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WORLD MARITIME UNIVERSITY



**THE APPLICATION OF PORTFOLIO THEORY IN SHIPPING ASSETS
AND BUSINESS FOR SHIPPING COMPANY**

By

ZHENG YING

China

A research paper submitted to the World Maritime University in partial
Fulfillment of the requirement for the award of the degree of

MASTER OF SCIENCE

ITL2011

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

ZHENG YING

2011-06-16

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Abstracts

Title of Research paper: **THE APPLICATION OF PORTFOLIO THEORY IN SHIPPING ASSETS AND BUSINESS FOR SHIPPING COMPANY**

Degree: **M.Sc.**

Since the year of 2003, the shipping market started to grow rapidly, this exciting period ended up with the sudden coming of financial crisis in 2008. Consequently, many shipping companies experienced the tragic loss some small ones even broke down. We do not know when the market will actually recover; although we did so many studies in forecasting the market cycle. Under this certain circumstances, many companies choose to adjust their strategies. Those companies no longer concentrate on excessive profits but figure out the connection of benefit and risk, and try to manage risk when they make the decisions. In this paper, we are going to apply the portfolio theory, which brought up in 1952 by Markowitz in the shipping market. This method has been widely used in securities, banking and many other financial areas, and all gets a big success. Here for shipping companies, I am going to use the portfolio theory model analyze the different combination of shipping assets and business based on alteration of variance. Considering different markets with different life cycle, shipping companies can use the portfolio method analyze the correlation between them, and make optimal arrangement of their fleet and company business. It is kind of cautious way in the risk management, for what I am thinking is under the bad time, keeping stable market share is the most important for companies especially those medium and small-scale companies.

KEYWORDS: Portfolio Theory, Assets portfolio, Business portfolio, Risk Management, Diversification

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List of Abbreviation

WTO	World Trade Organization
NPV	Net Present Value
IRR	Internal Rate of Return
PP	Payback Period
ARR	Accounting Rate of Return
NVOCC	Non-Vessel Owning Common Carrier
COSCO	China Ocean Shipping (Group) Company
OOCL	Orient Overseas Container Line
FIATA	International Federation of Freight Forward Association
SBU	Strategic Business Unit
BCG	Boston Consultancy Group
DCF	Discounted Cash Flow
GLS	Generalized Least Lquares

Chapter 1 Introduction

1.1 Background of the shipping market

As the process of the globalization accelerated, the trade cross-different regions and countries becomes more and more frequent; it brought large demand of transportation especially the seaborne transportation developed rapidly.

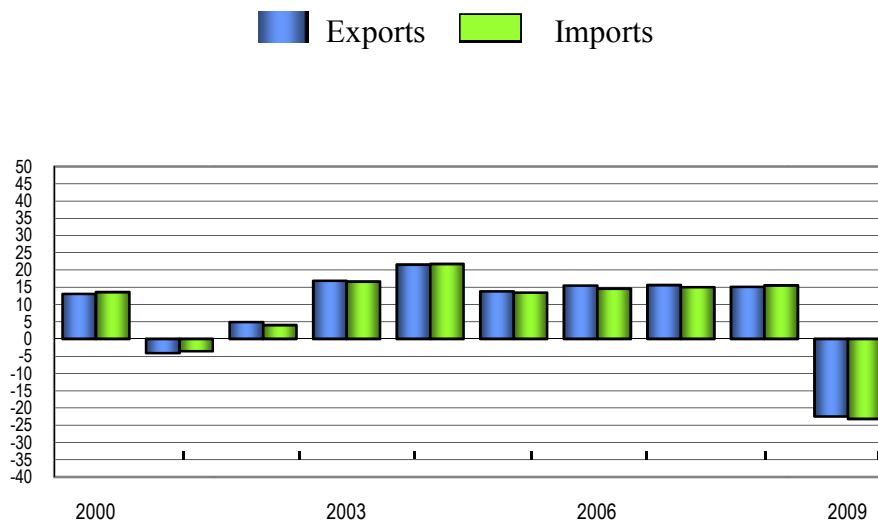


Figure 1 Value of World Merchandise Trade by Region, 2000-2009

Source: WTO

http://www.wto.org/english/res_e/statis_e/statis_e.htm, Organized by the writer



Chart created with NeoTicker EOD © 1998-2007 TickQuest Inc.

Figure 2 The Trend of BDI Index and Oil Price (2002-2009)

Source: <http://my.icxo.com/?uid-355778-action-view-space-itemid-1188879>

After comparing these two graphs, we can see the world trade kept increasing with the shipping industry since the year of 2003, but after the booming period in 2008 have been through a very tough time because of the financial economic crisis. Although from last year the market seems to recover, the situation is still not optimistic. Traffic started to increase as well as freight rate; many companies have re-opened many routes and raised freight rate in some popular routes. For example, CSCL has launched a plan to raise the freight on the Europe / Mediterranean, the Far East - U.S. East / US West, Australia and the Middle East routes, and also raise the

freight rate from \$ 200 / TEU to \$ 500 / TEU; COSCO also announced to increase the fuel surcharge of the Middle East and South Africa, the Far East routes.

In order to keep the tariffs, the shipping companies are very cautious of current capacity in the market. The entire industry is about 11.67% of idle capacity. Overcapacity in the market is one of the main reason causes company's loss, one of the most important reasons is that the huge pretention development of shipping market stimulated ship-owners to order ships that are more new. Because shipbuilding technology is now developing as standardized, large-scaled and professional, and as a result the transportation efficiency has improved greatly. The quick growing market demand and the economics of scale stimulate the strong accumulation of large number new-building ships. Some experts have opinions for what cause the market situation like this. A common outcome is a surplus capacity leading to a substantial deflation of rates and profitability; leading to the recessionary phase of the business cycle in maritime shipping (Rodrigue, Notteboom, & Pallis, 2010). Randers and Göluk (2007) argue that the turbulence in shipping markets is partly the consequence of the collective action of the members of the shipping community massively ordering new ships when demand peaks.

As we all know, it usually takes 2~3 years to deliver a new vessel, so there are still many orders under construction, although many shipping companies choose to postpone or even cancel their orders, the consequence of large new orders leads the overcapacity problem last for years.

Table 1 - Comparison of Three Main Shipbuilding Countries in 2009

Country	Delivered order		Handheld ship- building order		New ship-building order	
	Million	Market	Million DWT	Market	Million DWT	Market

	DWT	share		share		share
World	48.70	100%	153.13	100%	11.49	100%
China	15.23	31.27%	53.89	35.19%	7.11	61.88%
Korea	15.55	31.93%	52.84	34.50%	3.16	27.50%
Japan	9.84	20.20%	23.22	15.16%	0.18	1.57%
others	8.08	16.60%	23.18	15.15%	1.04	9.05%

Source: <http://www.chinaship.cn/>, Organized by the writer

Table 2 - Comparison of Three Main Shipbuilding Countries in 2010

Country	New delivery		Handheld shipbuilding order		New shipbuilding order	
	Million DWT	Market share	Million DWT	Market share	Million DWT	Market share
World	147.3	100%	473.4	100%	120.7	100%
China	61.2	41.5%	192.9	40.7%	58.5	48.5%
Korea	46.6	31.6%	156.6	33.1%	46.1	38.2%
Japan	31.4	21.3%	83	17.6%	7.3	6%
others	8.1	5.6%	40.9	8.6%	8.08	6.3%

Source: <http://www.chinaship.cn/>

Table 3 -Comparison of three main ship-building countries in 1Q11

Country	New delivery		Handheld ship- building order		New ship-building order	
	Million DWT	Market share	Million DWT	Market share	Million DWT	Market share
World	34.92	100%	447.13	100%	14.33	100%
China	13.95	39.90%	187.29	41.90%	5.99	41.80%
Korea	11.19	32.00%	147.23	32.90%	7.42	51.80%
Japan	7.87	22.50%	74.05	16.60%	0.56	3.90%
others	1.91	5.60%	38.56	8.60%	0.36	2.50%

Source: <http://www.chinaship.cn/>

Under this unpredictable and unoptimistic future situation, we would better consider to control the risk more than maximum the benefit. Ergo, there are two important things for the shipping companies: one is how to measure risks; another is how to

deal relationship between risk and benefit. Currently the portfolio theory has been widely applied to many industries, such as the banking, security, insurance, etc. and most of them achieve a quite satisfied result. The portfolio theory is one of the most important, complex and practical theory in the investment. It can be very useful conference to the companies when they have to make the optimal decisions, like many ship owners choose to invest different ship types and to arrange the capital in a proper proportion in the shipping industry in order to reduce the risk as well as get the best profit. By using this method, shipping companies can diversify the risk into different market in order to weaken the volatility of the freight rate; as a result, the shipping companies (ship-owners) can ensure the steady freight income in some extent. Other options like to build a business portfolio, so the companies can reduce the degree of market risk and take optimist use of the resources.

1.2 Risk management

Risk management can be understand as make organizational and process improvements aimed at anticipating and eliminating all the causes of risk. It does not necessarily imply risk reduction. In fact, the objective of risk management is NOT to reduce risk, but more importantly to quantify and control risk. Usually, the objective is not to eliminate risk, but rather to alter our risk profile according to the prevailing market conditions, our risk preferences, and potential regulatory or contractual requirements.

Risks are embedded in any business activity. For a ship owner, the decision to invest in a vessel signifies his belief that freight rates will go up, earning him a return on his

investment that is higher than the “risk-free” interest rate.

Risk management is only useful for the mere fact that we cannot predict the future. Risk management is a notion that exists in financial markets for decades, having experienced significant technological and modeling advances over the years. Shipping has proved rather slow in adopting modern risk management techniques and best practices from other industries. There are two components of our inability to be able to precisely predict what the future holds: these are **variability** and **uncertainty**:

Variability is the effect of change and is a function of the system. It is not reducible through either study or further measurement, but may be reduced through changing the physical system.

Uncertainty is the assessor’s lack of knowledge (level of ignorance) about the parameters that characterize the physical system that is being modeled. It is sometimes reducible through further study, or through consulting more experts.

1.3 Aim of the paper

This paper is going to illustrate the application of portfolio risk management in the shipping industry by using real assets and business portfolio as examples. The study of this method can help the shipping company to avoid the risk and to improve its market competent ability as well as deal with the relationship between risk and profit. We can learn the portfolio theory has the practical significance in the shipping industry from this paper. This paper has following main objectives:

- Understand the concept of modern portfolio theory
- Apply the portfolio risk management method to get the efficient portfolio configuration in shipping assets.
- Apply the portfolio risk management method to get the efficient portfolio configuration in shipping business.
- Concluding the results and illustrate the application of the portfolio theory in the shipping industry

Chapter 2 Literature review

In order to understand how the portfolio risk management can help us, first thing to know is get the basic idea of what is risk. The neoclassical theory of finance is based on the study of (a) efficient markets, meaning markets that use all available information in setting prices, (b) the trade-off between return and risk, (c) option pricing and the principle of no arbitrage, and (d) corporate finance, that is, the structure of financial claims issued by companies (Durlauf & Blume, 2008). Frank Knight had a famous definition of risk; he made a distinction between "risk" and uncertainty. He also argued that these situations, where decision-making rules such as maximizing expected utility can be applied, differ in a deep way from those where the probability distribution of a random outcome is unknown (Knight). Financial risk is often defined as the unexpected variability or volatility of returns, and thus includes both potential worse than expected as well as better than expected returns. We can see there are many different definitions about the word "risk". Authorities like the ISO 31000 (2009) /ISO Guide 73 gives a definition of risk is the 'effect of uncertainty on objectives'. In this definition, uncertainties include events (which may or not happen) and uncertainties caused by a lack of information or ambiguity. This definition also includes both negative and positive impacts on objectives.

After getting a brief understands of the concept of risk, we will take a review of the

current risk management area. The traditional method is using the DCF model to analyze the risk of the investment. It is usually based on the liability proportion of the companies, because this industry needs big amount of capital investment. Frankel E.G. used the NPV, IRR, PP, ARR and many other relevant indicators to evaluate the decision-making behavior (Frankel, 1982). These were using cash flow analysis to measure the risk. The limitation of this method is the lack consideration of the unexpected variability or volatility of returns also includes both potential worse or better than the expected returns (Ansari, 2006). What makes financial method better than the pure DCF method is that financial methods usually put more emphasis on the uncertainty of the object of the investment, and as a result, it is more practical in the real market. Bendall, Helen B and Stent, Alan F Studied the use of Conversion option and the compound option the in the ship investment (Bendall & Stent, 2004). Shao has generalized eight methods about the asset options, and used the Binomial Option Pricing Model to determine which kind of the options influenced the investment decision the most (Shao, 2006). These researches mostly aimed at single project risk management; in the real operation, we are more likely to face the multi-project decisions like multi-asset portfolio.

As we know the best known of these famous risk management methods models is the VaR Risk Metrics model developed by JP Morgan. This model is used to G30 Group of derivative products based on the published in 1993 The report was ready by around 1990 and the measure used was Value-at-Risk (VaR), or the maximum likely loss over the next trading day. VaR was estimated from a system based on standard portfolio theory, using estimates of the standard deviations and correlations between the returns of different traded instruments. In early 1994, JP Morgan set up the Risk Metrics unit to make its data and basic methodology available to outside parties. This

bold move attracted a lot of attention and raised awareness of VaR techniques and risk management systems. The subsequent adoption of VaR systems was very rapid, first among securities houses and investment banks, and then among commercial banks, other financial institutions and non-financial cooperation.

Zhu used a Mathematical Programming Approach to Evaluate Portfolio as a benchmark; it is based upon linear programming techniques and identifies the n-dimensional efficient portfolio frontier (Zhu & Wilkens, 2001). Some scholars also use the mathematic tools to evaluate the risk of each investment behavior. Sun used the fuzzy optimization model to resolve multi-project and multi-level system optimization problems (Sun, 2004). Gupta, Mehlawat, & Saxena also used fuzzy mathematical program to present a portfolio optimization model. They changed mean-variance portfolio model to semi-absolute deviation portfolio model to provide companies some reference when they are making such kind of decisions (Gupta, Mehlawat, & Saxena, 2008).

In 1952, U.S. economist Markowitz first proposed the portfolio theory, which is the method I am going to discuss in this paper (Markowitz, Portfolio Selection, 1952). Years after, he shared a Nobel Prize with Merton Miller and William Sharpe for what has become a broad theory for portfolio selection and corporate finance in 1990. Modern Portfolio Theory explores how risk averse investors construct portfolios in order to optimize market risk against expected returns. One of the key insights of portfolio theory is that the risk of any individual asset is measured by the extent to which that asset contributes to overall portfolio risk which depends on the correlation of its return with the returns to the other assets in the portfolio (a result known as diversification effect). Markowitz Diversification expressed that we can combine assets that are less than perfectly positively correlated in order to reducing portfolio

risk without sacrificing portfolio returns. It can be concluding as the following 2 principles: (a) more analytical than simple diversification and considers assets' correlations; (b) the lower the correlation among assets, the more will be risk reduction through Markowitz diversification (Markowitz, *Portfolio Selection: Efficient Diversification of Investments*, 1959). In 1963, William Sharpe proposed a simplified model for portfolio analysis called mean - variance single-index model (Sharpe, 1963). Harwood has introduced some opinions about the financing options like borrowing a ship than purchasing one, or shipyard credit, bank credit or securities. In the book, he also mentioned using portfolio theory in ship financing could be considered as package the risk (Stephenson, 1995). By considering a ship owner's financial commitments as investments, the development of a hedging strategy in shipping can be treated as a portfolio optimization problem. This is especially necessary now freight futures provide a comparatively novel medium for hedging risk in dry bulk shipping markets (Kevin, 1995). Following the Markowitz theory, we use subjective probabilities to operationally define perceived uncertainty to adopt risk metrics such as variance of return to define the specific aspects of perceived risk. Risk metrics are widely used in financial applications, like setting risk limits, compensation performance, and portfolio optimization and so on.

The Diversification model starts with the observation that the correlation between the returns from operating various types of vessels is high but not perfect, and thus there exists some limited possibility for diversification in the structure of fleets. The standard Markowitz theory is applied to obtain the risk - return tradeoffs between six representative types of vessels (Magirou, Psaraftis, Babilis, & Denisis, 1997). Campbell, Huisman, & Koedijk used the portfolio models to maximize the expected return through configuring financial assets (Campbell, Huisman, & Koedijk, 2001). Portfolio method can be used to reduce the risk as a result of diversification. Ship

owners invest in different ship markets and vessel sizes in the expectation of achieving a reduction in risk via the resulting diversification in their income (Tsolakis, 2002). Shen & Vogiatzis wrote a paper about how the portfolio theory work on the shipping financial risk management and explained the relevance of different ship types, and at the end, they gave a judgment of the optimal decision to the company (Shen & Vogiatzis, 2004). Claudio gave us two types of portfolio models to show us the volatility risk and mapping of risk factors and aimed at telling us the importance of the implementation of market-risk models (Claudio, 2006). The most important contribution of this article “Portfolio Performance Evaluation: Old Issues and New Insights” is the development of the positive period weighting measure (Grinblatt & Titman, 1989). These kinds of researches have been done for all the time, to conclude the existing theories, and try to make improvements to perfect this area. Professor Zhu and his colleagues in FuDan University also have concluded of history of development on the portfolio risk management. They have done a study of the Review and research issues on portfolio selection and financial optimization (Zhu, Zhou, Li, & Wang, 2004). Zhang restricted short-selling model of mean-variance portfolio replacing the model by the variable into the general quadratic programming problems. He also made a specific example of an effective verification of the, and proved in a certain range, the borrowing of funds and assets, the ratio of total capital investment opportunities in bigger and more help to expand the space. (Zhang, Zhang, & Zeng, 2008). Zhang wrote the Relative Index of Performance Evaluation of Portfolio Based on Mean-Variance Efficient Frontier (Zhang, Huang, & Zhou, 2002). Exactly evaluating and analyzing the expected return and risk is the key of performance evaluation of portfolio. Considering of return and risk of portfolio, there are several primary methods can be used to evaluate the performance of portfolio from different angles and are widely accepted and adopted by investors, they use different factors like the single index based on the

Mean-Variance standard and the components of risky return, the information ratio, the same risk-adjusted performance, the probability of decay rate, dynamic adjustment of performance, etc. but there are still some problems have not been solved to satisfy the market such as the validity of the Capital Asset Prices Model, the election of reference portfolio, the confirmation of risk-free return, the shortage of adopting historical data, etc. After studying the modern portfolio theory and the traditional methods of performance evaluation of portfolio, this paper chooses valid portfolio on the mean-variance efficient frontier as the reference portfolio and defines the relative index, the distance-index and the utility-index of performance evaluation of portfolio which is based on the mean-variance efficient frontier. The paper also studies the methods of performance evaluation of portfolio by using multiple objective decision analysis, and studies the performance evaluation of funds. The result of demonstration analysis proves that the methods of performance evaluation of portfolio based on the mean-variance efficient frontier are very useful.

Tianjing University has launched a national project, the result showed in order to solve the mean - variance model, we have to study the mean-VaR efficient frontier model first, and noted that the distribution of rate of return assumption for the normal distribution, Mean-VaR model for the effective set is mean - variance efficient frontier of the subset. About the existence of global minimum VaR analysis shows the level of confidence in the choice of VaR must be very careful (Tianjing University, 2005).

For shipping companies, they can also choose the business portfolio to achieve reducing the risks. There are some practical examples in the shipping industry actually achieve the target through the diversification of their business. Perhaps the best example of reaping advantage of such diversification can be seen in Shreyas

Shipping & Logistics, part of Transworld group. Indian shipping seems to be undergoing a sea-change given the fundamental structural adjustments that is happening across the sector, amidst uninspiring financial performance. It is possible that shipping as one knows it today would not exist as the industry is focusing more on new segments like offshore, dredging, logistics (ET Bureau, 2011). Therefore, an important principle of investment is to diversify your portfolio. Spreading investments over multiple, unrelated products reduce the risk of a sudden, unexpected outcome. Typically, the higher the risk you take, the higher the returns you can expect. Hence, every investor must think about how much risk he is prepared to take on (Gupta, Ashish ET Bureau , 2011). In a diversified portfolio, a loss (risk) in one product is offset by gains from another product. As such one can expect to get decent returns, though the returns would not be exceptionally high or exceptionally low. However, the portfolio cannot reduce all kinds of risks; it eliminates only company-specific risk until an undiversifiable level. Zenios, S.A., M.R. Holmer, R. McKendall, C. Vassiadou-Zeniou has published a paper to discuss multi-period dynamic models for fixed-income portfolio management under uncertainty, extensive validation experiments are carried out to establish the effectiveness of the models. The multi-period models outperform classical models based on portfolio immunization and single-period models (Martin, Raymond, Christiana, & Stavros, 1998).

Brandouy and his colleagues established "Portfolio performance gauging in discrete time using a Luenberger productivity indicator". It proposes a pragmatic, discrete time indicator to gauge the performance of portfolios over time to estimate the changes in the relative positions of portfolios with respect to the traditional Markowitz mean-variance efficient frontier, as well as the eventual shifts of this frontier over time. Based on the analysis of local changes relative to these

mean-variance and higher moment frontiers, this methodology allows to neatly separate between on the one hand performance changes due to portfolio strategies and on the other hand performance changes due to the market evolution (Brandouy, Bric, Kerstens, & Woestyne, 2008).

Multi-Horizon Markowitz Portfolio Performance Appraisals has mentioned that instead of reducing all risk dimensions (or expanding all return dimensions) over a given time horizon by a common scalar, one should simply measure for each period within the time horizon. Indeed, given standard assumptions about time discounting, gains in the distant past should be weighted less than gains in the near past (Bric & Kerstens, Multi-Horizon Markowitz Portfolio Performance Appraisals:, 2005). The paper “Mean-Variance-Skewness Portfolio Performance Gauging: A General Shortage Function and Dual Approach” expressed by Bric proposed a nonparametric efficiency measurement approach for the static portfolio selection problem in mean-variance-skewness space. For computational reasons, the optimal portfolios resulting from this dual approach are only locally optimal (Bric, Kerstens, & Jokung, 2007).

Kandel & Stambaugh expressed Portfolio Inefficiency and the Cross-Section of Expected Returns The mean-variance location of the index does determine the properties of a cross-sectional mean-beta relation fitted by generalized least squares (GLS). As the index portfolio moves closer to exact efficiency, the GLS mean-beta relation moves closer to the exact linear relation corresponding to an efficient portfolio with the same variance. The goodness-of-fit for the GLS regression is the index portfolio's squared relative efficiency, which measures closeness to efficiency in mean-variance space (Kandel & Stambaugh, 1995).

In Modern Portfolio Theory, the most efficient method is to create an optimal mix of

asset classes that generate the highest return to risk ratio. By owning assets that do not correlation with each other, you can reduce the risk in your portfolio. Market sectors have various levels of correlation. Owning sectors that are not correlated highly help to reduce your risk. It is better for the investor to own the sector rather than the individual. By owning asset classes that are not highly correlated, you can reduce your risk (Wagner, 2009). Anagnostopoulos & Mamanis showed us a formulation of the portfolio selection as a tri-objective optimization problem to find tradeoffs between risk, return and the number of securities (Anagnostopoulos & Mamanis, 2010).

Chapter 3 Portfolio risk management model

We have introduced some risk management researches includes the portfolio theory in chapter 2. We can see the Markowitz model wants to tell us a concept that high-risky projects should have a high payback, which means the higher return usually carry higher risks leaving with numerous efficient alternatives.

We can conclude the following two situations:

- 1) Under the given risk level, get the maximum profit;
- 2) Under the given expected return, choose the one with minimum risk.

3.1 Equal proportion investment model

To get a better understand of this portfolio model, we first have to know some factors related to this model.

3.1.1 Expected return

It is the average of a probability distribution of possible returns. The function as follows:

$$E(R) = \sum_{i=1}^n W_i R_i$$

Where:

$E(R)$: portfolio expected return

W_i : ratio of the capital on asset i

R_i : expected return of asset i

N : number of assets in the portfolio

3.1.2 Variance

Variance is a measure of risk based on the consideration of future uncertainty can influence the deviation of the expected return to what extent as we defined:

$$\sigma^2 = \sum_{i=1}^N [R_i - E(R)]^2 P_i$$

Where: P_i : The probability of happens

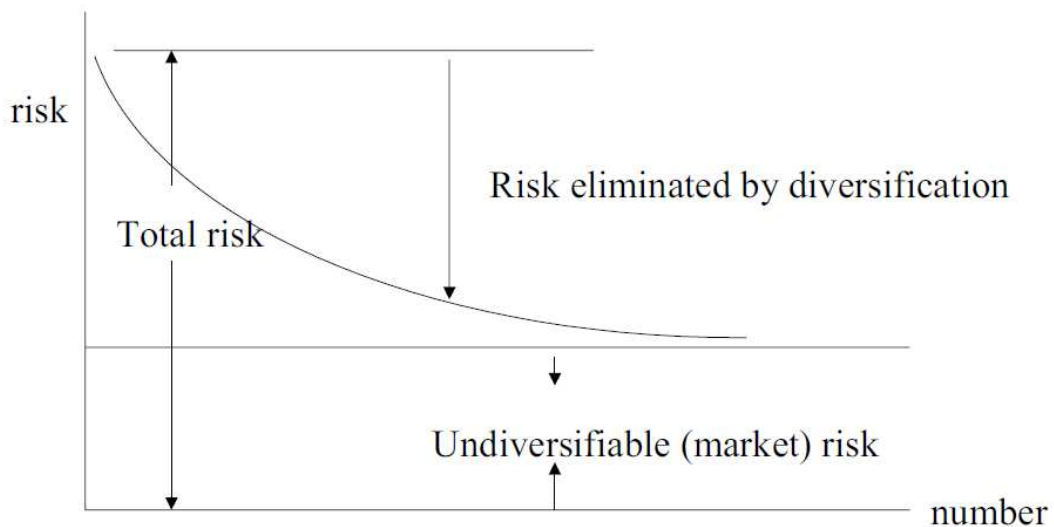


Figure 3 Relationship between assets number and risk level

Source: Electronic Data

As n increase, contribution of variance term goes to zero. Contribution of covariance

terms does to "average covariance". The portfolio variance goes to the average covariance.

3.1.3 Standard deviation

It is a widely used measurement of variability or diversity used in statistics and probability theory. It shows how much variation or "dispersion" there is from the average.

$$\sigma^2 = \sqrt{\sum_{i=1}^N [R_i - E(R)]^2 P_i}$$

3.1.4 Covariance

Covariance is a measure of linear relation between random variables. It can also be understood as how much two variables change compare to their average value.

$$\text{cov}_{ij} = E \{ [R_i - E (R_i)] [R_j - E (R_j)] \}$$

- i. Positive covariance means in the given period, the profit between two assets move the same direction compare to their average value.
- ii. Negative covariance means in the given period, the profit between two assets move the opposite direction compare to their average value.
- iii. Covariance equals to 0, positive deviation and negative deviation irrelevant.

The covariance between different assets is not comparable, we can just identify their profit trend compare to the average value, and the absolute value cannot reflect the relationship between different assets.

3.1.5 Correlation coefficient

It is standardized covariance, usually use to measure the correlation between assets; the value is between -1 to +1. Mathematical function as follows:

$$\rho_{i,j} = \frac{\text{cov}(i,j)}{\sigma_i\sigma_j}$$

Where:

$\text{cov}(i,j)$: Covariance between asset i and asset j

σ_i : Standard deviation of asset i

σ_j : Standard deviation of asset j

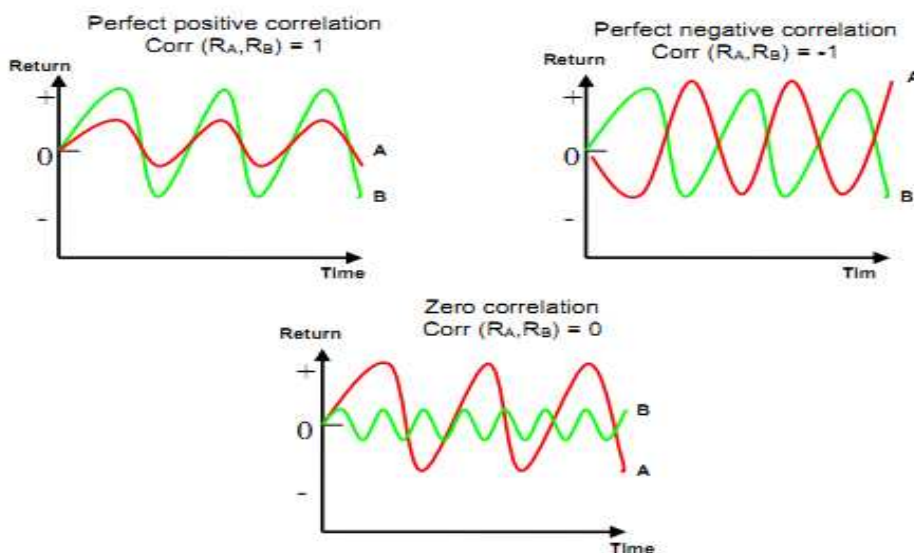


Figure 4 - Examples of Different Correlation Coefficients

Source: Redrawn from Ross, Westerfield, Jaffe Corporate Finance 7th edition

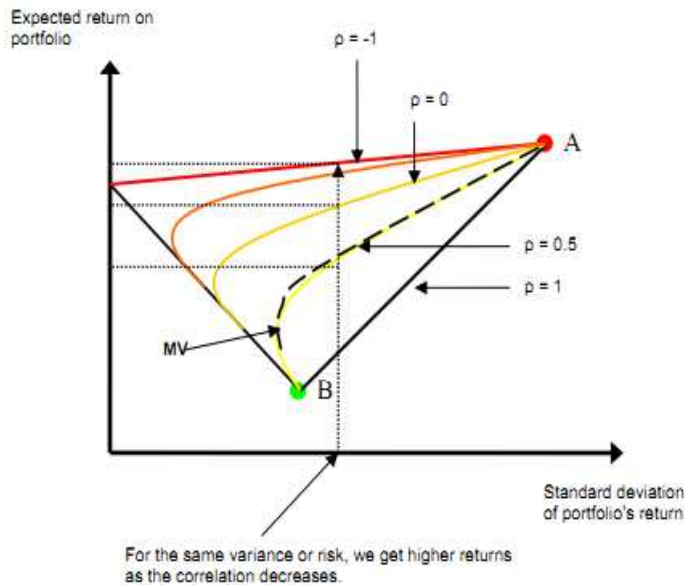


Figure 5 - Examples of Different Assets with Their Correlation Coefficients
 Source: Redrawn from Ross, Westerfield, Jaffe Corporate Finance 7th edition

- i. $\rho_{ij}=1$, R_i and R_j are completely positive linear related, it means the profit of these two assets move the same direction.
- ii. $\rho_{ij}=-1$, R_i and R_j are completely negative linear related, it means one profit is higher than the average value, another one is lower than the average value.
- iii. $\rho_{ij}=0$, R_i and R_j are not related, the profit of two assets is irrelevant.

In this model, we assume the capital distributed on every investment projects, like different ship types in shipping industry is equal, as $W_i=1/N$, we define the total risk is:

$$\sigma = \frac{1}{N} \sqrt{\sum_{i=1}^n \sum_{\substack{j=1 \\ j \neq i}}^n \rho_{ij} \sigma_i \sigma_j}$$

$\sum_{i=1}^n \sum_{\substack{j=1 \\ j \neq i}}^n \rho_{ij} \sigma_i \sigma_j$ is the average system risk of the portfolio; this value gets bigger

as long as the diversification increases, Theoretical speaking, if the ratio of capital on

each project is the same, its individual risk will get smaller and smaller, that's the principle how diversification can reduce the risk.

However, the assets categories cannot be too much or it will lose its efficiency to reduce the risk. Moreover, the relevance of the internal market is often higher than the external market, meanwhile, the possibility of assets come from same market to reduce the risk will be lower than those from different market.

3.1.6 Efficient frontier

A combination of assets, i.e. a portfolio, is referred to as "efficient" if it has the best possible expected level of return for its level of risk (usually proxied by the standard deviation of the portfolio's return).



Figure 4 Risk-reward Graph, comprised of Optimal Portfolios
Source: <http://www.investopedia.com/terms/e/efficientfrontier.asp>

The slope of the efficient frontier curve decreases steadily as we move upward (from left to right) on the efficient frontier. This declining slope tells us if add equal increments of risk gives you diminishing increments of expected return. In

conjunction with the efficient frontier, these utility curves determine which particular portfolio on the efficient frontier best suits an individual investor.

The most effective portfolio diversification will come from making investments that show negative correlation to each other. However, simply by investing in companies who show returns that are not correlated perfectly to each other, the risk in the portfolio will be lower than the associated risk of any individual one.

There is a limit to how many investments need to be held to reduce risk. Many studies have shown that an ideal number is between 15 and 20 projects. Beyond this number, portfolio diversification does not appear to reduce the risk any further. Any further risk is likely to be market risk and cannot be removed by simply adding more holdings.

3.2 Unequal proportion investment model

In the real operations, very few investors choose to distribute their capital equally in every project; they usually distribute their capital according to the preference. Hence, we can make some changes to the Markowitz model, the weight of every asset is W_i , $i=1, 2, \dots, n$ and $W_1+W_2+W_3+\dots+W_n=1$, the total risk of the portfolio formula is:

$$\sigma = \sqrt{\sum_{i=1}^n \sum_{\substack{i=1 \\ j \neq 1}}^n w_i w_j \rho_{ij} \sigma_i \sigma_j}$$

Where:

$$\sum_{i=1}^n w_i = 1, w_i \geq 0;$$

w_i : The ratio of the asset i

w_j : The ratio of the asset j

ρ_{ij} : The correlation coefficient of asset i and asset j

σ_i : The standard deviation of asset i

σ_j : The standard deviation of asset i

A single asset or portfolio of assets is considered to be efficient if no other asset or portfolio of assets offers higher expected return with the same (or lower) risk, or lower risk with the same (or higher) expected return

From these formulas, we can see the covariance of the total portfolio does not equal to the simple weighted average of total single project in the portfolio. it's not just related to the variance of single project, also related to the correlation between investment projects, the correlation coefficient can directly influence the variance of the whole portfolio, this is different from the expected return of portfolio equals to the weighted average of the single project return in the portfolio.

Markowitz has proved that the covariance between investment projects smaller than 1, the standard deviation of the portfolio will be less than the total weighted average in the portfolio, and as the number of the investment projects increases, we can find out that while the return on a diversified portfolio equals to the weighted average of the rates of return on its individual project, its variance will be less than average, which means you can combine those risky investment projects with high-expected returns to relatively low-risk projects, as long as one can minimize the correlation between the returns of individual securities.

Chapter 4 Portfolio model in shipping real assets

Shipping industry has strong life cycle, generally speaking, when the shipping market is booming, the more capacity the more profit you will get; on the contrary, when the shipping market is low, the strong operational ability will make you keep the stable market share. Not all markets have the same product cycle as each other, which gives shipping companies opportunity to give a proper arrangement of their fleet.

Most shipping companies have suffered a lot, as its industrial characteristics such as huge initial capital investment, long payback period; causes like these lead to the unpredictable risk. The ships' expense covers the largest proportion of the entire company cost. Faced with this situation, ship owners and other investors started to concern more about how to evaluate and control the risk they are going to take, other than how many money they earn. Ship investment is a very important decision, which has a direct impact on the operation and future development of the whole company, it is complex and volatile.

In this chapter, I will make two two-ship-types models under different proportion to show the effect of portfolio theory to the risk management.

4.1 Two ship type portfolio model

In this paper, we will use the TCE (Time Charter Rate Equivalent) as a factor to measure the risk. It provides with an estimate of the daily earnings of ships implied by the current level of spot freight rates. The formulae for TCE rate is given by the following:

$$TCE = \frac{FR*TC-VC+C+Ft}{DV}$$

Where:

TCE: Time Charter Rate Equivalent

FR: Freight rate per tonne of cargo

Tc: Tonnes of cargo loaded

VC: Voyage cost

C: Commission

Ft: Freight tax

Dv: Voyage day

Case study

Compare to the container market, bulk carriers are more flexible and fluctuated. Therefore, I collect 6 sample ships data (Appendix I) in the bulk and tanker market from November 2003 to June 2011 to make the assets portfolio model.

Table 4 - Sample Ship Types

Ship Types		Capacity (DWT)	Expected Return	Sample Number
Tanker	Aframax	80,000-120,000	13.82%	300
	Suezmax	120,000-200,000	6.87%	300

	VLCC	200,000-300,000	1.59%	300
Bulkер	Handymax	40,000-60,000	8.63%	300
	Panamax	60,000-100,000	4.60%	300
	Capesize	100,000-200,000	5.10%	300

Source: www.chinaship.com, organized by writer

50%-50%:

Expected Return (Appendix II):

$$E(R) = \sum_{i=1}^n W_i R_i$$

Where:

E(R): portfolio expected return of ship portfolio

W_i : ratio of the capital ship types

R_i : expected return of ship i

N: number of ship in the portfolio

Table 5 - Excel Calculation Resulted of 50%-50% Ship Portfolio (Expected Return)

	AFRAMAX	VLCC	SUEZMAX	CAPE SIZE	HANDYMAX	PANAMAX
AFRAMAX	0.1382	0.1035	0.0771	0.1123	0.0921	0.0946
VLCC	0.1035	0.0687	0.0423	0.0775	0.0574	0.0599
SUEZMAX	0.0771	0.0423	0.0159	0.0511	0.0310	0.0335
CAPE SIZE	0.1123	0.0775	0.0511	0.1550	0.1550	0.1550
HANDYMAX	0.0921	0.0574	0.0310	0.0662	0.0460	0.0485
PANAMAX	0.0946	0.0599	0.0335	0.0687	0.0485	0.0510

Source: Own Calculation

Correlation coefficient (Appendix III):

$$\rho_{ij} = \frac{\text{cov}(i, j)}{\sigma_i \sigma_j}$$

Where:

cov(i, j): Covariance between ship i and ship j (Appendix III)

σ_i : Standard deviation of ship i

σ_j : Standard deviation of ship i

Table 6 - The Excel Calculation Result of 50% -50% Ship Portfolio (correlation coefficient)

	AFRAMAX	VLCC	SUEZMAX	CAPESIZE	HANDYMAX	PANAMAX
AFRAMAX	1.0000	0.8821	0.9295	0.2749	0.1702	0.1985
VLCC	0.8821	1.0000	0.9088	0.2944	0.1976	0.2518
SUEZMAX	0.9295	0.9088	1.0000	0.2879	0.2082	0.2254
CAPESIZE	0.2749	0.2944	0.2879	1.0000	0.3700	0.6569
HANDYMAX	0.1702	0.1976	0.2082	0.3700	1.0000	0.5433
PANAMAX	0.1985	0.2518	0.2254	0.6569	0.5433	1.0000

Source: Own Calculation

The highest correlation coefficient is 0.9295, which between Suezmax and Aframax, these two ship types are both tankers. Moreover, the lowest is 0.1702 which between Handymax and Aframax. Base on the characteristics of correlation coefficient, we can see the tankers and bulk carriers are not highly related to each other, which means if one of these two markets suffered from loss, another one will not be influenced a lot. So according to this phenomenon, the shipping companies can choose different types of their ships in order to reduce the risk.

Two-ship Portfolio Variance:

$$\sigma^2 = w_{ship i}^2 \sigma_{ship i}^2 + 2w_{ship i} w_{ship j} \text{COV}_{ship i, ship j} + w_{ship j}^2 \sigma_{ship j}^2$$

Table 7 - The Excel Calculation Results of 50%-50% Ship Portfolio (Variance)

	AFRAMAX	VLCC	SUEZMAX	CAPESIZE	HANDYMAX	PANAMAX
AFRAMAX	0.4395	1.7578	0.6582	0.1633	0.1528	0.1444
VLCC	1.7578	6.9113	2.4947	0.8639	0.8368	0.8216
SUEZMAX	0.6577	2.4945	1.0169	0.2798	0.2674	0.2575
CAPESIZE	0.1634	0.8635	0.2801	0.0358	0.028	0.0206
HANDYMAX	0.1529	0.8374	0.2676	0.0275	0.0203	0.0132
PANAMAX	0.1445	0.8221	0.2576	0.0203	0.0132	0.006

Source: Own Calculation

Weighted average of variance of two ships:

$$\sigma^2 = w_i \sigma_i^2 + w_j \sigma_j^2$$

Table 8 - Excel Calculation Results of 50%-50% Ship Portfolio (weighted average of variance of two ships)

WEIGHTED AVERAGE OF VARIANCES OF THE TWO SHIPS						
	AFRAMAX	VLCC	SUEZMAX	CAPESE	HANDYMAX	PANAMAX
AFRAMAX	0.5598	1.9013	0.7839	0.3144	0.3002	0.2859
VLCC	1.9013	3.2428	2.1254	1.6559	1.6417	1.6274
SUEZMAX	0.7839	2.1254	1.0081	0.5386	0.5244	0.5101
CAPESE	0.3144	1.6559	0.5386	0.0691	0.0549	0.0406
HANDYMAX	0.3002	1.6417	0.5244	0.0549	0.0407	0.0264
PANAMAX	0.2859	1.6274	0.5101	0.0406	0.0264	0.0121

Source: Own Calculation

70%-30%:

Table 9 Excel Calculation Results of 70%-30% Ship Portfolio (Expected Return)

70% \ 30%	AFRAMAX	VLCC	SUEZMAX	CAPESE	HANDYMAX	PANAMAX
AFRAMAX	0.1382	0.1174	0.1015	0.1226	0.1105	0.1120
VLCC	0.0896	0.0687	0.0529	0.0740	0.0619	0.0634
SUEZMAX	0.0526	0.0317	0.0159	0.0370	0.0249	0.0264
CAPESE	0.1019	0.1076	0.1108	0.1593	0.3483	0.2113
HANDYMAX	0.0737	0.0528	0.0370	0.0581	0.0460	0.0475
PANAMAX	0.0772	0.0563	0.0405	0.0616	0.0495	0.0510

Source: Own Calculation

Two-ship Portfolio Variance

$$\sigma^2 = w_{ship i}^2 \sigma_{ship i}^2 + 2w_{ship i} w_{ship j} COV_{ship i, ship j} + w_{ship j}^2 \sigma_{ship j}^2$$

Table 10 - Excel Calculation Results of 70%-30% Ship Portfolio (Variance)

70% \ 30%	AFRAMAX	VLCC	SUEZMAX	CAPEXSIZE	HANDYMAX	PANAMAX
AFRAMAX	0.5604	1.0646	0.6589	0.3032	0.2887	0.2822
VLCC	2.1378	3.2444	2.3401	1.6536	1.6226	1.6107
SUEZMAX	0.8376	1.4462	1.0079	0.5297	0.5142	0.5043
CAPEXSIZE	0.1072	0.3834	0.1550	0.0572	0.0482	0.0451
HANDYMAX	0.0309	0.0511	0.0374	0.0229	0.0213	0.0213
PANAMAX	0.0636	0.3206	0.1067	0.0153	0.0110	0.0086

Source: Own Calculation

Weighted average of variance of two ships:

$$\sigma^2 = w_i \sigma_i^2 + w_j \sigma_j^2$$

Table 11 - Excel Calculation Results of 70%-30% Ship Portfolio (weighted average of Variance of two ships)

70% \ 30%	AFRAMAX	VLCC	SUEZMAX	CAPEXSIZE	HANDYMAX	PANAMAX
AFRAMAX	0.5598	1.3647	0.6943	0.4126	0.4041	0.3955
VLCC	2.4379	3.2428	2.5724	2.2907	2.2821	2.2736
SUEZMAX	0.8736	1.6785	1.0081	0.7264	0.7179	0.7093
CAPEXSIZE	0.2163	1.0212	0.3508	0.0691	0.0605	0.0520
HANDYMAX	0.1964	1.0013	0.3309	0.0492	0.0407	0.0321
PANAMAX	0.1764	0.9813	0.3109	0.0292	0.0207	0.0121

Source: Own Calculation

The Portfolio theory has proved the correlation coefficient smaller, the effect of diversification is more obvious. By comparing the results, the variance of the portfolio is less than the weighted average variance of two individual ships. It shows the portfolio effect directly and we can see the correlation coefficient inside the same market is higher, it tells us that invest ships in a single market is easily to be influenced when the market starts to be fluctuated. That is why the oil market has not been suffered as much as bulk market and container market.

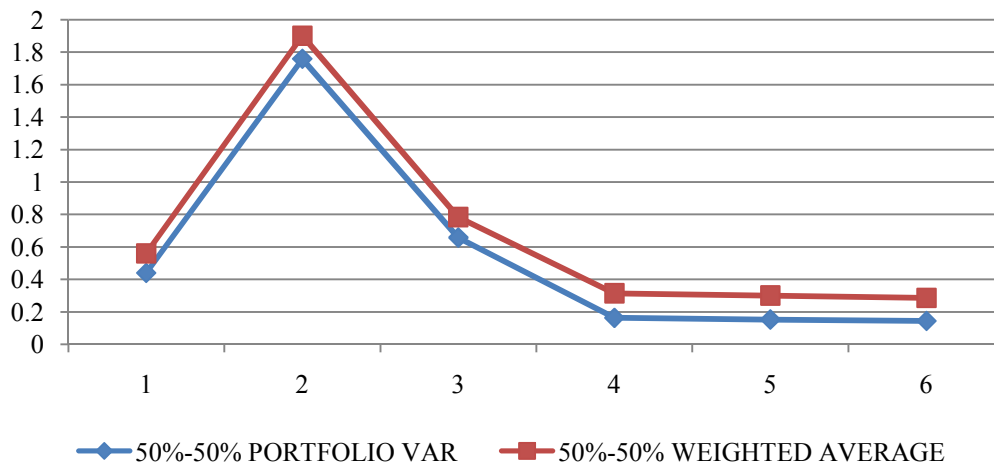


Figure 5 Comparison between portfolio variance and average weighted variance (50%-50%)
 Source: Own Calculation

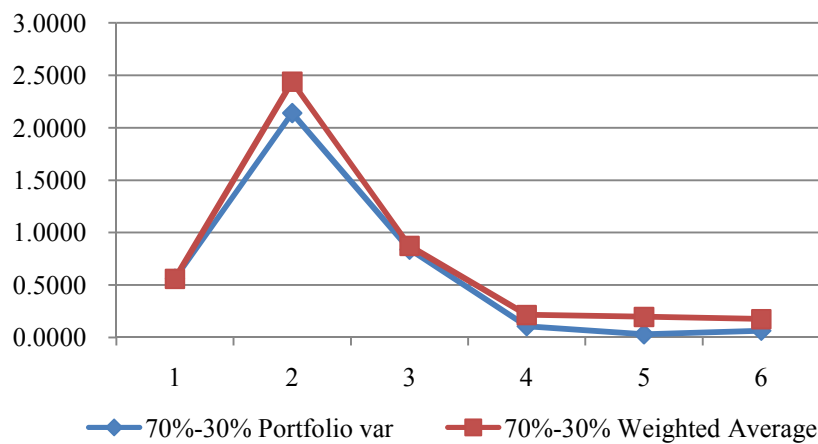


Figure 6 Comparison between portfolio variance and average weighted variance (70%-30%)
 Source: Own Calculation

We choose some data randomly from the previous results; it is very obvious that no matter in the 50%-50% case or the 30%-70% case, the weighted average variance is always higher than the portfolio variance. Under the same sample numbers, the higher variance means a more fluctuated market. For shipping companies, we can recognize different markets have different life cycle, shipping companies can use the portfolio method analyze the correlation between them, and make optimal decisions.

4.2 Multi-ship type portfolio model

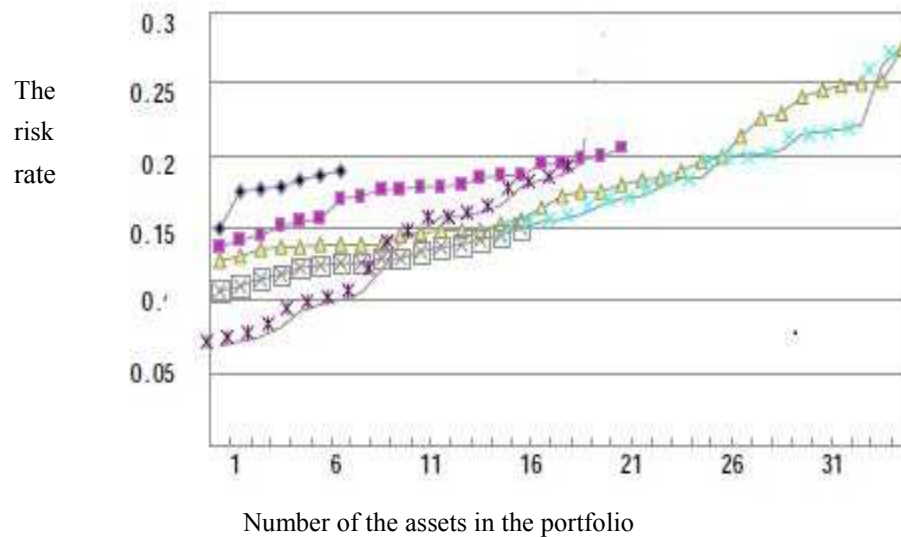


Figure 7 Chart of the portfolio risk value (6 sample ship portfolio)

Source: Organized by writer

From the figure, we can see that the portfolio can actually reduce the risks, but the projects in the portfolio cannot be over certain numbers, in this case, it is better for the shipping companies choose two to three, because when there are four ships in the portfolio, the effect has been reduced.

In a word, for the companies, the most important thing is not just consider the profit of the portfolio but also the choice of the assets. If they do not make a through consideration, just pick random things in their portfolio, it is not seems to be possible to get the original target.

Chapter 5 Portfolio model in shipping Business

5.1 Motivations of the business portfolio diversification for shipping company

5.1.1 Risk diversification

This is the primary objective for most shipping companies choose to diversify their business. As we know, shipping is such high-risk industry with so many changeable factors like fluctuated freight rate, international financial situation or even the political environment. These factors make companies with single business take more risk than those with many business; we can easily understand that if these companies have other derivatives, when the market is down, they can get compensation from these extended business. It can be seen as the diversification mechanics which is essential to the creation of an efficient investment, because it can reduce the variability of returns around the expected return. It can be divided to two types of diversification: Simple diversification and Diversification across industries. Simple diversification means the

In a word, it is necessary for them to develop other business, to reduce the overreliance of the major business, as well as to diversify the risk and increase the operational safety.

5.1.2 Improve the competitive strength of the company

The domestic companies have to face challenges from other foreign companies in the perfect competition market. How to remain a stable market share under the huge impact forces many companies to remake their operational strategies.

5.1.3 Profit

It is no doubt for every company is that no matter what kind of strategy they take, the most important is always get more profit. The diversification can help the companies take fully usage of their internal resources as well as the control the market.

5.2 Characteristics of the shipping industry

5.2.1 International

a. Shipping is perhaps the most international of the world's industries; it is highly related to the world economics. The international shipping industry is responsible for the carriage of 90% of world trade, that characteristic determined the uncertainty and complexity of the operation for the shipping companies.

b. Common international practices of the shipping document

The transportation documents have common international practices because vessels have to go around the different ports in different areas worldwide.

c. Unified international shipping law and regulations

Many maritime cases may concern many different nationalities, usually not easy for both parties to determine the jurisdiction. Therefore, some international organizations started to establish and they made many regulations to regulate the market.

5.2.2 Capital-intensive and technology-intensive

The scale of the vessel becomes more and more large and need of the high technology equipments makes the cost of building a new ship gets higher and higher. In addition, more and more hi-technology operation system and information system applied in the shipping industry requires well-skilled people

Table 12 The average price of the sample ships from 2009 to 2011 (million dollar)

AFRAMAX	VLCC	SUEZMAX	CAPE SIZE	HANDYMAX	PANAMAX
56.03	105.96	66.25	58.69	31.81	37.40

Source: <http://www.chinaship.cn/>, Organized by the writer

5.2.3 Uncertainty and fluctuation

Except the reasons I have mentioned in the last chapter, there are some other reasons such as the transportation demand is imbalance on the time and space, or the

elasticity of the demand is quite small, etc.

5.3 The main business in the current shipping market

5.3.1 Dealer

These shipping companies have certain scale and usually capable to purchase or build vessels, and operate by themselves. They should make a long-term plan to make sure they can get profit. Some ship-owners also operate as the voyage charterers.

5.3.2 Charter

This business can be caused by seasonal change and other temporary reasons, in order to remain the stable reputation and freight rate or to save the operation cost, some shipping companies choose this type of operation method. A charterer may also be a party without a cargo who takes a vessel on charter for a specified period from the owner and then trades the ship to carry cargoes at a profit above the hire rate.

Time Charter Equivalent is a standard shipping industry performance measure used primarily to compare period-to-period changes in a shipping company's performance despite changes in the mix of charter types. there are basically three types of charterers names as voyage charter who is the hiring of a vessel and crew for a voyage between a load port and a discharge port. He should pay the ship owner

money on a per-ton or lump-sum basis. The owner pays the port costs (excluding stevedoring), fuel costs and crew costs. The payment for the use of the vessel is known as freight. A time charter is the hiring of a vessel for a specific period of time; the owner still manages the vessel but the charterer selects the ports and directs the vessel where to go. Another one is bareboat charter or demise charter is an arrangement for the hiring of a vessel whereby no administration or technical maintenance is included as part of the agreement. The charterer pays for all operating expenses, including fuel, crew, port expenses and P&I and hull insurance. In commercial demise chartering, the charter period may last for many years; and may end with the charterer acquiring title (ownership) of the ship. In this case, a demise charter is a form of hire-purchase from the owners, who may well have been the shipbuilders. Demise chartering is common for tankers and bulk-carriers

5.3.3 Entrust

Small-scale shipping companies aimed at saving operational cost, or not good at management skills, or don't have the reliable resources, entrust vessels to a big company or some other capable experienced agents to operate, normally pay commissions or rent , The ship-owners self-financing.

5.3.4 Joint Venture

Different shipping companies gather together in order to avoid the vicious competition, so the liner conferences and strategic alliances their target is to increase the freight rate, monopoly the market, exclude those vessels outside the conference, the shipping, the shipping companies belong to the conference still remain

independent.

5.3.5 Shareholder

Shipping companies establish the subsidiaries in order to adopt the local economics or practical market environment and for different routes. They operate independently, the parent companies just need to take care of the shareholdings, mainly just the important business and profit part.

5.3.6 Shipping Agent

A ship agent should know all shipping regulations for all ports, ensuring compliance with international shipping regulations, safety practices and policies of the ship's owner. They should maintain copies of all documents, including bills of lading, and insurance and inspection certificates, make good communication with the ship owners and cargo owners. They also play important roles in shipping related deals.

5.3.7 Broker

This business covers wide areas, mainly work on selling and purchasing the vessels, offer ship owners and charterers with market-related information to help both them to make a deal successfully, also maritime insurance, consultant of the maritime regulations, etc (Mark, 2001). Normally these operators have established offices in the important shipping countries or ports; the benefit usually comes from the commission and document transfer fee/document handover fee. This kind of service

can be considered as a bridge between every party in a deal to ensure a better communication.

5.3.8 Freight Forwarder

The FIATA describe the freight forwarder as the 'Architect of Transport'. A freight forwarder is a person or a company that organizes shipments for individuals or other companies and act as a carrier. Their works can function as planning the most appropriate route for a shipment, arranging appropriate packing, delivery and warehousing of goods at their final destination; checking and preparing documentation to clear customs and meet insurance requirements; offering consolidation services by air, sea and road, arranging insurance and assisting the client in the event of a claim; arranging payment of freight and other charges; or collection of payment on behalf of the clients, etc.

5.4 Business portfolio model

Build this kind of portfolio model is based the same concept of assets portfolio model; we use the business income as the factor to show the effect of portfolio risk management. When examining a complete portfolio it is imperative to consider fully the important factors that comprise your core investable core assets. The company has to analyze its current business portfolio and decide which businesses should receive more or less investment. Develop growth strategies for adding new products and businesses to the portfolio, whilst at the same time deciding when products and businesses should no longer be retained.

The two best-known business portfolio methods are the Boston Consulting Group Portfolio Matrix and the McKinsey / General Electric Matrix (discussed in this revision note). In both methods, the first step is to identify the various Strategic Business Units ("SBU's") in a company portfolio. An SBU is a unit of the company that has a separate mission and objectives and that can be planned independently from the other businesses. Rely on liquid markets where there is a ready market to buy and sell your core asset. Assets that cannot be immediately priced and sold are subject to sudden and deep losses.

Your stock portfolio is part of your total asset valuation that includes savings for emergencies, real estate, bonds, and possibly precious metals. By taking this broad perspective, you have a better chance to employ overall hedges that are non-correlated to address market risk. When examining a complete portfolio it is imperative to consider fully the important factors that comprise your core investable core assets (Wagner, 2009).

The McKinsey/GE Matrix overcomes a number of the disadvantages of the BCG Box. Firstly, market attractiveness replaces market growth as the dimension of industry attractiveness, and includes a broader range of factors other than just the market growth rate. Secondly, competitive strength replaces market share as the dimension by which the competitive position of each SBU is assessed. We can express business portfolio by comparing three big companies in the shipping industry, which are COSCO, OOCL and China Shipping.

Table 13- Proportion of Business of Total Revenue in 2005

	Container Transportation	Container Lease	Terminal	Freight Forwarder and Shipping Agent
--	-----------------------------	-----------------	----------	--

COSCO	81.60	3.13	0.27	14.99
OOCL	90.07	19.47	9.47	
China Shipping	Single business			

Source: Company website, organized by writer

In 2005, the container freight rate started to reduce, unlike other two companies the total revenue of COSCO remained to grow, the effect of business portfolio gave COSCO the advantage of stable operation. There are many optional business diversifications at both horizontal and vertical level for shipping companies, Dr. David Swensen, has identified three characteristics of core assets that should be part of your evaluation to help reduce systematic or market risk. For example, COSCO not only has many business covers almost every area in the shipping industry, but also reaches to other industries like real estate. These three companies have all their SBUs, which definitely is the container transportation. This part gets the most capital as well as they get the most revenue.

Chapter 6 Conclusion

6.1 Main Findings

As we can see that the profit higher than the average is the investor's preference, but it is considered as a factor to measure the risks in the average-variance portfolio model. In this paper, we use six types of ship belong to oil and bulk carriers to prove the practical usage of the portfolio theory in the shipping industry for risk management. After we analyzed these calculation results, we can get ideas which are variance of each asset contributes little to portfolio risk and covariance among assets determines portfolio risk. It means we can use the variance and correlation coefficient as the factors to measure the risk level in order to prove the portfolio diversification can help to reduce the risks.

And also these factors can be used to help the shipping companies to make decision about the fleet investment and what business they are going to take based on the relationship between different factors.

We also know that if we take the projects from the same market, the possibility of reducing risk among different markets to be lower than the portfolio. The results show that the portfolio theory also applies to the shipping market, the route / ship's portfolio helps reduce risk. But the types of portfolio investment assets cannot too

much; the certain number of the portfolio projects has good influence to the combined effectiveness of investments; but it's not like "the more the better" rule, too many projects will make the combination significantly reduced the efficiency of portfolio.

This is why we can use this model to help us make the decisions about what kind of ships are we going to choose and in what ratio is the better choice. It is kind of cautious way in the risk management, but considers the current market, I think it is a better way to maintain the market share; for those medium and small-scale companies, it can help them to survive under the huge impact of economic crisis and such fierce competition.

6.2 Research limitations

This model here is static that is a shortage of this method; we have determined the capital distribution case at the beginning of the investment in the practical operation. The investors can change different types of asset and the ratio of capital. also we haven't consider the cost happens in the real operation, like transfer fee or other costs we cannot expect. so for better choice, we can set up a dynamic model to simulate thousands of situations in order to help us build the portfolio models more accurate, the information system can give us more data to help the shipping companies make the investment decisions and avoid the risks.

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Appendix I – Time Charter Equivalent 2003-2011

	AFRAMAX	VLCC	SUEZMAX	CAPESIZE	HANDYMAX	PANAMAX
2011.06.08	15500	24500	21000	5500	3100	3600
2011.06.01	15500	24500	21000	5500	3100	3600
2011.05.25	15500	26500	21000	5500	3100	3600
2011.05.18	15500	27000	21000	5500	3100	3600
2011.05.11	15500	29000	21000	5500	3100	3600
2011.05.04	15500	27500	20500	5500	3100	3600
2011.04.27	15000	27500	20500	5500	3100	3600
2011.04.22	15000	27500	20500	5500	3100	3550
2011.04.13	15000	27500	20500	5500	3100	3600
2011.04.06	15000	27500	20500	5500	3100	3600
2011.03.30	15500	27500	20000	5500	3100	3600
2011.03.23	15500	27500	21000	5500	3100	3600
2011.03.16	15500	27500	21000	5500	3100	3600
2011.03.09	15500	29500	21000	5500	3100	3600
2011.03.02	15500	29500	21000	5500	3100	3600
2011.02.23	15500	30000	22000	5500	3100	3600
2011.02.16	17000	28000	22000	5500	3100	3600
2011.02.09	17000	27000	22000	5500	3100	3600
2011.02.02	17000	28000	22000	5500	3100	3600
2011.01.26	17500	28000	23000	5500	3100	3600
2011.01.19	17250	28000	23000	5500	3100	3600
2011.01.12	17500	28500	23500	5500	3100	3600
2011.01.05	18000	28500	25000	5500	3100	3600
2010.12.29	18000	28500	25000	5500	3100	3600
2010.12.22	18000	28500	25000	5500	3100	3600
2010.12.15	18000	29000	25000	5500	3100	3600
2010.12.08	18000	29000	25000	5500	3100	3600
2010.12.01	18000	29500	25000	5700	3100	3700
2010.11.24	18000	28500	25000	5700	3100	3700
2010.11.10	18750	29500	25000	5700	3100	3700
2010.11.03	18750	29500	27000	5700	3100	3700
2010.10.27	18750	32000	27000	5700	3100	3700
2010.10.20	18750	32000	27000	5700	3100	3700
2010.10.13	18750	35000	27000	5700	3100	3700

2010.10.06	19000	36000	26500	5700	3100	3700
2010.09.22	19000	38000	27000	5700	3100	3700
2010.09.01	18750	38000	27000	5700	3100	3700
2010.08.25	18750	40000	27000	5700	3100	3700
2010.08.18	19000	41000	28000	5700	3100	3700
2010.07.30	19250		28500	5700	3100	3700
2010.07.14	19750	24500	29500	5700	3100	3700
2010.07.07	19750	24500	29500	5700	3100	3700
2010.06.30	19750	26500	29500	5700	3100	3700
2010.06.23	20000	27000	29500	5700	3100	3700
2010.06.16	19250	29000	26000	5700	3100	3700
2010.06.09	19000	27500	26000	5700	3100	3700
2010.06.02	19000	27500	26000	5700	3100	3700
2010.05.19	18750	27500	26000	5700	3100	3700
2010.05.12	18500	27500	26000	5700	3100	3700
2010.05.05	18500	27500	27500	5600	3000	3600
2010.04.28	18500	27500	27500	5600	3000	3600
2010.04.23	17500	27500	25000	5600	3000	3600
2010.04.16	17500	27500	23500	5600	3000	3550
2010.03.26	17500	29500	25000	5500	3000	3500
2010.03.05	18000	29500	25000	5500	3000	3500
2010.02.26	18000	30000	25000	5500	3000	3500
2010.01.29	18500	28000	29000	5500	3000	3500
2010.01.22	18500	27000	28000	5500	3000	3500
2010.01.08	18000	28000	23000	5500	3000	3500
2009.12.25	18000	28000	23000	5500	3000	3500
2009.12.18	18000	28000	23000	5500	3000	3500
2009.12.11	17500	28500	22000	5500	3000	3500
2009.12.04	17500	28500	22000	5500	3000	3500
2009.11.20	17000	28500	21000	5600	3050	5600
2009.11.13	17000	28500	20000	5600	3050	3550
2009.11.06	16750	29000	22000	5600	3050	3550
2009.10.30	17000	29000	21500	5800	3100	3600
2009.10.23	17000	29500	22000	5800	3100	6300
2009.09.11	17000	28500	25000	6000	3200	3700
2009.09.04	17000	29500	25000	6000	3300	3700
2009.08.28	17000	29500	25000	6100	3300	3700
2009.08.14	17000	32000	25000	6200	3400	3800
2009.08.07	17000	32000	25000	6200	3400	3800

2009.07.31	17000	35000	25000	6300	3400	3800
2009.07.24	17250	36000	25000	6300	3400	3800
2009.07.17	17750	38000	27000	6300	3400	3800
2009.07.08	17000	38000	27000	6500	3500	3900
2009.06.19	17750	40000	27000	6500	3500	3900
2009.06.05	18000	41000	27000	6600	3500	3900
2009.05.22	18000	35000	29000	6800	3500	3900
2009.05.15	18000	37500	29000	6800	3500	3900
2009.05.08	18000	37500	29000	7000	3500	3900
2009.04.24	19000	40000	30000	7000	3500	3900
2009.04.03	22000	45000	30000	7100	3600	4000
2009.03.27	23000	50000	32000	7100	3600	4000
2009.03.13	24000	50000	33000	7100	3600	4000
2009.03.06	25000	50000	34000	7100	3600	4000
2009.02.20	26000	50000	35000	7200	3600	4100
2009.02.13	26000	55000	35000	7200	3600	4100
2009.01.23	27000	55000	40000	7450	3650	4100
2009.01.16	28000	55000	40000	7500	3650	4100
2008.12.19	29000	55000	40000	7800	3750	4300
2008.12.12	29000	55000	40000	7800	3750	4300
2008.12.05	29000	62500	40000	7900	3800	4400
2008.11.14	32000	67500	42500	9100	4550	5150
2008.11.07	35000	85000	47500	9100	4550	5150
2008.09.12	41000	85000	55000	9600	4800	5400
2008.09.05	41000	85000	55000	9600	4800	5400
2008.08.22	40500	85000	55000	9500	4700	5400
2008.08.15	40500	90000	55000	9400	4700	5400
2008.08.08	42000	90000	55000	9400	4700	5400
2008.08.01	42000	90000	55000	9400	4700	5400
2008.07.18	42000	90000	50000	9400	4700	5400
2008.07.11	38000	90000	50000	9400	4700	5400
2008.07.04	38000	87500	50000	9400	4700	5300
2008.06.27	36000	85000	50000	9300	4700	5300
2008.06.20	35000	82500	45000	9300	4700	5300
2008.06.13	34000	80000	44500	9300	4700	5300
2008.06.06	32000	80000	44500	9300	4700	5300
2008.05.30	32000	80000	44500	9300	4700	5300
2008.05.23	32000	75000	44000	9300	4600	5200
2008.05.09	31000	70000	42500	9300	4600	5200

2008.04.25	30000	70000	42500	9300	4600	5200
2008.04.18	30000	72000	42500	9300	4600	5200
2008.04.11	30000	72000	42000	9300	4600	5200
2008.04.04	30000	72000	42000	9300	4600	5200
2008.03.28	30000	72000	42000	9300	4600	5200
2008.03.14	30000	70000	42000	9300	4600	5200
2008.03.07	30000	70000	42000	9300	4600	5200
2008.02.29	30500	70000	42000	9300	4600	5200
2008.02.22	31000	70000		9300	4600	5200
2008.02.15	31000	60000	42000	9300	4600	5200
2008.01.25	30000	65000	42000	9500	4600	5200
2008.01.18	30000	67500	42500	9500	4600	5200
2008.01.11	30000	70000	45000	9300	4500	5200
2008.01.09	35000	52500	47500	9200	4500	5200
2007.12.21	35000	52500	42000	9200	4500	5100
2007.12.14	31000	50000	40000	9200	4500	5100
2007.12.07	30000	45000	40000	9200	4500	5000
2007.11.30	30000	45000	40000	9200	4500	5000
2007.11.16	31000	45000	40000	9200	4500	5000
2007.11.09	31000	45000	40000	9200	4500	5000
2007.11.02	31000	42500	40000	9000	4400	5000
2007.10.26	31000	45000	40000	9000	4400	4900
2007.10.19	31000	52000	43000	8900	4400	4900
2007.10.12	32000	51000	43500	8700	4300	4900
2007.09.21	33000	55000	45000	8700	4300	4800
2007.09.14	31500	57500	45000	8700	4200	4600
2007.08.24	33000	57500	45000	8700	4200	4600
2007.08.17	35000	57500	45000	8700	4200	4600
2007.08.10	35000	57500	45000	8600	4200	4500
2007.08.03	35000	57500	45000	8600	4200	4500
2007.07.27	35000	57500	45000	8500	4200	4500
2007.07.20	35000	57500	45000	8500	4200	4500
2007.07.13	35000	60000	45000	8200	4200	4500
2007.07.06	34000	47500	43000	8200	4200	4500
2007.06.29	34000	60000	45000	8200	4100	4350
2007.06.22	33000	60000	45000	8200	4000	4250
2007.06.15	34000	60000	45000	8100	4000	4250
2007.06.08	34000	60000	44500	8100	4000	4250
2007.06.01	34000	57500	43500	8100	3800	4100

2007.05.25	33000	55000	43000	8100	3800	4100
2007.05.18	32000	50000	41000	7800	3800	4100
2007.05.11	31500	52500	41000	7800	3800	4100
2007.04.27	31000	52500	41000	7800	3700	4100
2007.04.26	31000	54000	42000	7800	3700	4100
2007.04.12	31000	52500	42000	7800	3700	4100
2007.04.05	31500	50000	42000	7700	3700	4100
2007.03.29	32000	50000	42000	7700	3700	4100
2007.03.22	32000	52000	42000	7200	3700	4100
2007.03.15	32000	52000	42000	7000	3700	4100
2007.02.15	32000	52000	42000	7000	3600	4000
2007.02.08	32000	52000	42000	7000	3500	3900
2007.02.01	32000	52000	42000	6800	3500	3900
2007.01.25	32000	55000	42000	6800	3400	3800
2007.01.18	32000	70000	44000	9300	3400	3800
2007.01.11	32000	55000	44000	6800	3400	3800
2006.12.21	32500	55000	45000	6800	3400	3800
2006.12.14	32500	57500	45000	6800	3400	3800
2006.12.07	32500	27500	46000	6500	3400	3800
2006.11.30	32500	60000	44000	6500	3400	3800
2006.11.23	33500	62000	44000	6500	3400	3800
2006.11.16	33500	64000	44000	6500	3400	3800
2006.11.09	35000	65000	47000	6500	3400	3800
2006.11.02	35000	65000	47000	6500	3400	3800
2006.10.26	35000	65000	48000	6500	3400	3800
2006.10.19	36000	66000	52500	6500	3400	3800
2006.10.12	36000	68000	52500	6500	3400	3800
2006.09.28	36000	72500	52500	6500	32350	3750
2006.09.21	36000	72500	52500	6400	3250	3750
2006.09.14	36000	72500	52500	6400	3250	3750
2006.09.07	36000	72500	50000	6200	3250	3750
2006.08.31	36000	72500	50000	6200	3100	3600
2006.08.24	35500	72500	45000	6200	3100	3600
2006.08.17	35000	70000	45000	6200	3100	3600
2006.08.10	33000	62500	42500	6000	3100	3600
2006.08.03	33000	62500	41000	6000	3000	3500
2006.07.27	32500	55000	41000	6000	3000	3500
2006.07.20	32000	50000	40000	6000	3000	3500
2006.07.13	32000	50000	40000	6000	3000	3500

2006.07.06	31000	50000	40000	6000	3000	3500
2006.06.29	30000	50000	38500	6000	3000	3500
2006.06.22	30000	50000	38500	6000	3000	3500
2006.06.15	29000	49500	38000	6000	3000	3500
2006.06.08	29000	49000	37000	6000	3000	3500
2006.06.01	29000	49000	37000	6000	3000	3500
2006.05.25	29000	48000	37000	6000	3000	3500
2006.05.18	29000	48000	37000	6000	3000	3500
2006.05.11	29000	48000	37000	6000	3000	3500
2006.04.27	29000	48000	39000	6000	3000	3500
2006.04.20	29000	48000	40000	6000	3000	3500
2006.04.06	30500	48000	40000	6000	3000	3500
2006.03.30	31000	50000	40000	6000	3000	3500
2006.03.23	32500	52500	41000	6000	3000	3500
2006.03.16	32500	52500	41000	6000	3000	3500
2006.03.09	34000	55000	42500	6000	3000	3500
2006.03.02	34000	55000	42500	5900	3000	3500
2006.02.23	35000	57500	42500	5900	3000	3500
2006.02.16	35000	57500	42500	5900	3000	3500
2006.02.09	35000	57500	42500	5900	3000	3500
2006.01.26	35000	57500	42500	5900	3100	3600
2006.01.19	35000	57500	43000	5900	3100	3600
2006.01.05	35000	57500	42500	5900	3100	3600
2005.12.22	35500	58000	42500	6000	3100	3600
2005.12.15	35000	57500	45000	6000	3100	3600
2005.12.08	35000	57500	45000	6000	3100	3600
2005.11.24	35000	60000	45000	6000	3100	3600
2005.11.17	35000	60000	40000	6000	3100	3600
2005.11.10	35000	52500	40000	6000	3100	3600
2005.11.03	32000	52500	40000	6000	3100	3600
2005.10.27	32000	52500	40000	6000	3100	3600
2005.10.20	32000	52500	40000	6000	3100	3600
2005.10.13	32000	52500	40000	6200	3100	3600
2005.09.29	32000	52500	40000	6200	3200	3700
2005.09.22	30000	52500	40000	6200	3200	3700
2005.09.15	30000	52500	40000	6200	3200	3700
2005.09.08	30000	52500	40000	6200	3200	3700
2005.09.01	30000	52500	40000	6200	3200	3700
2005.08.25	30000	52500	40000	6300	3200	3700

2005.08.18	30000	52500	40000	6300	3200	3700
2005.08.11	30000	52500	40000	6300	3200	3700
2005.08.04	30000	52500	37500	6300	3200	3700
2005.07.28	30000	52500	37500	6300	3200	3700
2005.07.21	30000	52500	37500	39000	3200	3700
2005.07.21	30000	52500	37500	28500	20000	19000
2005.07.07	30000	52500	39000	6400	3200	3700
2005.06.30	30000	57500	40000	6400	3200	3700
2005.06.23	32000	65000	40000	6400	3200	3700
2005.06.16	33000	65000	40000	6500	3200	3700
2005.06.09	33000	65000	40000	6500	3200	3700
2005.05.19	33000	65000	41000	6500	3200	3700
2005.05.12	33000	70000	41000	6500	3200	3700
2005.04.28	35000	70000	41000	6500	3200	3700
2005.04.21	35000	70000	41000	6500	3200	3700
2005.04.14	35000	70000	41000	6500	3200	3700
2005.04.07	35000	70000	41000	6500	3200	3700
2005.03.31	35000	70000	41000	6200	3000	3500
2005.03.17	35000	70000	47500	6200	3000	3500
2005.03.10	35000	65000	47500	6200	3000	3500
2005.03.03	37500	65000	47500	6200	3000	3500
2005.02.24	37500	65000	47500	6200	3000	3500
2005.02.03	37500	65000	50000	6100	3000	3500
2005.01.27	37500	70000	55000	6100	3000	3500
2005.01.20	37500	90000	60000	6100	3000	3500
2005.01.13	37500	100000	60000	6100	3000	3500
2005.01.06	40000	100000	60000	6100	3000	3500
2004.12.23	40000	100000	60000	6100	3000	3500
2004.12.16	40000	100000	60000	6100	3000	3500
2004.12.09	40000	100000	60000	6100	3000	3500
2004.12.02	40000	100000	55000	6100	2900	3450
2004.11.25	40000	75000	55000	6000	2900	3400
2004.11.18	40000	75000	55000	6000	2900	3400
2004.11.11	40000	75000	55000	6000	2900	3400
2004.11.04	40000	75000	41000	5900	2900	3400
2004.10.28	40000	50000	41000	5800	2800	3300
2004.10.21	30000	30000	41000	5800	2800	3300
2004.10.14	30000	50000	40000	5800	2800	3300
2004.09.23	30000	50000	37500	5800	2700	3300

2004.09.16	30000	50000	32500	5600	2700	3200
2004.09.09	30000	50000	32500	5500	2700	3200
2004.08.26	28000	50000	32500	5400	2700	3200
2004.08.19	28000	50000	32000	5400	2800	3200
2004.08.12	28000	50000	32000	5350	2800	3300
2004.08.05	28000	50000	32000	5350	2800	3300
2004.07.29	27500	50000	32000	5350	2800	3300
2004.07.22	27500	50000	30000	5350	2800	3300
2004.07.15	27500	50000	30000	5350	2800	3300
2004.07.08	25000	45000	30000	5200	2800	3300
2004.07.01	25000	42500	30000	5200	2800	3300
2004.06.24	25000	40000	30000	5200	2800	3300
2004.06.17	25000	40000	30000	5200	2800	3300
2004.06.10	25000	40000	32000	5200	2800	3300
2004.05.27	25000	40000	32000	5200	2800	3300
2004.05.20	25000	40000	32000	5200	2800	3300
2004.05.13	25000	40000	25000	5200	2700	3300
2004.04.29	25000	40000	32000	5200	2700	3200
2004.04.22	25000	40000	32000	5200	2700	3200
2004.04.15	25000	40000	32000	5200	2700	3200
2004.04.01	25000	40000	32000	5100	2600	3200
2004.03.18	25000	40000	32000	4900	2600	3000
2004.03.11	25000	40000	32000	4900	2500	3000
2004.03.04	25000	40000	32000	4900	2400	2800
2004.02.26	25000	40000	32000	4800	2400	2650
2004.02.19	25000	40000	29000	4800	2400	2650
2004.02.12	25000	38500	28000	4800	2400	2650
2004.02.05	25000	38500	28000	4800	2250	2650
2004.01.15	20000	40000	27000	4700	2250	2500
2004.01.08	19500	39000	26000	4700	2250	2500
2003.12.25	19500	38000	26000	4700	2250	2500
2003.12.18	19500	38000	25000	4700	2250	2500
2003.12.11	18750	38000	24000	4700	2250	2500
2003.12.04		35000		4700	2150	2500
2003.11.28				4600	2150	2500
2003.11.20				4600		2500

Appendix II – Price of the New-building Ship (million dollars)

	Aframax	Panamax	Handymax	Capesize	Suezmax	VLCC
2011.06.08	55	36	31	55	65	102
2011.06.01	55	36	31	55	65	102
2011.05.25	55	36	31	55	65	102
2011.05.18	55	36	31	55	65	102
2011.05.11	55	36	31	55	65	102
2011.05.04	55	36	31	55	65	102
2011.04.27	55	36	31	55	65	102
2011.04.22	55	35.5	31	55	65	102
2011.04.13	55	36	31	55	65	102
2011.04.06	55	36	31	55	65	102
2011.03.30	55	36	31	55	65	102
2011.03.23	55	36	31	55	65	102
2011.03.16	55	36	31	55	65	102
2011.03.09	55	36	31	55	65	102
2011.03.02	55	36	31	55	65	102
2011.02.23	55	36	31	55	65	102
2011.02.16	55	36	31	55	65	102
2011.02.09	55	36	31	55	65	102
2011.02.02	55	36	31	55	65	102

2011.01.26	55	36	31	55	65	102
2011.01.19	55	36	31	55	65	102
2011.01.12	55	36	31	55	65	102
2011.01.05	55	36	31	55	65	102
2010.12.29	55	36	31	55	65	102
2010.12.22	55	36	31	55	65	102
2010.12.15	55	36	31	55	65	102
2010.12.08	55	36	31	55	65	102
2010.12.01	55	37	31	57	65	102
2010.11.24	55	37	31	57	65	102
2010.11.10	102	37	31	57	64	102
2010.11.03	65	37	31	57	65	102
2010.10.27	55	37	31	57	65	102
2010.10.20	65	37	31	57	65	102
2010.10.13	55	37	31	57	65	102
2010.10.06	55	37	31	57	65	102
2010.09.22	55	37	31	57	65	102
2010.09.01	55	37	31	57	65	102
2010.08.25	53	37	31	57	65	102
2010.08.18	53	37	31	57	65	102
2010.07.30	53	37	31	57	65	100
2010.07.14	53	37	31	57	65	100
2010.07.07	53	37	31	57	65	100

2010.06.30	52	37	31	57	65	100
2010.06.23	52	37	31	57	65	100
2010.06.16	52	37	31	57	65	100
2010.06.09	52	37	31	57	65	100
2010.06.02	52	37	31	57	65	100
2010.05.19	52	37	31	57	65	100
2010.05.12	52	37	31	57	65	100
2010.05.05	51	36	30	56	64	100
2010.04.28	51	36	30	56	64	100
2010.04.23	51	36	30	56	64	100
2010.04.16	51	35.5	30	56	63	97.5
2010.03.26	50	35	30	55	62	97.5
2010.03.05	50	35	30	55	62	97.5
2010.02.26	50	35	30	55	62	97.5
2010.01.29	50	35	30	55	61	97.5
2010.01.22	50	35	30	55	61	97.5
2010.01.08	50	35	30	55	61	97.5
2009.12.25	50	35	30	55	60	95
2009.12.18	50	35	30	55	60	95
2009.12.11	50	35	30	55	60	95
2009.12.04	50	35	30	55	61	95
2009.11.20	51	56	30.5	56	61	95
2009.11.13	51	35.5	30.5	56	61	95

2009.11.06	51	35.5	30.5	56	61	97
2009.10.30	52	36	31	58	62	98
2009.10.23	55	63	31	58	62	98
2009.09.11	55	37	32	60	63	98
2009.09.04	55	37	33	60	63	100
2009.08.28	56	37	33	61	64	100
2009.08.14	57	38	34	62	66	102
2009.08.07	58	38	34	62	66	104
2009.07.31	59	38	34	63	67.5	105
2009.07.24	59	38	34	63	68	115
2009.07.17	59	38	34	63	68	115
2009.07.08	61	39	35	65	72	115
2009.06.19	61	39	35	65	72	115
2009.06.05	62	39	35	66	74	115
2009.05.22	62	39	35	68	75	120
2009.05.15	62	39	35	68	75	120
2009.05.08	62	39	35	70	75	122
2009.04.24	62	39	35	70	75	124
2009.04.03	63	40	36	71	77	124
2009.03.27	63	40	36	71	77	124
2009.03.13	63	40	36	71	77	124
2009.03.06	63	40	36	71	77	126
2009.02.20	65	41	36	72	80	126

2009.02.13	65	41	36	72	80	126
2009.01.23	65.5	41	36.5	74.5	80	126
2009.01.16	66	41	36.5	75	81	130