0	0.00%	9.40%	6.12%	0.17608%	95.0%	0.00000%
CCC	22	1	4.55%	7.38%	13.40%	0.78190%	95.0%	0.03376%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.85%	0.00725%	90.0%	0.00000%
AA	22	0	0.00%	7.38%	0.87%	0.00755%	90.0%	0.00000%
A	92	0	0.00%	30.87%	0.93%	0.00882%	90.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.41%	0.02010%	90.0%	0.00000%
BB	57	0	0.00%	19.13%	2.31%	0.05464%	90.0%	0.00000%
B	28	0	0.00%	9.40%	4.76%	0.23774%	90.0%	0.00000%
CCC	22	1	4.55%	7.38%	9.89%	1.08846%	90.0%	0.04453%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.62%	0.00381%	75.0%	0.00000%
AA	22	0	0.00%	7.38%	0.63%	0.00396%	75.0%	0.00000%
A	92	0	0.00%	30.87%	0.68%	0.00463%	75.0%	0.00000%
BBB	71	0	0.00%	23.83%	1.02%	0.01059%	75.0%	0.00000%
BB	57	0	0.00%	19.13%	1.69%	0.02895%	75.0%	0.00000%
B	28	0	0.00%	9.40%	3.52%	0.12813%	75.0%	0.00000%
CCC	22	1	4.55%	7.38%	7.51%	0.61018%	75.0%	0.02080%
TOTAL	298	1	4.55%					

Grades	No of Shipping Co.	No of Defaults	Avr. Default Rate	Bayesian Estimates	Realized PDs Estimates	Convolution	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.00%	2.01%	0.46%	0.00215%	50.0%	0.00000%
AA	22	0	0.00%	7.38%	0.47%	0.00224%	50.0%	0.00000%
A	92	0	0.00%	30.87%	0.51%	0.00262%	50.0%	0.00000%
BBB	71	0	0.00%	23.83%	0.77%	0.00600%	50.0%	0.00000%
BB	57	0	0.00%	19.13%	1.27%	0.01646%	50.0%	0.00000%
B	28	0	0.00%	9.40%	2.68%	0.07374%	50.0%	0.00000%
CCC	22	1	4.55%	7.38%	5.83%	0.36130%	50.0%	0.00821%
TOTAL	298	1	4.55%					

TABLE 14-15 7 DEFAULT AT EACH GRADE – 7 DEFAULT PORTFOLIOS

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	1.34%	0.00891%	99.9%	0.66213%
AA	22	1	0.34%	7.38%	1.40%	0.00961%	99.9%	0.68764%
A	92	1	0.37%	30.87%	1.62%	0.01287%	99.9%	0.79490%
BBB	71	1	0.56%	23.83%	3.49%	0.05873%	99.9%	1.68201%
BB	57	1	0.93%	19.13%	8.52%	0.33290%	99.9%	3.90225%
B	28	1	2.00%	9.40%	27.68%	2.85426%	99.9%	10.30094%
CCC	22	1	4.55%	7.38%	68.01%	21.31525%	99.9%	31.30813%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.63%	0.00198%	99.0%	0.31056%
AA	22	1	0.34%	7.38%	0.66%	0.00214%	99.0%	0.32286%
A	92	1	0.37%	30.87%	0.76%	0.00289%	99.0%	0.37480%
BBB	71	1	0.56%	23.83%	1.68%	0.01388%	99.0%	0.81781%
BB	57	1	0.93%	19.13%	4.27%	0.08742%	99.0%	2.02559%
B	28	1	2.00%	9.40%	15.45%	1.01658%	99.0%	6.51500%
CCC	22	1	4.55%	7.38%	46.93%	13.13303%	99.0%	27.70425%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.30%	0.00088%	95.0%	0.28186%
AA	22	1	0.34%	7.38%	0.31%	0.00096%	95.0%	0.29322%
A	92	1	0.37%	30.87%	0.36%	0.00130%	95.0%	0.34129%
BBB	71	1	0.56%	23.83%	0.81%	0.00289%	95.0%	0.34118%
BB	57	1	0.93%	19.13%	2.10%	0.04336%	95.0%	1.95746%
B	28	1	2.00%	9.40%	8.20%	0.61842%	95.0%	7.16479%
CCC	22	1	4.55%	7.38%	29.21%	6.24844%	95.0%	20.32142%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.20%	0.00039%	90.0%	0.17776%
AA	22	1	0.34%	7.38%	0.21%	0.00042%	90.0%	0.18496%
A	92	1	0.37%	30.87%	0.24%	0.00057%	90.0%	0.21551%
BBB	71	1	0.56%	23.83%	0.54%	0.00289%	90.0%	0.48272%
BB	57	1	0.93%	19.13%	1.42%	0.02002%	90.0%	1.26424%
B	28	1	2.00%	9.40%	5.73%	0.30939%	90.0%	4.86282%
CCC	22	1	4.55%	7.38%	21.84%	3.79075%	90.0%	15.62326%
TOTAL	298	7	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.10%	0.00011%	75.0%	0.07837%
AA	22	1	0.34%	7.38%	0.11%	0.00012%	75.0%	0.08157%
A	92	1	0.37%	30.87%	0.13%	0.00016%	75.0%	0.09515%
BBB	71	1	0.56%	23.83%	0.29%	0.00082%	75.0%	0.21495%
BB	57	1	0.93%	19.13%	0.77%	0.00588%	75.0%	0.57305%
B	28	1	2.00%	9.40%	3.22%	0.10007%	75.0%	2.33437%
CCC	22	1	4.55%	7.38%	13.36%	1.55605%	75.0%	8.73220%
TOTAL	298	7						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	1	0.34%	2.01%	0.06%	0.00004%	50.0%	0.02965%
AA	22	1	0.34%	7.38%	0.06%	0.00004%	50.0%	0.03087%
A	92	1	0.37%	30.87%	0.07%	0.00005%	50.0%	0.03604%
BBB	71	1	0.56%	23.83%	0.16%	0.00027%	50.0%	0.08186%
BB	57	1	0.93%	19.13%	0.44%	0.00196%	50.0%	0.22073%
B	28	1	2.00%	9.40%	1.90%	0.03545%	50.0%	0.93240%
CCC	22	1	4.55%	7.38%	8.39%	0.64643%	50.0%	3.85157%
TOTAL	298	7						

TABLE 14-16 15 DEFAULT AT EACH GRADE – 5% DEFAULT PORTFOLIO

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	4.85%	0.12361%	99.9%	2.54693%
AA	22	1	0.34%	7.38%	5.02%	0.13256%	99.9%	2.63992%
A	92	5	0.37%	30.87%	5.71%	0.17308%	99.9%	15.14013%
BBB	71	4	0.56%	23.83%	10.84%	0.66121%	99.9%	24.38345%
BB	57	3	0.93%	19.13%	20.31%	2.64402%	99.9%	39.01819%
B	28	1	2.00%	9.40%	33.57%	9.75311%	99.9%	29.02120%
CCC	22	1	4.55%	7.38%	36.75%	29.47774%	99.9%	80.13298%
TOTAL	298	15						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	2.49%	0.03030%	99.0%	1.20340%
AA	22	1	0.34%	7.38%	2.59%	0.03263%	99.0%	1.24810%
A	92	5	0.37%	30.87%	2.99%	0.04330%	99.0%	7.17472%
BBB	71	4	0.56%	23.83%	6.29%	0.18538%	99.0%	11.67743%
BB	57	3	0.93%	19.13%	14.67%	0.92410%	99.0%	18.71283%
B	28	1	2.00%	9.40%	42.24%	5.62373%	99.0%	13.17928%
CCC	22	1	4.55%	7.38%	83.86%	26.47760%	99.0%	31.25637%
TOTAL	298	15						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.21%	0.01437%	95.0%	1.13197%
AA	22	1	0.34%	7.38%	1.25%	0.01551%	95.0%	1.17581%
A	92	5	0.37%	30.87%	1.45%	0.02080%	95.0%	6.80142%
BBB	71	4	0.56%	23.83%	3.15%	0.04494%	95.0%	5.42877%
BB	57	3	0.93%	19.13%	7.74%	0.55389%	95.0%	20.39057%
B	28	1	2.00%	9.40%	25.63%	5.00792%	95.0%	18.56119%
CCC	22	1	4.55%	7.38%	65.22%	20.29723%	95.0%	29.56420%
TOTAL	298	15	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.81%	0.00652%	90.0%	0.72353%
AA	22	1	0.34%	7.38%	0.84%	0.00704%	90.0%	0.75198%
A	92	5	0.37%	30.87%	0.98%	0.00948%	90.0%	4.35998%
BBB	71	4	0.56%	23.83%	2.14%	0.04494%	90.0%	7.54953%
BB	57	3	0.93%	19.13%	5.39%	0.27518%	90.0%	13.78186%
B	28	1	2.00%	9.40%	18.93%	2.94023%	90.0%	13.97974%
CCC	22	1	4.55%	7.38%	54.07%	16.00026%	90.0%	26.63197%
TOTAL	298	15	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.43%	0.00187%	75.0%	0.32392%
AA	22	1	0.34%	7.38%	0.45%	0.00203%	75.0%	0.33688%
A	92	5	0.37%	30.87%	0.53%	0.00274%	75.0%	1.95850%
BBB	71	4	0.56%	23.83%	1.17%	0.01344%	75.0%	3.45747%
BB	57	3	0.93%	19.13%	3.01%	0.08810%	75.0%	6.57772%
B	28	1	2.00%	9.40%	11.38%	1.15306%	75.0%	7.59603%
CCC	22	1	4.55%	7.38%	37.86%	9.50995%	75.0%	18.83678%
TOTAL	298	15						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.25%	0.00061%	50.0%	0.12374%
AA	22	1	0.34%	7.38%	0.26%	0.00066%	50.0%	0.12875%
A	92	5	0.37%	30.87%	0.30%	0.00090%	50.0%	0.74976%
BBB	71	4	0.56%	23.83%	0.67%	0.00452%	50.0%	1.33969%
BB	57	3	0.93%	19.13%	1.77%	0.03094%	50.0%	2.61496%
B	28	1	2.00%	9.40%	7.05%	0.46233%	50.0%	3.28004%
CCC	22	1	4.55%	7.38%	26.13%	5.17454%	50.0%	9.90288%
TOTAL	298	15						

TABLE 14-17 30 DEFAULT AT EACH GRADE – 10% DEFAULT PORTFOLIO

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	15.85%	1.06502%	99.9%	6.71470%
AA	22	2	0.34%	7.38%	16.35%	1.12829%	99.9%	13.78486%
A	92	9	0.37%	30.87%	18.44%	1.40241%	99.9%	68.38362%
BBB	71	7	0.56%	23.83%	33.18%	3.85355%	99.9%	81.21570%
BB	57	6	0.93%	19.13%	58.60%	8.89112%	99.9%	90.94645%
B	28	3	2.00%	9.40%	92.31%	14.36460%	99.9%	46.63811%
CCC	22	3	4.55%	7.38%	99.93%	30.43566%	99.9%	91.28225%
TOTAL	298	30						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	8.30%	0.31672%	99.0%	3.77628%
AA	22	2	0.34%	7.38%	8.59%	0.33827%	99.0%	7.79350%
A	92	9	0.37%	30.87%	9.80%	0.43446%	99.0%	39.49576%
BBB	71	7	0.56%	23.83%	19.01%	1.48200%	99.0%	54.01410%
BB	57	6	0.93%	19.13%	38.24%	4.82777%	99.0%	75.00095%
B	28	3	2.00%	9.40%	77.53%	12.27650%	99.0%	47.02618%
CCC	22	3	4.55%	7.38%	98.83%	30.20844%	99.0%	90.78480%
TOTAL	298	30						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	4.21%	0.17012%	95.0%	3.83576%
AA	22	2	0.34%	7.38%	4.37%	0.18267%	95.0%	7.94316%
A	92	9	0.37%	30.87%	5.02%	0.23976%	95.0%	40.81440%
BBB	71	7	0.56%	23.83%	10.27%	0.48436%	95.0%	31.35678%
BB	57	6	0.93%	19.13%	22.73%	4.06663%	95.0%	101.98303%
B	28	3	2.00%	9.40%	57.37%	17.30142%	95.0%	85.95446%
CCC	22	3	4.55%	7.38%	93.30%	28.96872%	95.0%	88.49103%
TOTAL	298	30	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	2.89%	0.08092%	90.0%	2.52319%
AA	22	2	0.34%	7.38%	3.00%	0.08707%	90.0%	5.23177%
A	92	9	0.37%	30.87%	3.45%	0.11525%	90.0%	27.02369%
BBB	71	7	0.56%	23.83%	7.22%	0.48436%	90.0%	42.26389%
BB	57	6	0.93%	19.13%	16.63%	2.32676%	90.0%	75.54982%
B	28	3	2.00%	9.40%	46.35%	12.89852%	90.0%	75.13868%
CCC	22	3	4.55%	7.38%	87.11%	27.38613%	90.0%	84.88743%
TOTAL	298	30	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.58%	0.02460%	75.0%	1.16700%
AA	22	2	0.34%	7.38%	1.64%	0.02653%	75.0%	2.42329%
A	92	9	0.37%	30.87%	1.90%	0.03547%	75.0%	12.59193%
BBB	71	7	0.56%	23.83%	4.08%	0.15980%	75.0%	20.55905%
BB	57	6	0.93%	19.13%	9.88%	0.88210%	75.0%	40.17962%
B	28	3	2.00%	9.40%	31.29%	7.00257%	75.0%	50.35589%
CCC	22	3	4.55%	7.38%	73.06%	23.08064%	75.0%	71.07703%
TOTAL	298	30						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.92%	0.00835%	50.0%	0.45481%
AA	22	2	0.34%	7.38%	0.95%	0.00902%	50.0%	0.94527%
A	92	9	0.37%	30.87%	1.11%	0.01214%	50.0%	4.92994%
BBB	71	7	0.56%	23.83%	2.42%	0.05715%	50.0%	8.26604%
BB	57	6	0.93%	19.13%	6.06%	0.34517%	50.0%	17.09184%
B	28	3	2.00%	9.40%	20.98%	3.53218%	50.0%	25.25340%
CCC	22	3	4.55%	7.38%	58.11%	17.59006%	50.0%	45.40927%
TOTAL	298	30						

TABLE 14-18 5%-AAA, AA, A, 5%-BBB, BB, B, 5%-CCC DEFAULT OF PORTFOLIO, 17 DEFAULT PORTFOLIO

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	5.93%	0.18693%	99.9%	3.15053%
AA	22	1	0.34%	7.38%	6.13%	0.20014%	99.9%	3.26354%
A	92	4	0.37%	30.87%	6.95%	0.25962%	99.9%	3.73400%
BBB	71	4	0.56%	23.83%	12.82%	0.94789%	99.9%	7.38885%
BB	57	4	0.93%	19.13%	22.84%	3.48587%	99.9%	15.24662%
B	28	2	2.00%	9.40%	34.69%	10.93275%	99.9%	31.48008%
CCC	22	2	4.55%	7.38%	36.77%	29.88963%	99.9%	81.19656%
TOTAL	298	17						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	3.11%	0.04700%	99.0%	1.49396%
AA	22	1	0.34%	7.38%	3.23%	0.05055%	99.0%	1.54847%
A	92	4	0.37%	30.87%	3.72%	0.06680%	99.0%	1.77564%
BBB	71	4	0.56%	23.83%	7.75%	0.27756%	99.0%	3.54525%
BB	57	4	0.93%	19.13%	17.71%	1.30412%	99.0%	7.28973%
B	28	2	2.00%	9.40%	48.40%	6.86324%	99.0%	14.03794%
CCC	22	2	4.55%	7.38%	88.39%	27.73058%	99.0%	31.05946%
TOTAL	298	17						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.52%	0.02265%	95.0%	1.41889%
AA	22	1	0.34%	7.38%	1.58%	0.02443%	95.0%	1.47325%
A	92	4	0.37%	30.87%	1.82%	0.03268%	95.0%	1.70160%
BBB	71	4	0.56%	23.83%	3.92%	0.06997%	95.0%	1.69617%
BB	57	4	0.93%	19.13%	9.51%	0.81986%	95.0%	8.19363%
B	28	2	2.00%	9.40%	30.27%	6.63178%	95.0%	20.81007%
CCC	22	2	4.55%	7.38%	71.60%	22.57827%	95.0%	29.95882%
TOTAL	298	17	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	1.02%	0.01033%	90.0%	0.91018%
AA	22	1	0.34%	7.38%	1.06%	0.01116%	90.0%	0.94568%
A	92	4	0.37%	30.87%	1.23%	0.01499%	90.0%	1.09522%
BBB	71	4	0.56%	23.83%	2.68%	0.06997%	90.0%	2.34878%
BB	57	4	0.93%	19.13%	6.66%	0.41510%	90.0%	5.60543%
B	28	2	2.00%	9.40%	22.65%	4.04294%	90.0%	16.06231%
CCC	22	2	4.55%	7.38%	60.63%	18.56760%	90.0%	27.56114%
TOTAL	298	17	9.09%					

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.55%	0.00299%	75.0%	0.40916%
AA	22	1	0.34%	7.38%	0.57%	0.00324%	75.0%	0.42544%
A	92	4	0.37%	30.87%	0.66%	0.00437%	75.0%	0.49423%
BBB	71	4	0.56%	23.83%	1.47%	0.02119%	75.0%	1.08383%
BB	57	4	0.93%	19.13%	3.76%	0.13588%	75.0%	2.71270%
B	28	2	2.00%	9.40%	13.85%	1.66262%	75.0%	9.00298%
CCC	22	2	4.55%	7.38%	43.73%	11.84272%	75.0%	20.31209%
TOTAL	298	17						

Grades	No of Shipping Co.	No of Defaults	Avg. Default Rate	Bayesian Estimates	Realized PDs Estimates	Complexity	Confidence Level	Implied Model to Actual Portfolio
AAA	6	0	0.34%	2.01%	0.31%	0.00099%	50.0%	0.15670%
AA	22	1	0.34%	7.38%	0.33%	0.00107%	50.0%	0.16301%
A	92	4	0.37%	30.87%	0.38%	0.00145%	50.0%	0.18974%
BBB	71	4	0.56%	23.83%	0.85%	0.00718%	50.0%	0.42190%
BB	57	4	0.93%	19.13%	2.22%	0.04839%	50.0%	1.08765%
B	28	2	2.00%	9.40%	8.67%	0.68802%	50.0%	3.96779%
CCC	22	2	4.55%	7.38%	30.83%	6.83428%	50.0%	11.08371%
TOTAL	298	17						

TABLE 14-19 EXPECTED LOSS BASED ON CONFIDENCE LEVELS DURING

The value of the ship is $10M with 20% recovery rate.

Grade	Expected Premium: PD*LGD*EDF %99.9	Expected Premium: PD*LGD*EDF %99	Expected Premium: PD*LGD*EDF %95	Expected Premium: PD*LGD*EDF %90	Expected Premium: PD*LGD*EDF %75	Expected Premium: PD*LGD*EDF %50
AAA	79,816.35	51,690.31	49,394.68	41,066.25	33,115.14	29,217.84
AA	81,857.13	52,674.32	50,302.94	41,642.74	33,371.21	29,315.21
A	90,437.30	56,829.86	54,148.98	44,086.35	34,457.96	29,728.74
BBB	161,406.70	92,270.05	74,140.19	65,463.52	44,041.99	33,394.56
BB	339,025.74	188,892.91	183,442.12	127,984.77	72,689.47	44,504.06
B	850,921.19	548,045.50	600,028.66	415,871.35	213,594.99	101,437.36
CCC	2,531,496.18	2,243,185.56	1,652,559.51	1,276,706.76	725,421.71	334,971.13

TABLE 14-20 EXPECTED LOSS BASED ON CONFIDENCE LEVELS DURING

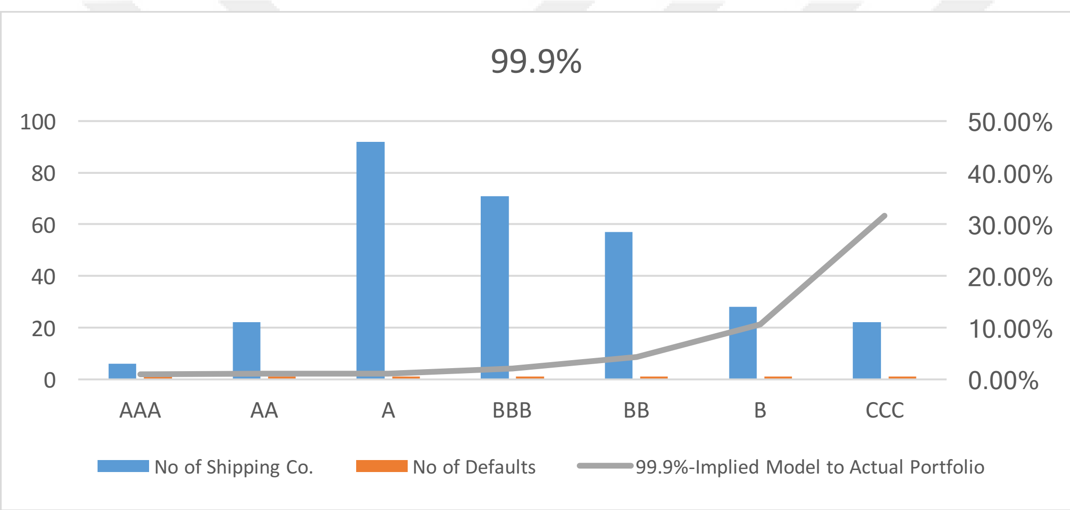
The value of the ship is $20M with 15% recovery rate.

Grade	Expected Premium: PD*LGD*EDF %99.9	Expected Premium: PD*LGD*EDF %99	Expected Premium: PD*LGD*EDF %95	Expected Premium: PD*LGD*EDF %90	Expected Premium: PD*LGD*EDF %75	Expected Premium: PD*LGD*EDF %50
AAA	169,609.74	109,841.90	104,963.69	87,265.79	70,369.67	62,087.91
AA	173,946.41	111,932.92	106,893.76	88,490.83	70,913.83	62,294.82
A	192,179.25	120,763.46	115,066.58	93,683.50	73,223.17	63,173.57
BBB	342,989.24	196,073.86	115,047.90	139,109.97	93,589.22	70,963.44
BB	720,429.69	401,397.44	389,814.51	271,967.64	154,465.13	94,571.13
B	1,808,207.54	1,164,596.68	1,275,060.90	883,726.63	453,889.36	215,554.39
CCC	5,379,429.38	4,766,769.32	3,511,688.97	2,713,001.87	1,541,521.13	711,813.66

TABLE 14-21 EXPECTED LOSS BASED ON CONFIDENCE LEVELS DURING

The value of the ship is $30M with 10% recovery rate.

Grade	Expected Premium: PD*LGD*EDF %99.9	Expected Premium: PD*LGD*EDF %99	Expected Premium: PD*LGD*EDF %95	Expected Premium: PD*LGD*EDF %90	Expected Premium: PD*LGD*EDF %75	Expected Premium: PD*LGD*EDF %50
AAA	269,380.18	174,454.79	166,707.04	138,598.61	111,763.59	98,610.22
AA	276,267.83	177,775.82	169,772.44	140,544.25	112,627.85	98,938.83
A	305,225.87	191,800.79	182,752.80	148,791.43	116,295.62	100,334.49
BBB	544,747.61	311,411.42	182,723.13	220,939.37	148,641.70	112,706.63
BB	1,144,211.86	637,513.59	619,117.16	431,948.61	245,326.97	150,201.20
B	2,871,859.03	1,849,653.55	2,025,096.72	1,403,565.82	720,883.10	342,351.08
CCC	8,543,799.61	7,570,751.28	5,577,388.36	4,308,885.32	2,448,298.27	1,130,527.58



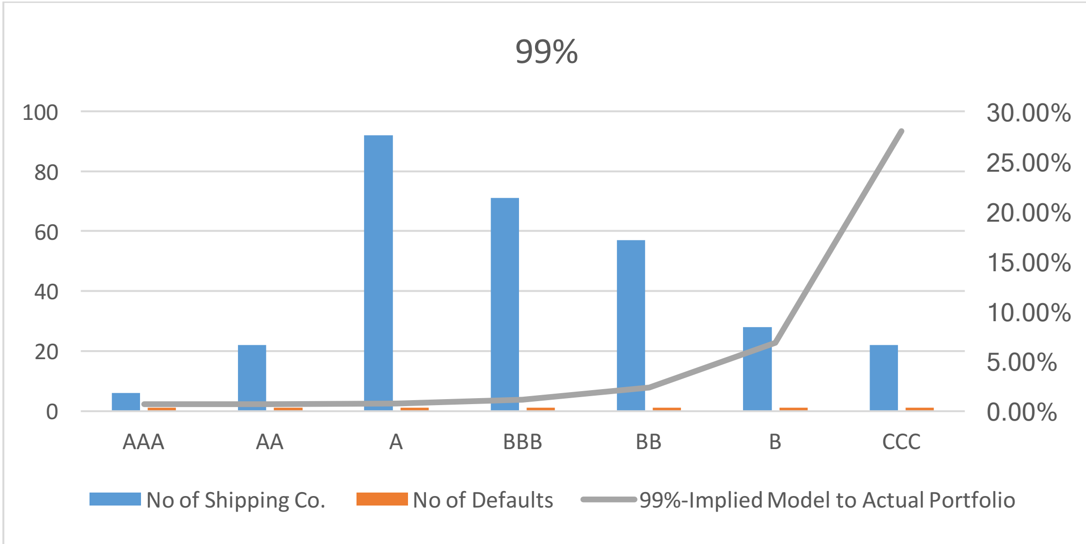
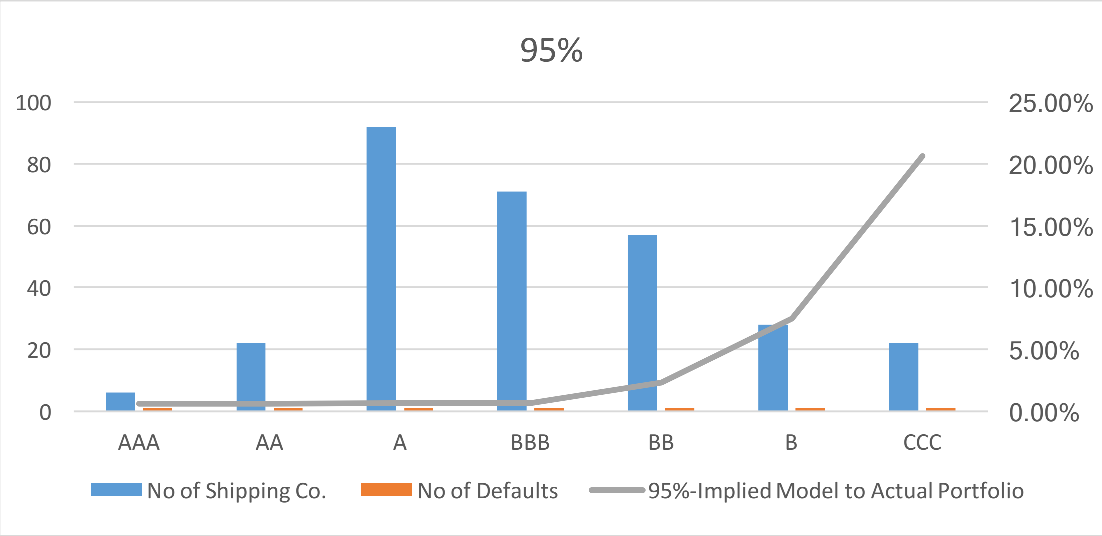


Figure 14-4 99.9% & 99% Implied Model to Actual Portfolio



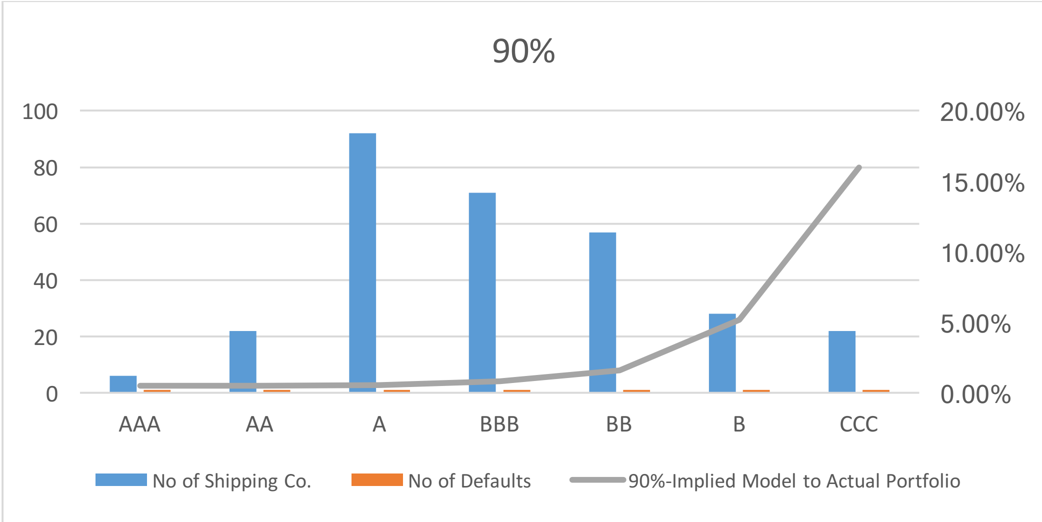


Figure 14-5 95% & 90% Implied Model to Actual Portfolio

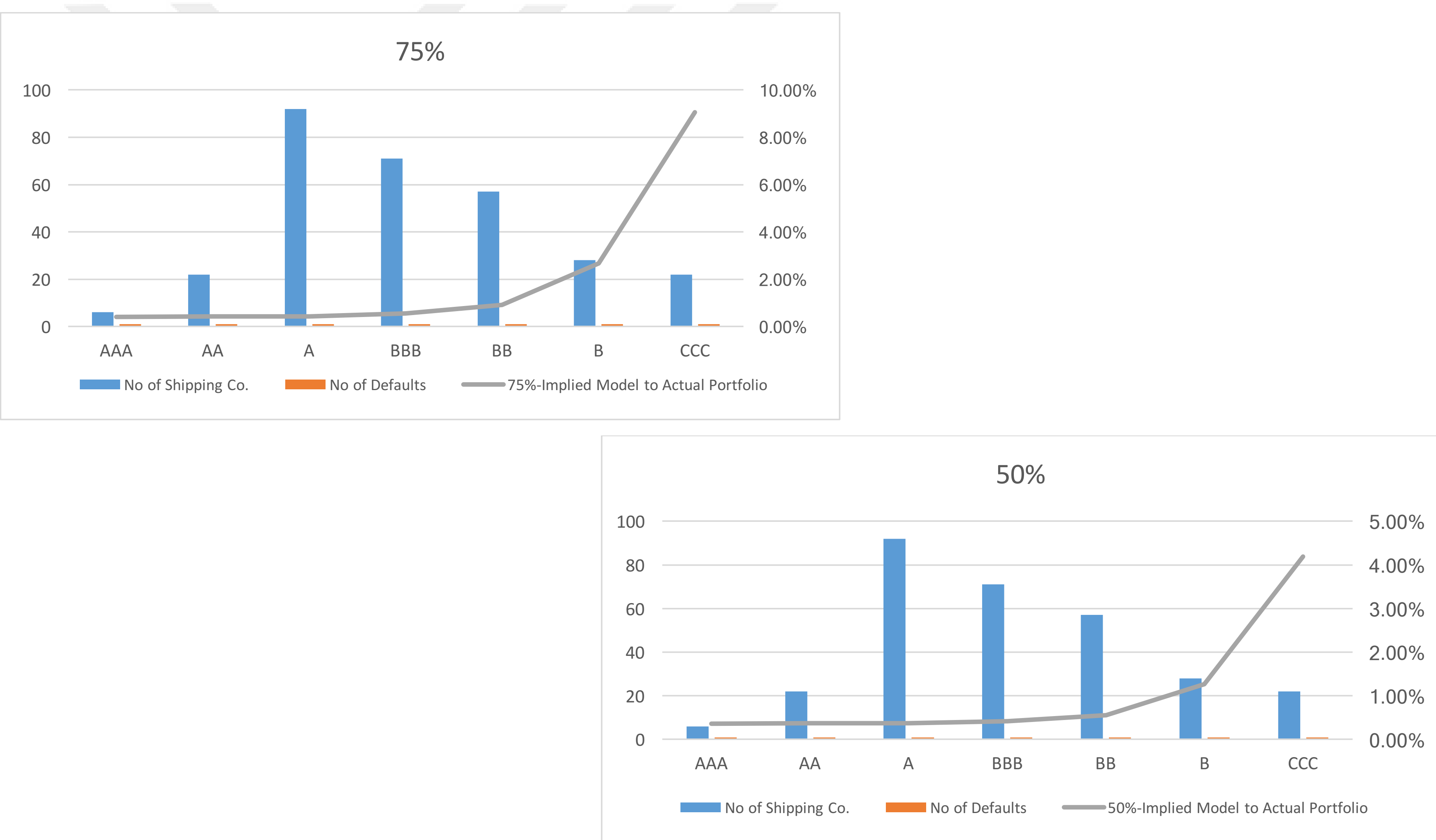


Figure 14-6 75% & 50% Implied Model to Actual Portfolio

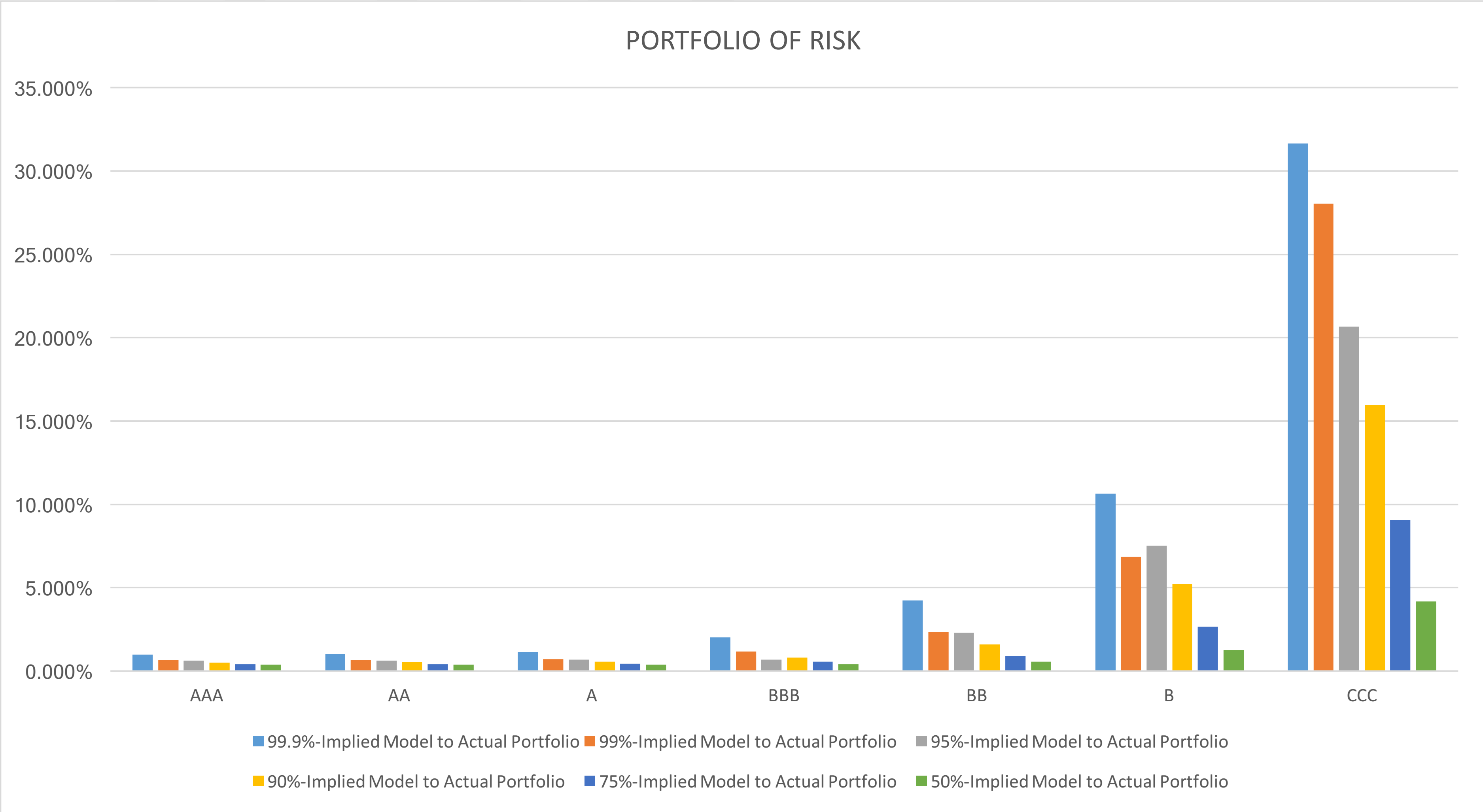


Figure 14-7 Portfolio Risk by Confidence Levels

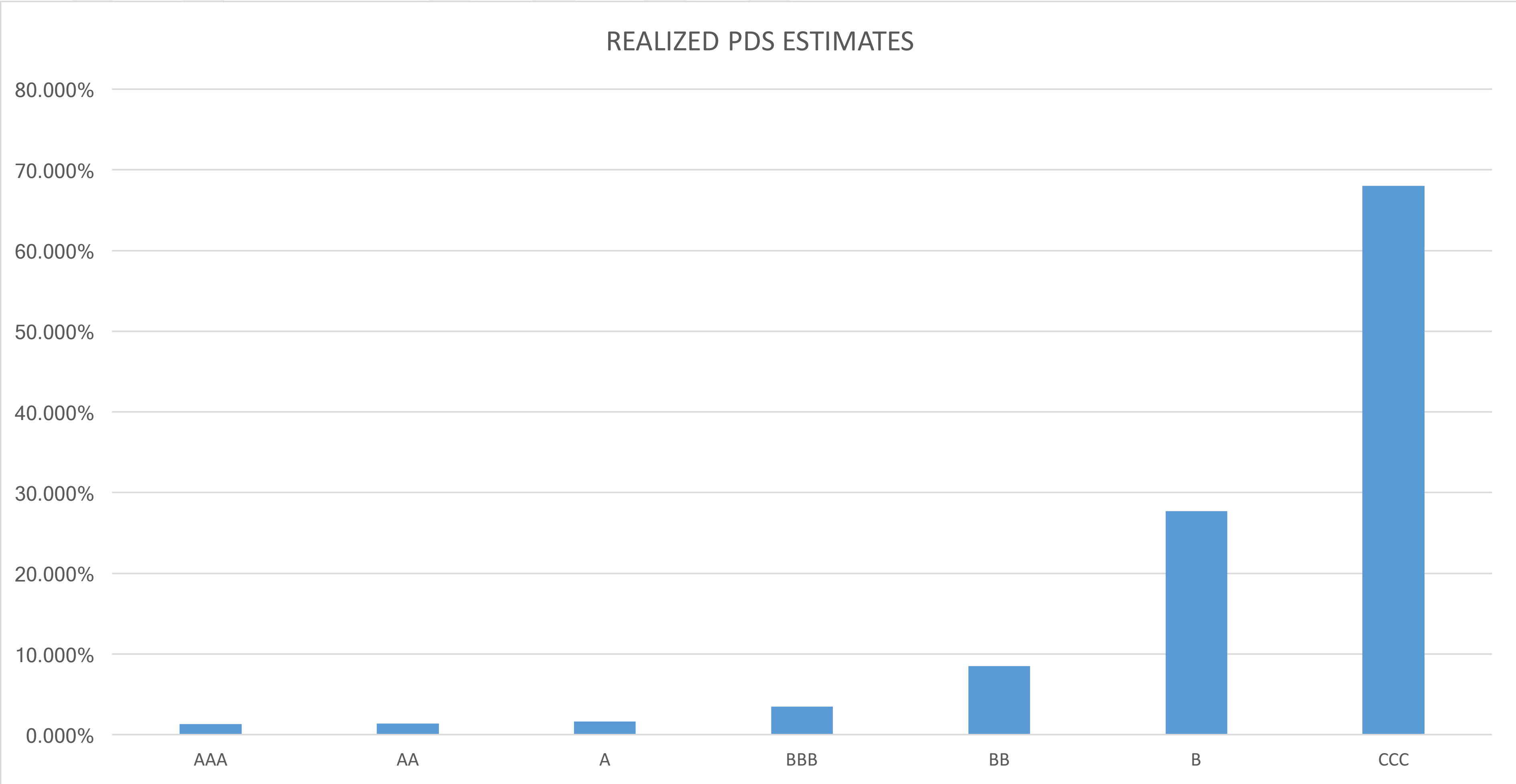


Figure 14-8 Realized Probability of Default Estimates

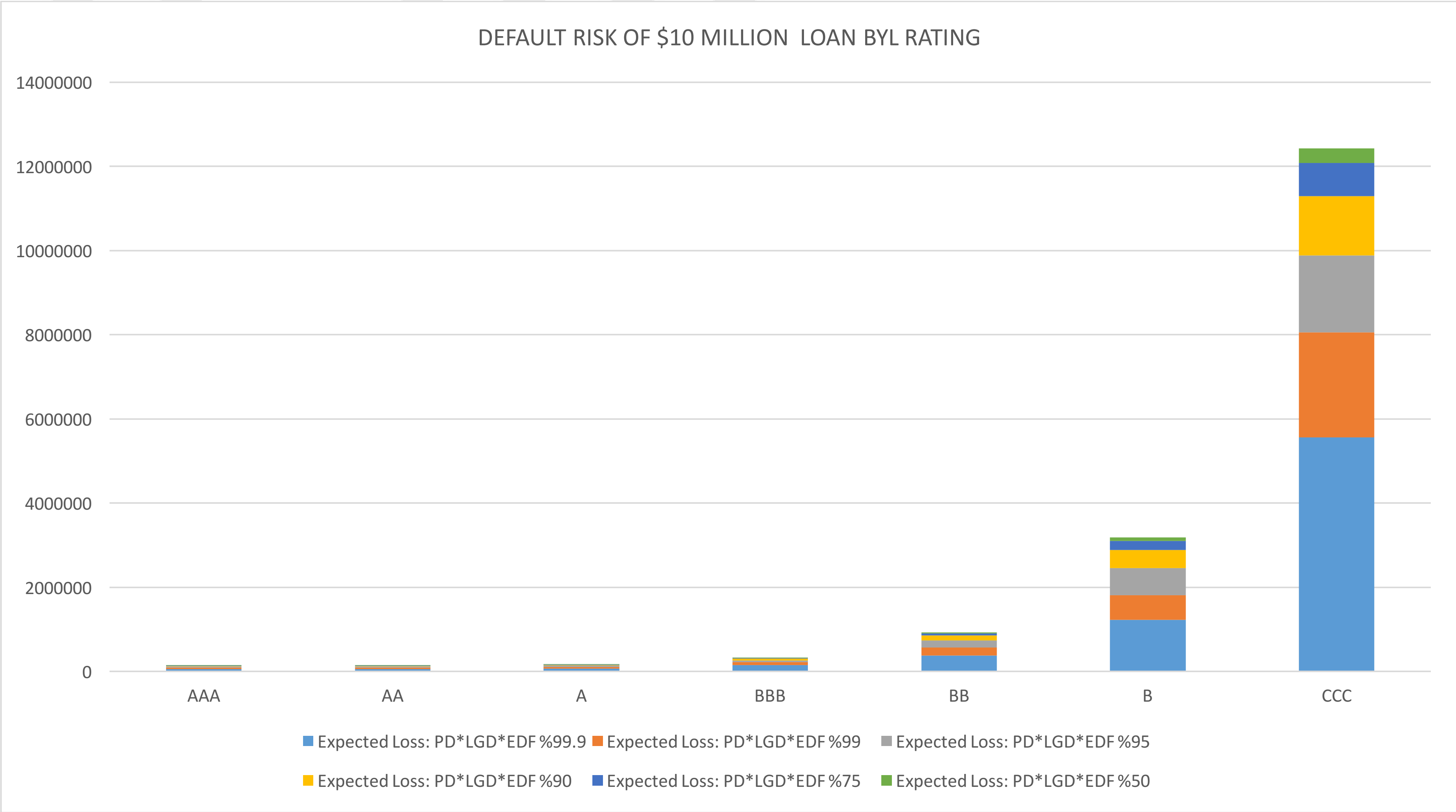


Figure 14-9 Default Risk Of 10 Million Loan by Rating

THE DATA SAMPLE CONSISTS OF 298 SHIPPING COMPANIES.

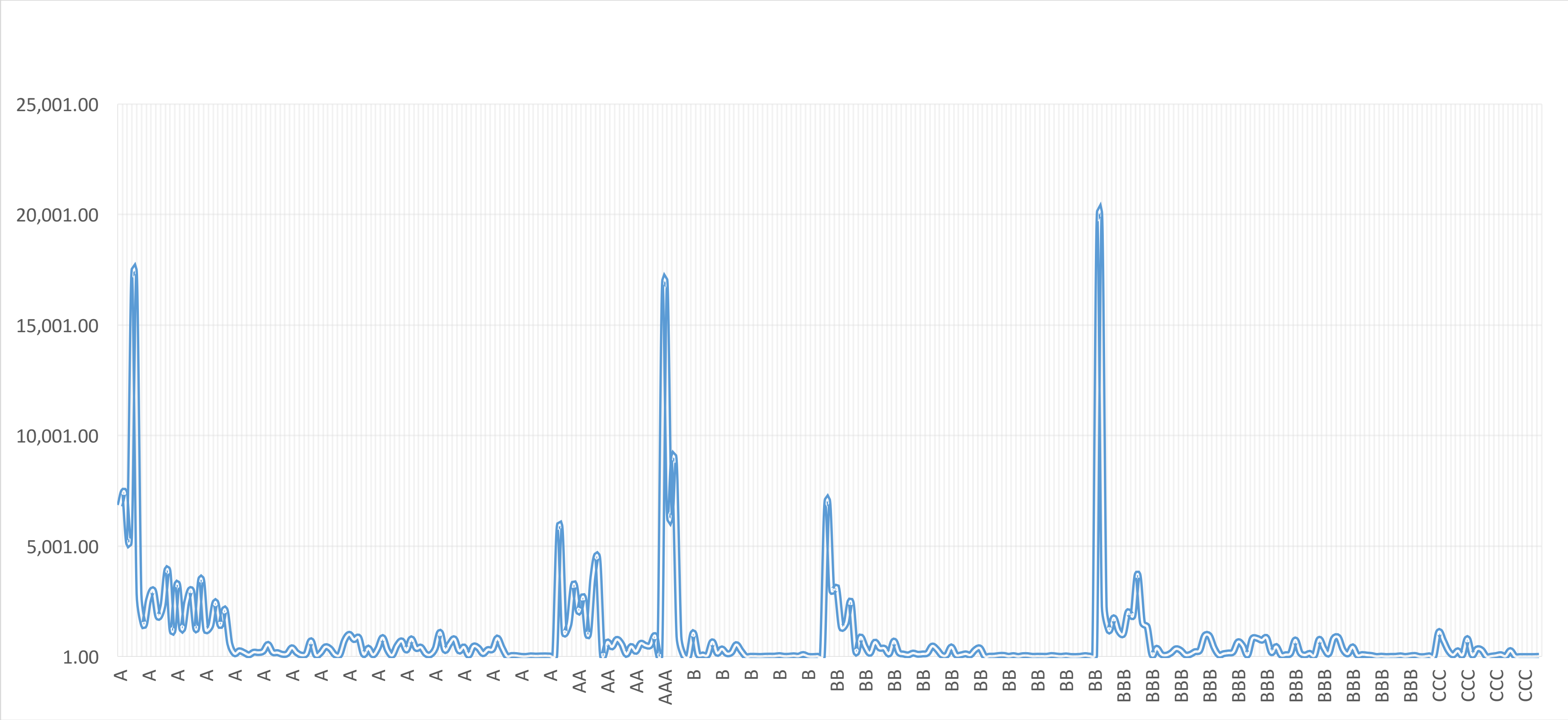
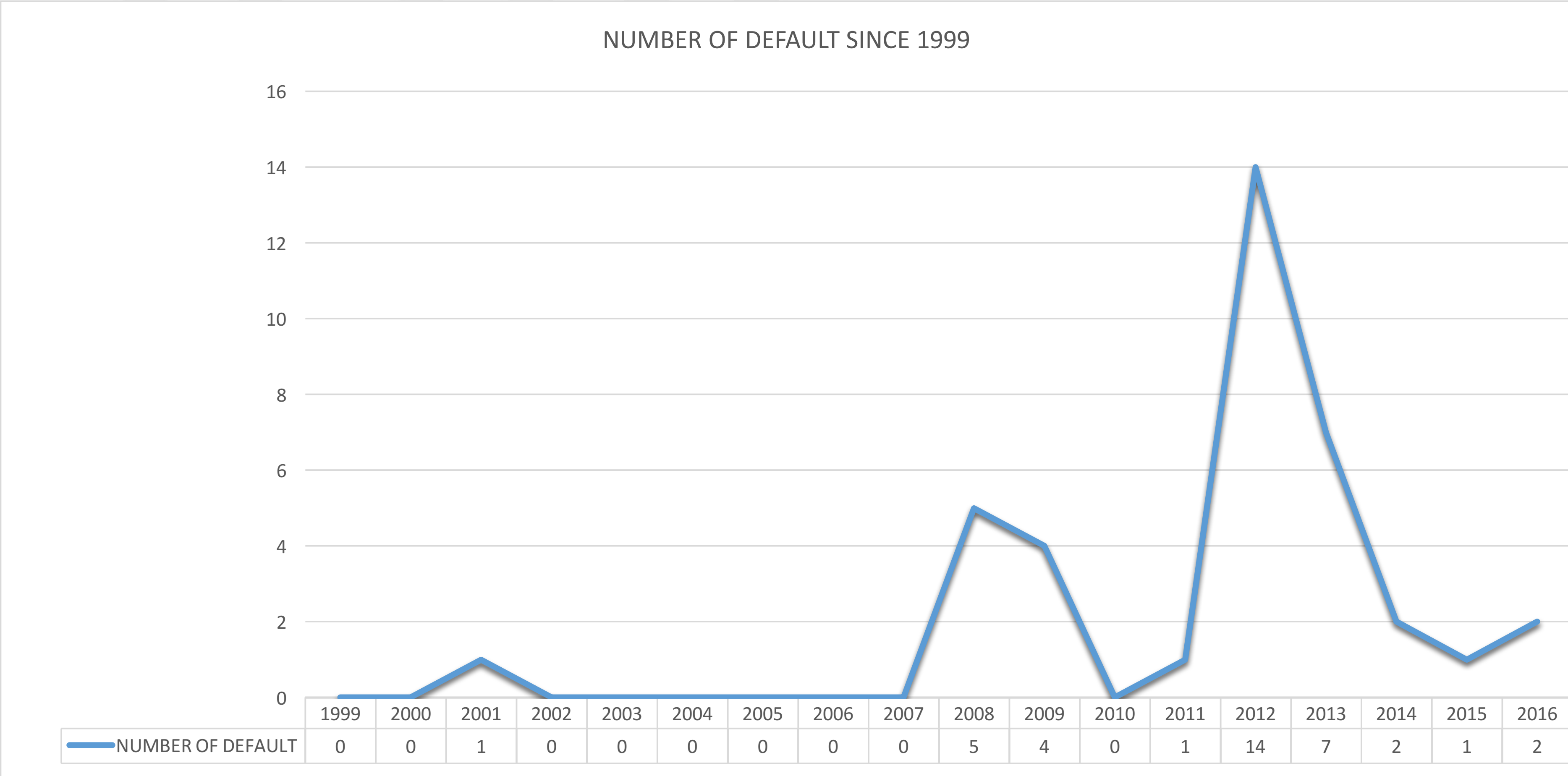


Figure 14-10 Shipping Finance Rating According to Market Cap.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NUMBER OF DEFAULT	0	0	1	0	0	0	0	0	0	5	4	0	1	14	7	2	1	2

Figure 14-11 Number of Default