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A portfolio analysis of market investments in oil tanker transportation

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A Portfolio Analysis of Market Investments in Oil Tanker Transportation

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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.

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Abstract

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As we all know, shipping is a lucrative and risky business. With the development of the modern portfolio theory, it has been proposed that the shipowner should view his/her fleet as a portfolio of assets whose risk can be minimized by diversification.

This research paper “A portfolio analysis of market investments in oil tanker transportation” investigates the applicability of the MPT by modelling in the oil tanker transportation market. A real case study of the investment appraisal in eleven typical routes of the oil tanker transportation market for a four-year period of time has been conducted, based on the assumption that the investor is a risk adverse, who wants to get the maximum turns in the condition of the lowest risks, and then the author defines the variables, adopting the freight rate of oil tanker shipping as the return from physical market investments and using the IRR as the expected return. After modelling assumptions and defining variables, the MPT’s modelling has been formed to analyse the case and the spreadsheet simulation is applied to calculate the data mathematically, which helps to find out the optimal portfolio choice.

Keywords

Oil Tanker Transportation Market, Modern Portfolio Theory (MPT), Expected Return, Investment Appraisal

List of Abbreviations

MPT	**Modern Portfolio Theory**
BIFFEX	**Baltic International Freight Futures Exchange**
OPEC	**Organization of Petroleum Exporting Countries**
IMF	**International Monetary Fund**
TEU	**Twenty Foot Equivalent Unit**
VLCC	**Very Large Crude Carrier**
WS	**Worldscale**
IRR	**Internal Rate of Return**

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Chapter 1 Introduction

1.1 Background

According to Brealey and Myers (2003)[1], risk is best judged in a portfolio context. Most investors do not put all their eggs into one basket but they tend to diversify. In 1952, U.S. economist Harry Markowitz first proposed the modern portfolio theory (MPT) and won the Nobel Prize for Economics.

There are two main risks in the shipping market, they are market risk and individual risk (Kavusanoss and Visikis, 2006)[2]. The former means changes in prices of all individuals in the whole market, resulted from some outside factors, such as the financial crisis or the closing of the Suez Canal. The latter one refers to the risk has nothing to do with the overall market. It is defined as the change in price of a single individual. As long as there is an investment, the market risk will not be able to avoid, but the formulation of investment strategy can reduce or minimize the individual risk.

The portfolio theory in the securities market has been fully applied and practised. The securities market is a very active and volatile market. Since returns and risks are co-exist, investors often take advantage of diversification of investments to diversify risks and thus to obtain the expected returns.

Similarly, shipping is a lucrative and risky business. For example, during a eight-month period of time, from October 2008 to June 2009, the clean spot rate for the AG-Japan/ 55 000 mt tanker decreased from WS336 to WS94 [3]. Even shipowners who signed long term charters hoping to have a steady flow of income at low risk were surprised by the great fluctuation.

With the development of the modern portfolio theory, it has been proposed that the shipowner should view his/her fleet as a portfolio of assets whose risk can be minimized by diversification. Lorange and Norman[4] have shown how

a static single period model can be used for planning the investment in the portfolio.

In the shipping market, there are a number of routes and various types of ships, the incomes of each type of ship are inter-related but different. Many owners tend to invest in different routes or types of ships to share the risk. For example, a shipowner or ship investor may decide to invest in more than one of the seven different ship types (Panamax, Aframax, Suezmax and VLCC tankers or Handy size, Panamax and Cape size bulk carriers), in order to reduce his/her risks. In this way the sharp drop in the income of a particular ship size can be compensated by a less severe drop or even an increase in the income in another one, which is exactly the main point of the portfolio theory.

According to Brealey and Myers (2003)[1], diversification is a strategy designed to reduce risks by spreading the portfolio across many investments. Nevertheless, diversification cannot eliminate the market risk. Suppose the number of assets you invested in the market is equal to the number of all assets in the market, your income would be equal to the average market returns. That means the risk of a fully diversified portfolio is the market risk. The purpose of the modern portfolio theory is to optimize a certain group of investment proportion, minimize portfolio investment risks. In the shipping market, if the limited funds distributed to each type of ship on the each route, it will eventually get the market average returns rather than the optimal choice. So, investors should design a proper proportion of investments in a certain combination of the assets, otherwise the strategy of diversification is meaningless.

As we all know, the shipping market can be mainly divided into three main parts, they are bulk shipping market, oil tanker and container shipping market.

Since the freight rate of the container shipping market is relatively stable, meanwhile, lots of papers has been written about the portfolio analysis of the bulk shipping market, so this research paper will only focus on the analysis of the oil tanker transportation market.

1.2 Research Aim and Objectives

1.2.1 Research Aim

This research paper aims at testing the applicability of the portfolio theory by modelling in the oil tanker transportation market in a long run, which including the investigation of whether and in which cases diversification through investing in different market segments can help to reduce risks, and whether there is an optimal portfolio proposal for the shipping investment.

1.2.2 Objectives

To achieve this aim, the following objectives have to be met:

●To provide a historic analysis of the major shipping markets in oil tanker transportation market.

●To apply the modern portfolio theory (MPT) to investigate whether investing in a combination of assets reduces risk more effectively compared to an investment in a single market in a long run.

●To identify from all possible portfolio combinations the ones where risk reduction based on returns is possible.

●To investigate whether ship investors can optimise their investment performance by utilising the modern portfolio theory.

1.3 Literature Review

Developed in 1952 by Nobel Prize winner Harry Markowitz, the modern portfolio theory (MPT) made a new paradigm of portfolio selecting for investors, which suggested how investors could strike a balance between returns and risks. Markowitz showed that it could make sense for investors to hold securities or assets only in such proportion that the combined portfolio

either achieved maximum return for a given level of risk, or minimized the risk for a given level of returns. The theory incorporates various measures of volatilities and returns[5] such as standard deviation, correlation coefficient, expected return and so on. It gave rise to rules that could recommend an asset-allocation formula for any investor. Later on, lots of efforts have been performed by experts in order to solve and expand Markowitz's model. These attempts, regarding the limitations of a factual market, have tried to make his model more practical.

In 1956, Markowitz represented the critical line method to solve his quadratic model (Markowitz, 1956). Wolfe tried to solve Markowitz's model by Simplex algorithm (Wolfe, 1959). Konno's new definition of risk in his mean absolute deviation (MAD) model, has been led several investigations. Interestingly, Konno's model can be solved by linear methods like Simplex, (Konno, 1990; Konno & Yamazaki, 1991). Again, Markowitz, himself, studied more complex objective functions, based on the notions of semi-variance (Markowitz, Todd, Xu, & Yamane, 1993).[6]

By considering a shipowner's financial commitments as investments in the shipping market, the development of a hedging strategy in shipping can be also treated as a portfolio optimization problem. In 1973, [4]Lorange and Norman applied the portfolio theory in the management of bulk shipping companies. They looked at the problem as a "one-shot" static decision and their research was in terms of the net present value. This paper is the most famous one that aimed at reducing the risk inherent in shipping market by using the Markowitz's portfolio theory. And then, [7]Sudeep Anand (1975) presented a multi-period portfolio selection model for companies operating in charter shipping markets. Both bulk and tanker shipping markets in the charter field have been analysed as the selected objects, which expanded the portfolio theory to the tanker charter market. He researched the combined market and shown a long range portfolio planning model for a period of five

years. In 1995, [8]Kevin Cullinane represented a portfolio analysis of market investment in dry bulk shipping. He tried to apply the modern portfolio theory to determine a subjectively optimal portfolio of market investments in the dry bulk shipping sector and to assess the role that BIFFEX might play in allowing shipowners to develop more appropriate hedging strategies. He chose three sub-markets as the assets in order to simplify the portfolio analysis, and the collected data was derived for a four-year period of time. Furthermore, he has not assessed the correlation coefficient between each two sub-markets, and the analysis was static. In 2005,[9] Prof. Lamberts provided an economic analysis of the bulk shipping markets and the implications for shipping investment and finance. In this paper, he applied the MPT to investigate whether investing in a combination of assets reduces risk more effectively compared to an investment in a single market. He analysed the integration and efficiency of the bulk shipping markets both in the short and the long run. But he only focused on the bulk shipping and adopted a static analysis.

Though the MPT has been applied to analyse the shipping market in many papers, there is few papers that especially applied the MPT to analyse the inherent investment in oil tanker transportation market. Hence, there is plenty of room for research and development in this field.

1.4 Research Methodology

In this paper, the following methods have been adopted to analyse the applicability of the modern portfolio theory (MPT) in the oil tanker transportation market:

● Theory: the modern portfolio theory (MPT)

● Comparison Research: Comparing the correlation coefficients between each two assets as different portfolios inside the oil tanker transportation market.

● Modelling:

1. The portfolio theory's modelling: Using the standard deviation to describe

the risk, and adopting Markowitz's multi-asset portfolio model to analyse a real case.

2. Spreadsheet modelling: Using the spreadsheet simulation to find the best split of the investment share.

A spreadsheet[10] is a computer application that simulates a paper, accounting worksheet. It displays multiple cells that together make up a grid consisting of rows and columns, each cell containing alphanumeric text, numeric values or formulas. A formula defines how the content of that cell is to be calculated from the contents of any other cell (or combination of cells) each time any cell is updated.

1.5 Structure

Chapter 1 gives a background introduction of the research paper followed by the research aim and objectives, and then the literature review of studies, which focuses on the background of the MPT and its influence on the shipping market.

Chapter 2 gives the overview of the world crude oil market, in respect of the world crude oil stocks structure, global crude oil demand and supply balance, and overview of the global crude oil price. And then, it represents the overview of the oil tanker transportation market, which comprises the development history of the tanker transportation market and the analysis of its characteristics.

Chapter 3 gives an introduction of the modern portfolio theory's model, based on the portfolio risk, correlation coefficient, expected return, and its drawbacks, and then it applies the MPT and Spreadsheet model to analyse the oil tanker transportation market in a real case, and it investigates the result of the simulation based on the MPT's model.

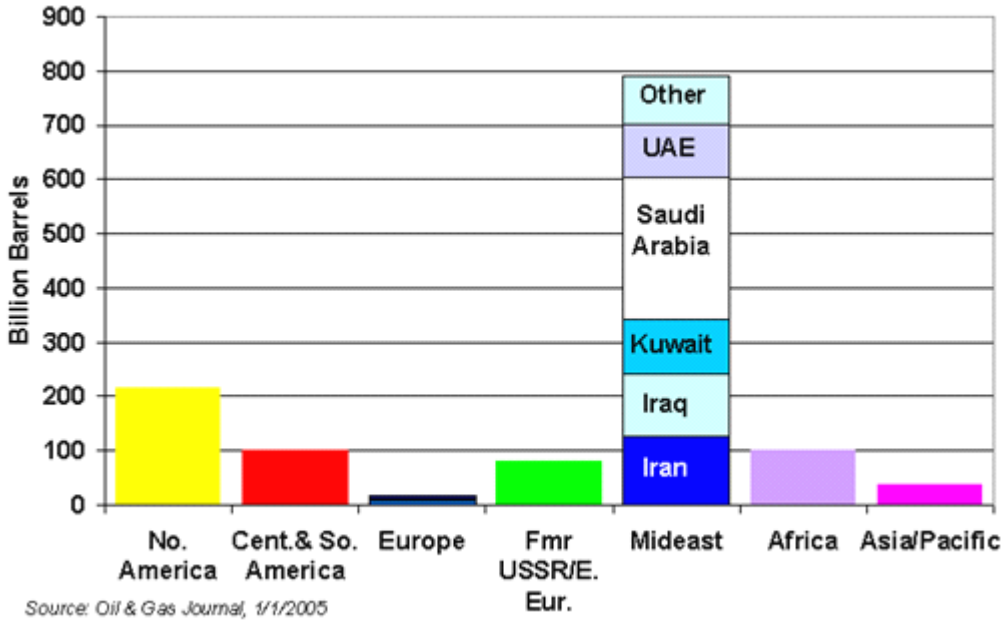
Finally, chapter 4 and 5 gives the author's conclusions and recommends that have been derived from the research.

Chapter 2 Overview of the Oil Tanker Transportation Market

2.1 The World Crude Oil Stocks Structure

The Mideast is the largest oil-producing region, which holds about two-thirds of the one trillion barrels of global proved oil reserves (Graph 1). Since, the Middle East is a region that exhibits both favorable characteristics, the petroleum traps are large and numerous, and the reservoir rock holds the oil in substantial pools. This region's dominance in world oil supply is a clear result. Other regions, however, also have large oil stocks, even if the oil is more difficult to identify and more expensive to produce. The United States, with its rich oil history, is such a region.

Graph 1: World Oil Stocks by Region, January1, 2005



Source: Oil & Gas Journal, 1/1/2005

Saudi Arabia (Graph1), the market in the early 1980s, has been the world's largest producer during the 1990s. Not only did Saudi Arabia increase its production to fill the gap left by the loss of Iraqi and Kuwaiti supplies after Iraq

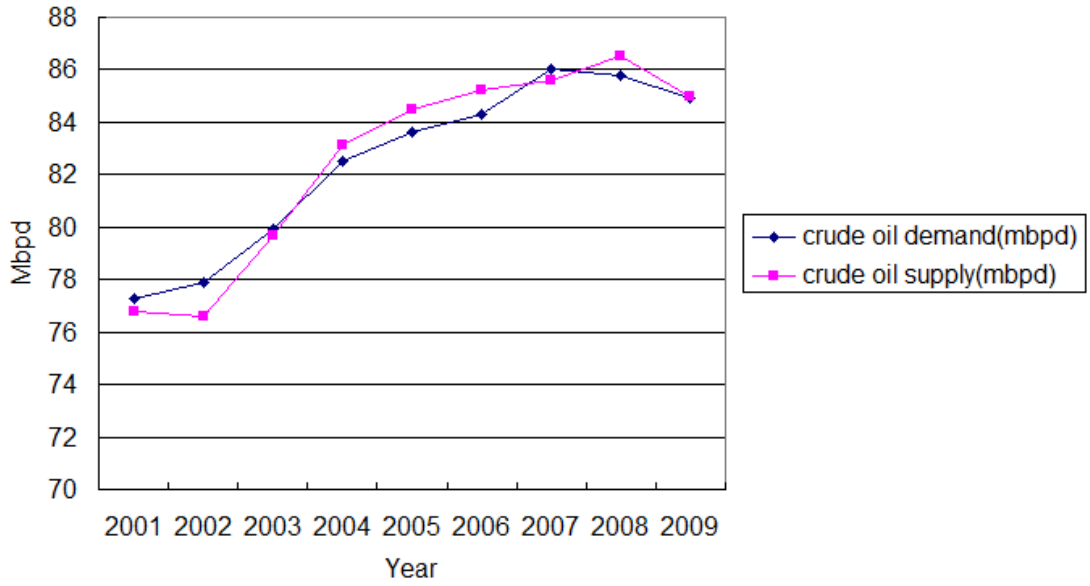
invaded Kuwait in 1990, but production declined in the other two large producers, the United States and the Former Soviet Union.

North America (Graph 1) is the second largest producing area after the Middle East. The United States, the second largest producing country in the world, accounts for almost 60 percent of the North American region's total. Canada, the United States and Mexico all have long production histories, and production from mature fields has been declining. However, a new surge in technology has benefited both new field development and more complete production from existing fields[11].

2.2 Global Crude Oil Demand and Supply Balance

Recent years, from 2001 to 2007, both the global crude oil demand and supply turned on an upward trend (Graph 2), both from about 77 mbpd to 86 mbpd. Since, the recovery of the world economic in 2001 and its strong growth stimulated both sides to increase greatly. During the four-year period, from 2004 to 2007, the level of demand was lower than the supply's. After 2007, the volume of crude oil demand began to decrease, which was followed by the supply side in one year later.

Graph 2: Yearly Global Crude Oil demand and supply balances (mbpd)

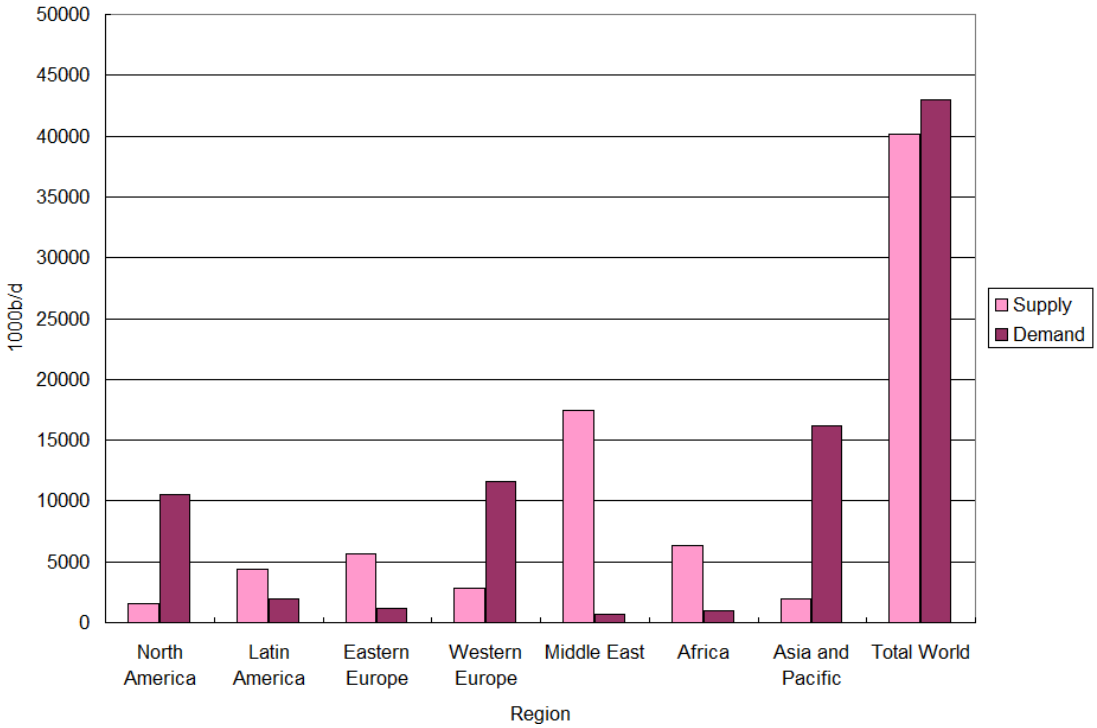


Source: Clarkson. Drawn by the author ©Copyright Xu Zeye, WMU-SMU

Regionally, until 2008, the largest consuming area was Asia/Pacific (Graph 3), followed by North America (dominated by the United States), Western Europe.

On the supply side, Middle East was ranked as the biggest amount of export, followed by Africa, and then Eastern Europe. Moreover, as for Asia/Pacific, the volume of demand side was almost six times more than that of the supply side. Similarly, North America and Western Europe were also import-oriented regions. However, Middle East had almost no actual demand on importing the crude oil. Furthermore, Africa, Latin America and Eastern Europe were export-oriented regions as well.

Graph 3: Global Regional Crude Oil Supply/Demand Balances, 2008

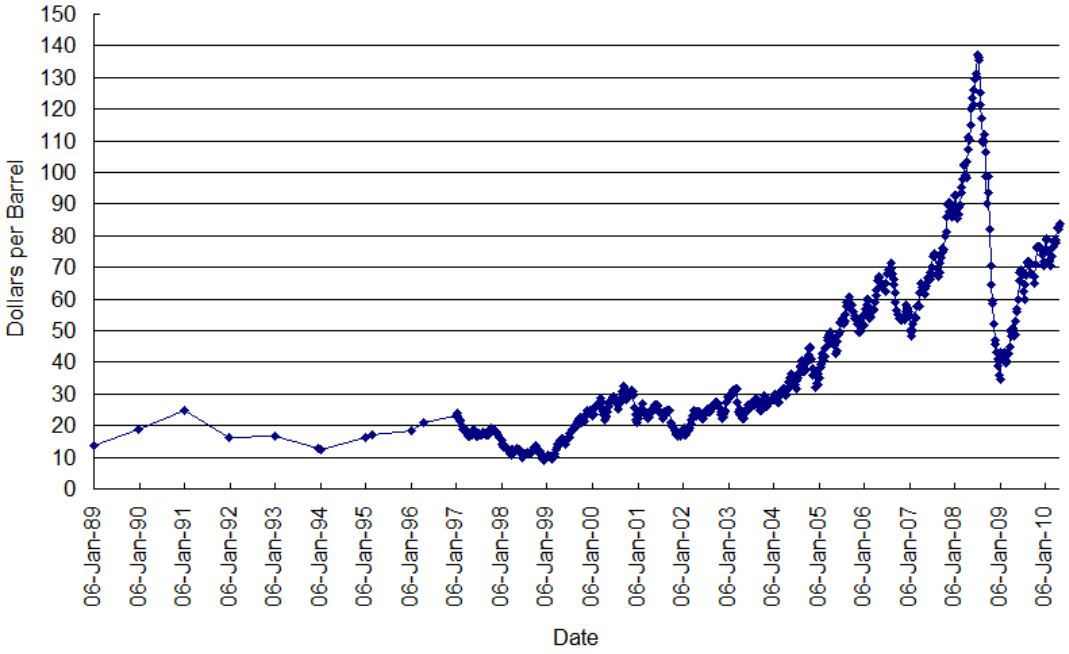


Source: OPEC Annual Statistical Bulletin, 2008. Drawn by the author

2.3 Overview of the Global Crude Oil Price

Over the past few decades, the price of the crude oil fluctuated from about 12 dollars per barrel in 1989 to about 140 dollars per barrel in 2008[3], and then dropped off sharply to about 35 dollars per barrel in 2009, and now the price is around 85 dollars per barrel (Graph 4), which gives us a sign that the oil market is quite changeable and full of risks.

Graph 4: Yearly Global Crude Oil Spot Price FOB Weighted by Estimated Export Volume (Dollars per Barrel)



Source: Energy Information Administration, EIA. Drawn by the author

2.4 The Development History of the Tanker Transportation Market

2.4.1 The 1950s

During 1950-1957, the demand for tanker shipments was rising at an annual rate of 10.6% per annum.

2.4.2 The 1960s

In the early 1960s the growth rate of the tanker fleet was restrained and with demand growing strongly, the market began to recover in 1963. This contributed to a significant improvement in the freight market balance. Most of the laid up ships were absorbed by this increase. By 1963 lay-up had fallen to 2%. As a result, rates began to oscillate around a higher level. Prices and shipbuilding responded positively while scrapping fell. The market benefited from the second closure of the Suez Canal in the summer of 1967. The closure of the Suez added about 75% to the Gulf North Europe voyage distance and immediately put a huge premium on the largest tanker sizes.

2.4.3 The 1970s

The 1967-1973 phases were one of the most profitable of the whole post-war period. The fundamental factors that contributed to this were many. Most important of all was the extreme increase in the growth rate of demand for shipments. Indeed with the closure of the Suez Canal from 1967 to 1975, the growth rate in demand rose to record levels. Despite of full shipyard capacity utilisation and minimal scrapping tanker freights soared nearly to WS280. At such a rate a VLCC would make a profit of $5 million from one voyage lasting 70 days. The price of this ship in the early 70s would have been $30 million implying that the vessel could have been repaid in just 14 months. VLCCs reached $65 million in value while the orderbook expanded to a level which represented about 90% of the existing fleet! Paradoxically dry cargo deliveries as a percentage of the fleet had been on a downward trend ever since the closure of the Suez Canal in 1967 and the trend continued up to 1975, in spite of the strong market. This may be attributed to the fact that tankers under construction occupied most of the newbuilding berths. Between 1971 and 1976 tanker construction absorbed 52% of actual shipbuilding capacity.

In the early 70s, banks which were hungry for shipping business started offering 90 to 100 % financing and some deals were transacted in which the borrower actually received finance for more than the cost of the vessel. By the time of the final inrush of banks into ship finance in 1972-1973 owners were expecting to be charged margins between 0.5 and 1%.

Investors were caught as OPEC[12] unexpectedly raised the oil price in October 1973, which was the time when the tanker market and expectations were at their high peak. As oil price quadrupled the economic boom was suddenly over. The implications for the tanker market were catastrophic. A devastating drop in freight rates and ship values followed the massive 1973 orders and the stagnation of demand. Overnight VLCC values fell by $20

million. A 210,000 dwt VLCC that in 1973 would have been ordered for $47 million would be worth just $5 million in1977. In 1979 the market made a partial recovery as the higher bunker prices associated with the tripling of oil prices and other exogenous fleet inefficiencies led to a freight market shortage. However this short-lived boom was followed by a new depression which was even more severe than the previous one.

There were three problems that contributed to the depth of this recession:

- The oversupply of tankers resulting from the speculative investment in the early 1970s.
- Excess Shipyard capacity. It took a decade of over production to cut capacity to a level more in line with demand.
- The oil price rises in 1973 and 1979 dramatically reduced the demand for oil imports.

By the end of 1974 and early 1975, with financial strains on many tanker owners becoming critical complacency gave way to gloom and panic. Bankers came to realize the extent of the potential losses they could be facing on their tanker loans which were in most cases technically under-secured even if the owners were continuing to repay the principal and interest (Stokes 1997). Furthermore, the existence in the major shipbuilding countries of export credit agencies acting as guarantors or insurers of subsidised fixed interest loans for the majority of the delivered cost of newbuildings represented a distortion likely to encourage the construction of more vessels than actually required by the market. The availability of this credit often with additional commercial finance arranged through banks or trading houses connected with the shipyard, ensured that orders remained in place that would otherwise have been cancelled.

1976 and 1977 were the years in which large sections of the banking industry took a look at their shipping portfolios and decided to overhaul them. The

result was a withdrawal of many banks from the market, partly because of a conscious decision to shut their doors on new business and partly because existing problems were monopolising their time. Most of the banks that took this attitude were the ones that had entered the market in the early 1970s in a spirit of misguided optimism. However, there were some banks with a long history in shipping finance, which also decided to exit the market when some relatively heavy losses started to be felt.

For those banks that continued to do business in 1976 and 1977 the rewards were considerable.

2.4.4 The 1980s

Demand dropped for two consecutive years in 1982 and 1983. Values of VLCCs collapsed to scrap levels. Lay-up rose to 20% of the fleet with the real surplus being as much as 50% according to some estimates. The orderbook remained extremely depressed. Profitability in the freight market was persistently negative.

In 1986 OPEC allowed oil price to drop. These were the first signs of a recovery. Freight rates increased by 70% and VLCC prices doubled from 5 to 10 million USD. In 1989, when the market peaked, the same vessel was worth $38 million despite being three years older.

2.4.5 The 1990s

In the tanker market the freight peak was accompanied by three years of heavy ordering from 1988 to 1991. This rush of investment was based on four expected developments in the tanker market:

- The fleet of ageing tankers built in the 1970s construction boom was expected to be scrapped at twenty years of age, creating heavy replacement demand in the mid-1990s.
- Shipbuilding capacity had shrunk so much in the 1980s that a shortage seemed likely when increasing newbuilding prices seemed to support this

view. In 1986 a new VLCC had cost less than USD 40 million but by 1990 the price was over USD 90 million

- New legislation. When the Exxon Valdez ran aground in Alaska, leaking 36,500 tonnes of crude oil into the pristine waters of Prince William Sound in March 1989, it was not by any means the most voluminous of the big tanker spills. But it was the wrong place for it to happen. The severe ecological damage made Washington not to feel obliged to canvass international consent before taking its own action. Consequently, one year after the Exxon Valdez incident, the Oil Pollution Act of 1990 was approved by congress. Besides the fact that its double hull requirement added substantially to the cost of constructing compliant tankers, OPA 90 also imposed potentially unlimited liabilities on tanker operators unfortunate enough to be caught polluting. Perceived at the time as draconian and unfair, it prompted many shipowners — respectable companies and rogues alike — to consider avoiding the US trades in the future or invest heavily in new double hull tankers.
- Growing oil demand was expected to be met from long haul Middle East exports, creating rapidly increasing demand for tankers, especially VLCCs.

As it turned out none of these expectations was realized. Most of the 1970s built tankers continued to trade beyond twenty years and Middle East exports stagnated as technical innovation allowed oil production from short haul sources to increase faster than expected.

Delivery of the tanker order book pushed the market into a recession which lasted from early 1992 to middle of 1995 when a recovery finally started and freight rates moved on to a steady improving path.

However, the worst were still to come. Beginning in the middle of 1997, many Eat Asian economies including Indonesia, Korea, Malaysia and Thailand

experienced a common set of economic events known collectively as the East Asian crisis (Stiglitz 2002). The macroeconomic phenomena that characterised this crisis were a devaluation of the currency exchange rate with the US dollar, a sharp expansion in the current account and a general contraction in economic production.

In 1998, Russia was deeply in debt and the higher interest rates that the East Asia crisis had provoked created an enormous additional strain. The whole system collapsed when oil prices fell. Due to recessions and depressions in Southeast Asia, which IMF [13] policies had exacerbated, oil demand not only failed to expand as expected but actually contracted. The resulting imbalance between supply and demand of oil turned into a dramatic fall in crude oil prices (down over 40% in the first half of 1998 compared to the average prices of 1997). Oil is both a major export commodity and a source of government tax revenue for Russia, and the drop in prices had a predictably devastating effect. Given the exchange rate at the time and the fact that the price of oil was below the cost of extraction plus transportation of Russian oil, devaluation would be inevitable[9].

2.4.6 The 2000s

Bulk carriers started recovering first, along with improvements in world economy in late 1999 early 2000. For tankers, a low orderbook and an increase in oil price and trading further tightening the supply demand balance, led to the best freight market for thirty years. However, after the September 11 2001 attacks in the World Trade Center and the economic recession already evident since March 2001 when the dot.com bubble burst, both markets plummeted until the end of 2002. Thanks to an unprecedented growth of the Chinese economy, 2003 showed signs of recovery for the tanker market. Then the tanker market seemed to get its power, the fleet of tankers increased up to 384.6 million dwt in 2007(Table 1).The prosperous development story reached its end when the financial crisis came from

America and spread into the whole world, as the result, crude oil price dropped sharply from nearly 140 dollars per barrel in Jun 2008 to less than 35 dollars per barrel in Jan 2009(Graph 4). Consequently, the average tanker spot rate dropped from 47.7 tce $'000pd in 2008 to 15.0 tce $'000pd in 2009[3]. This depression was definitely the most severe in modern tanker history. Freight rates, profits, ship prices and shipbuilding hit all-time lows.

Table 1: Tanker Fleet Development by Size

	Fleet '000 Dwt										Avg. Growth p.a.	
Size Dwt (tonnes)	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**		
10,000 - 14,999	3,452	3,517	3,645	3,661	3,785	4,084	4,729	5,660	6,800	7,654	466.9	9.2%
15,000 - 19,999	5,270	5,381	5,569	5,858	6,078	6,423	6,757	7,366	8,540	9,498	469.7	6.8%
20,000 - 24,999	2,822	2,732	2,648	2,357	2,376	2,351	2,259	2,116	1,957	1,991	-92.3	-3.8%
25,000 - 29,999	6,651	6,502	6,109	5,745	5,445	5,550	5,449	5,270	4,903	4,612	-226.6	-4.0%
30,000 - 34,999	8,044	7,962	7,262	7,066	6,977	6,856	6,647	6,175	6,243	6,221	-202.5	-2.8%
35,000 - 39,999	10,586	11,059	11,346	11,973	12,979	13,650	14,348	15,328	16,090	16,121	615.0	4.8%
40,000 - 44,999	6,674	7,056	7,605	8,294	8,666	9,319	10,044	10,490	10,898	11,064	487.8	5.8%
45,000 - 49,999	9,172	9,543	10,559	12,613	15,882	18,187	20,296	22,786	25,597	28,987	2201.6	13.6%
50,000 - 59,999	4,903	4,791	4,167	3,344	3,213	3,536	4,869	6,352	9,271	11,804	766.8	10.3%
60,000 - 69,999	11,741	11,818	12,115	11,581	10,846	10,716	10,789	10,471	9,882	8,778	-329.2	-3.2%
70,000 - 79,999	2,756	2,519	2,440	3,219	5,396	8,021	10,539	13,435	16,189	18,937	1797.8	23.9%
80,000 - 89,999	15,541	14,577	13,480	11,068	9,585	8,458	7,228	6,550	5,409	4,284	-1250.7	-13.3%
90,000 - 99,999	20,220	19,935	20,120	19,662	19,098	18,533	18,344	18,554	17,196	15,487	-525.9	-2.9%
100,000 - 119,999	17,179	18,356	21,452	28,629	33,584	40,593	45,763	51,324	58,453	68,067	5654.2	16.5%
120,000 - 159,999	40,398	37,991	39,077	40,519	42,069	44,458	46,927	47,700	47,327	51,564	1240.6	2.7%
160,000 - 199,999	2,000	2,286	3,108	3,069	3,429	4,638	5,785	7,270	8,247	8,867	763.0	18.0%
200,000 - 254,999	10,569	8,923	7,759	7,051	6,547	6,302	6,302	5,837	4,399	3,171	-822.0	-12.5%
255,000 - 319,999	100,183	100,568	107,156	112,850	120,292	128,744	133,417	139,011	145,290	154,525	6038.0	4.9%
320,000 & Above	17,341	15,064	9,485	4,811	3,379	2,328	2,288	2,930	3,571	4,091	-1472.3	-14.8%
T O T A L	**295,503**	**290,583**	**295,103**	**303,369**	**319,627**	**342,746**	**362,781**	**384,623**	**406,263**	**435,722**	15579.9	4.4%
Note: All totals at start year												

Source: Clarkson

After Feb 2009, the price of crude oil turned to increase, and reached about 80 dollars per barrel in April 2010[3].

Despite a slight recovery towards the end of the year, 2009 proved to be one of the weakest years in the history of tanker markets. As the world economy witnessed its worst recession since the Great Depression of the 1930s, tanker owners suffered from abysmally low earnings upon a notable drop in oil demand (and in turn tanker demand), coupled with a steady and sizeable rise in tonnage supply (over 5% y-o-y)[3] . Freight rates in 2009 fell by an average 60% (in crude as well as the product tanker markets); with owners' earnings falling by an even greater extent, due to the steadily rising bunker cost.

Hence, from the overview of the development history of the oil tanker transportation market, we can see that shipping is a lucrative and risky business, and how to control the risk has become more and more important for shipowers or investors.

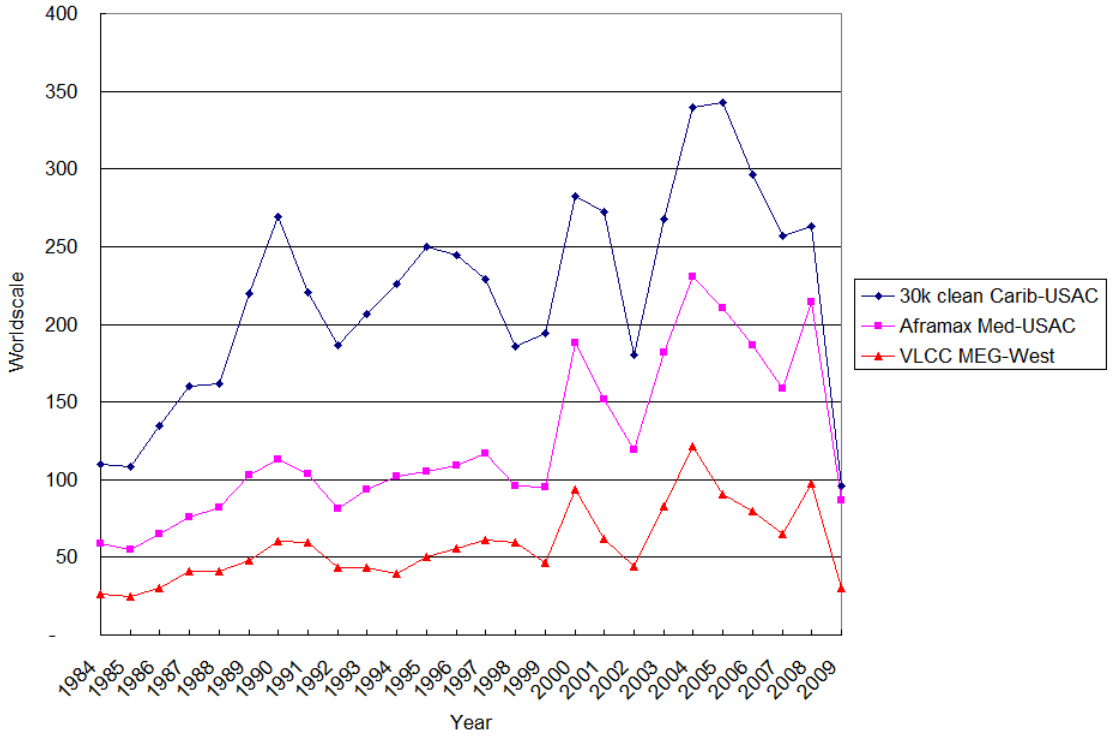
2.5 Characteristics of the Oil Tanker Transportation Market

The oil tanker transportation market was promoted by the development of offshore oil trade with about a hundred-year history, which is recognized as a legal operation, a high degree of specialization, information integrity, openness and highly transparent mature industry. And we can summarize some typical characteristics of the oil tanker transportation market.

2.5.1 Highly Cyclical

Changes of the world economy lead to the changes of the oil requirement, and consequently, such changes influence the oil tanker transportation market as well. As we can see from the previous data (Graph 5), the changes of the oil tanker transportation market turned on a periodically feature. For example, Carib-USAC,Med-USAC and MEG-West are the three typical voyage charter routes of the oil tanker transportation market, the worldscale of them (see graph) changed periodically, and the average cycle of each is around six years.

Graph 5: Yearly Worldscales for the Typical Three Routes



Source: Clarkson. Drawn by the author

2.5.2 Highly Specialized

The oil tanker transportation market is highly specialized and full of risks. All related factors, including security, technology, specification standard, potential leakage and pollution make very high requests to the tanker carrier. The obvious differences between the work divisions of the oil tanker and container transport or bulk shipping reflect its specialized feature. The world top oil tanker fleets (Table 2) at present are all very professional in this market.

Table 2: Tank Top Five Companies, 2008

Rank	Company Name	total	Unit
1	Fredriksen Group	17,210,000	DWT
2	MOL	13,790,000	DWT
3	Nippon Yusen Kaisha	11,270,000	DWT
4	Teekay	10,290,000	DWT
5	NIOC	9,670,000	DWT

Source: Clarkson. Drawn by the author

2.5.3 The Oligopoly Situation

Now there are two modes of the oil tanker management in the international market, they are the subsidiary fleet of the oil company and the independence shipowner.

Today the independence shipowner has become the mainstream of the oil tanker market, which has taken over 80% market shares[14]. With the growing of the independence shipowners, the division of works between shipowners and oil companies are getting more and more obvious.

The rising of independence shipowners promoted the large scale promotion of the fleet size and the increase in mergers and acquisitions activity.

Subsequently, several super big professional tanker fleets appeared, and leaded to the oligopoly market structure step by step.

2.5.4 The Rules of Oil Tanker Operation: Single-Vessel Company and Flag of Convenience

Most independence shipowners register their tanker fleets as separate single-vessel companies. The reasons are as following:

1) The oil tanker transportation is a very high risk business, as long as an accident happened during the shipping period, it might cause huge losses and responsibilities to the shipowner. In order to separate the risk and avoid effecting on the whole fleet management, they usually register as a single vessel company.
2) The vessel is very high cost construction, registered as a single vessel company will be easier to get financing and capital control.
3) The operating rule of oil tanker fleet when contracting is that, usually, a single-vessel is regarded as a unit. Hence, registering as a single-vessel company is more convenient to manage, rent and sell.

Each tanker is registered as a single vessel company and hang up the flag of convenience is accepted by most shipping companies. In fact, such situation does not only happen in the oil tanker transportation market but also container

and bulk shipping market as well.

Chapter 3 Modelling the Case

3.1 Introduction of the Modern Portfolio Theory's Model

The modern portfolio theory (MPT) is a mathematical formulation of the concept of diversification in investing, with the aim of selecting a collection of investment assets that has collectively lower risk than any individual asset[15].

In its broadest sense, the Markowitz's model of portfolio selection involves the measurement of the expected return, risks, and risk attitude in order to derive a specific optimal portfolio of available market investments which satisfies the risk and return trade-off requirements of individual decision-makers or investors.

3.1.1 Portfolio Risks

There are two main risks in the shipping market, they are market risk and individual risk[2], leading to six different risk exposures when dealing with shipping projects.

1. Operation risks that lead to fluctuation in Earning before Interest and Taxes (EBIT) and might be due to changes in freight rates, voyage costs, operating costs.
2. Ownership risks that come from changes in the value of the asset.
3. Interest rate risks that are due to the fact that projects are high capital intensive and refund on variable interest rate.
4. Exchange rate risks or transaction risks that depend on the trade pattern.
5. Credit risks that are due to the non-performance of counterparties and become more of an issue during market downturn.
6. Accidents and losses risks.

The degree of risk can be measured by the standard deviation (σ) or the

variance (σ^2) of the expected return[5]. An explicit assumption is that either the standard deviation or the variance of a time series of returns from an individual investment must be used as a proxy for the risk of that investment. Both imply that risk relates to the level of dispersion around an expected return. The greater the dispersion is around an expected return, the greater the level of risk is. In this essay, the variance is used as the appropriate measure of risk.

3.1.2 Correlation Coefficient

Correlation coefficients are numerical indices providing information regarding the relationship between two variables. Correlation coefficients range from -1 through 0 to +1. Coefficients close -1 and +1 indicate strong linear relationships, whereas coefficients close to zero indicate weak ones.
The greatest payoff to diversification comes when the two assets are perfectly negatively correlated. In this case, there is always a portfolio strategy represented by a particular set of portfolio weights that will completely eliminate risk. Unfortunately, this almost never occurs in practice.

3.1.3 Calculating the Expected Return and Risks

3.1.3.1Two-Asset Portfolio

Let A and B be two assets available for an investor. He invests x% of his money in A and (1-x)% in B. The expected return of asset A and B are $E(r_A)$ and $E(r_B)$. The expected return and variance of the portfolio p are[16]:

$$E(r_p) = x\ E(r_A) + (1-x)\ E(r_B) \qquad (3\text{-}1)$$

$$\sigma_p^2 = x^2 \sigma_A^2 + (1-x)^2 \sigma_B^2 + 2x(1-x)\ \ p_{AB}\ \ \sigma_A \sigma_B \qquad (3\text{-}2)$$

3.1.3.2 Multi-Asset Portfolio

The risk and the expected (or real) return of a portfolio consisting of N different assets are calculated as:

$$E(r_p) = \sum_{i-1}^{N} x_i E(r_i) \tag{3-3}$$

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_i \sigma_j \rho_{ij} \tag{3-4}$$

Where x_i and x_j are the percentage of the portfolio invested in assets i and j respectively, while σ_p^2 is the variance of the portfolio.

3.1.4 Drawbacks of Using the Correlation Coefficient to Determine Our Investment Appraisal

The correlation coefficient, the usual parameter used to measure the degree of integration between any two markets by financial analysts may be misleading since markets often diverge considerably in the short-run, like periods of up to a year, but may actually be well integrated over longer periods. For example a low correlation coefficient may suggest that ships A and B offer diversification opportunities relative to other ship markets, and as a result shipowners and other investors with long investment horizons may diversify between these two markets believing that they will be spreading their risk more effectively. However, if the markets are in fact integrated to an extent that is not obvious by looking at the simple correlation coefficients then investors may not achieve the degree of diversification initially expected [17]. In this research paper, in order to investigate the applicability of the MPT to the oil tanker transportation market, a long term period is more sensible. Since, if in a long term, the theory is effective, it will be more effective in a short term.

3.2 Applying the Methodology

3.2.1 Sample Trades

Mainly, the oil tanker transportation market comprises five sub-markets, they

are [3]VLCC, Suezmax, Aframax, Panamax and Product, and each sub-market has its typical routes. Here, eleven typical trade routes (Table 3) have been selected as the assets to invest.

Table 3: Eleven Routes of the Oil Tanker Transportation Market

VLCC	A	AG-Japan/200-300,000 dwt
	B	AG-South Korea/200-300,000 dwt
	C	AG-NW Europe/200-300,000 dwt
	D	W.Africa-US Gulf/200-300,000 dwt
Suezmax	E	W.Africa-Caribs/USES/100-160,000 dwt
Aframax	F	Med-Med/70-100,000 dwt
	G	NWE-NEW/70-100,000 dwt
	H	Caribs-USES/70-100,000 dwt
Panamax	I	Caribs-USES/40-70,000 dwt
Product	J	AG-Japan (clean)/50-60,000 dwt
	K	Caribs-USES (clean)/35-50,000 dwt

Source: Clarkson. Drawn by the author

These routes were chosen for two reasons. Firstly, in terms of the ship size and routes, they represent a good cross-section of the oil tanker transportation market. Secondly, since the routes are typical and regularly traded, so the freight rate data is easily available with can help to facilitate the case analysis.

3.2.2 Data Collection

For the sake of simplicity, we ignore the cost considerations, and we assume that the freight rate of oil tanker shipping is the return from physical market investments. And the freight rate is measured by Worldscale. [18]Worldscale is a unified system of establishing payment of freight rate for a given oil tanker's cargo which was established in November 1952 by London Tanker

Brokers' Panel on the request of British Petroleum and Shell as an average total cost of shipping oil from one port to another by ship.

The monthly clean and dirty spot rates of the eleven typical routes will be investigated for a four-year period of time (a long term), from Mar.2006 to Mar.2010. (Table 4)

Table 4: Monthly clean and dirty spot rates of oil tanker shipping

				Mar-06	Apr-06	May-06	Jun-06
VLCC	A	AG-Japan/200-300,000 dwt	WS	83	56	74	101
	B	AG-South Korea/200-300,000 dwt	WS	76	56	68	102
	C	AG-NW Europe/200-300,000 dwt	WS	77	60	69	80
	D	W.Africa-US Gulf/200-300,000 dwt	WS	95	88	103	114
Suezmax	E	W.Africa-Caribs/USES/100-160,000 dwt	WS	129	120	143	129
Aframax	F	Med-Med/70-100,000 dwt	WS	149	149	165	154
	G	NWE-NEW/70-100,000 dwt	WS	126	101	144	123
	H	Caribs-USES/70-100,000 dwt	WS	204	133	195	186
Panamax	I	Caribs-USES/40-70,000 dwt	WS	217	216	219	231
Product	J	AG-Japan (clean)/50-60,000 dwt	WS	157	155	229	225
	K	Caribs-USES (clean)/35-50,000 dwt	WS	267	198	272	292

Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07
112	120	109	69	68	58	58	59	82	50	81
119	109	109	72	66	59	58	55	81	53	72
90	95	95	75		58	54	52	66	45	69
120	134	107	101	91	79	85	84	86	76	82
159	174	135	148	122	130	129	116	116	113	108
187	176	144	197	115	178	231	121	157	146	173
155	140	122	180	120	151	169	168	138	139	129
205	200	170	235	187	219	174	211	187	156	170
221	238	166	211	179	243	212	205	214	207	198
202	260	255	160	155	194	185	161	182	172	185
330	296	247	260	198	305	258	282	324	235	252

Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08
63	63	56	54	57	71	195	122	96	97	109
60	55	53	52	53	86	189	127	99	88	102
60	50	45	42	42	82	163	135	88	84	69
65	64	54	53	65	82	169	92	101	125	122
112	99	79	79	93	114	251	135	125	157	175
107	117	94	106	145	150	205	183	146	192	251
105	128	87	104	125	140	190	163	128	159	196
140	170	105	115	153	166	299	204	168	240	226
161	176	161	158	154	168	334	194	159	221	236
168	184	188	175	163	172	236	224	171	182	166
292	230	172	154	159	184	220	232	195	184	232

May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09
212	204	238	84	105	81	57	66	51	44	41
167	190	211	83	115	104	63	61	53	42	36
160	145	141	70	80	62	61			35	30
212	164	205	103	123	110	85	102	74	53	52
249	190	241	162	166	144	122	139	86	71	77
263	222	272	182	186	157	126	212	107	86	74
240	206	229	194	178	149	126	165	99	80	81
288	309	233	226	264	206	130	258	105	78	112
275	344	299	282	291	258	142	243	131	80	108
207	288	309	371	354	336	240	156	85	118	79
340	344	345	310	247	182	190	215	170	116	93

Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10
27	27	46	42	40	33	43	44	56	104	71	84
27	27	41	33	35	34	40	43	53	88	76	76
		28	27	27		29	31	34	70		57
46	35	48	31	44	41	47	58	63	97	80	87
53	50	61	46	49	55	58	75	73	114	97	96
62	68	103	66	68	73	85	91	117	124	95	135
72	66	80	73	69	69	76	96	115	137	113	126
59	73	77	67	67	71	70	94	112	173	146	127
70	83	106	72	74	85	89	87	116	176	181	151
52	63	85	87	94	104	131	100	121	151	139	124
72	106	96	81	84	85	83	76	99	149	139	159

Source: Drewry. Drawn by the author

Table 5 presents a correlation matrix of the spot freight rate of each two-sample asset. After comparing each two combination, we can see that most assets are highly correlated to each other. This means that risk reduction opportunities through diversification are rather limited. This is especially true in the case of bulk carriers where the correlation between Panamax and Handy Bulk carriers and Panamax and Cape size bulk carriers is almost perfect (0.94 and 0.95 respectively[8]). In this case, correlation coefficients are still high but not close to those of bulk carriers thus increasing the probability of higher diversification.

Further, the smaller is the correlation coefficient, the smaller strength of the linear relation between two variables. Among all the combinations, the relatively smaller combinations of the correlation coefficient are CJ (0.5793),

AJ (0.6116), AK (0.6415), FJ (0.6457), BK (0.6528), CK (0.6554). Since, it has been found that investing in more than one type of markets nullifies risk reduction benefits. Furthermore, [9]risk reduction benefits decrease as diversification increases with no risk reduction benefits obtained when investment involves more than five different ship types/sizes. So we only chose A, C, J, K as the asset for the further investigation.

Table 5: Correlation Matrix of the Spot Freight Rate for the Eleven Sample Routes

	A	B	C	D	E	F	G	H	I	J	K
A	1	0.980	0.935	0.938	0.888	0.765	0.795	0.757	0.761	0.612	0.642
B		1	0.947	0.929	0.896	0.773	0.805	0.782	0.796	0.684	0.653
C			1	0.901	0.895	0.772	0.795	0.818	0.767	0.579	0.655
D				1	0.966	0.866	0.892	0.854	0.848	0.67	0.723
E					1	0.899	0.929	0.908	0.904	0.724	0.775
F						1	0.948	0.867	0.857	0.646	0.773
G							1	0.922	0.884	0.702	0.782
H								1	0.941	0.709	0.795
I									1	0.800	0.827
J										1	0.696
K											1

Source: Calculated and drawn by the author

3.2.3 Forming the Portfolio

Since we have four assets (A, C, J, K), so we can form eleven different portfolios, they are AC, AK, AJ, CK, CJ, KJ, ACK, ACJ, AKJ, CKJ, ACKJ. The correlation coefficients of AC and KJ are 0.9804 and 0.6959 (see table), which are relatively high, so this two portfolios can be eliminated. As a result, we have nine possible asset portfolios, they are AK, AJ, CK, CJ, ACK, ACJ, AKJ, CKJ, and ACKJ.

3.2.4 Calculating the Expected Return

The internal rate of return (IRR)[19] is a rate of return used in capital budgeting to measure and compare the profitability of investments. The discount rate is often used to make the net present value of all cash flows from a particular project equal to zero. IRR is sometimes referred to as "economic rate of return (ERR)". Hence, we can use the IRR as the expected return. From Mar 2007 to Mar 2010(Table 6), the average IRRs for the product and VLCC oil tanker market are 6.71% and 8.22%. Though IRRs of each sub-routes of the product and VLCC market are different, we applied the two average IRRs of the product and VLCC oil tanker markets as the sub-routes' expected return because of the unavailable data of each route. Namely, the expected returns for asset A and C are both 6.71%, and for asset J and K are both 8.22%.

Table 6: IRRs for New Buildings of the Product and VLCC Sub-markets

IRR-NB%	Product	VLCC
Mar-07	10.60	8.76
Jun-07	11.43	8.97
Sep-07	10.40	8.30
Dec-07	9.41	9.70
Mar-08	8.19	11.15
Jun-08	7.89	12.53
Sep-08	8.26	12.86
Dec-08	7.51	8.63
Mar-09	5.83	7.57
Jun-09	3.80	4.60
Sep-09	1.70	3.90
Dec-09	0.60	4.50
Feb-10	1.55	5.34
Average	6.71	8.22

Source: Drewry. Drawn by the author

3.2.5 Investigating the Best Split of the Asset Portfolio

Harry Markowiz[5] considered the rule that firstly the investor should maximize discounted expected, or anticipated, returns. This rule is rejected both as a hypothesis to explain, and as a maximum to guide investment behavior. He next considered the rule that the investor should consider expected return a

desirable thing and variance of return an undesirable thing. This rule had many sound points, both as a maxim for, and hypothesis about, investment behavior.

Hence, according to the "expected returns-variance of returns" rule, the investment behavior comprises two kinds, one is the risk adverse, who prefers the lower risk but lower expected returns, the other is called risk taker, who prefers higher expected returns but higher risks. In this research paper, the investor is assumed to be a risk adverse, who wants to get the maximum turns in the condition of the lowest risks. Since, different splits of each portfolio will lead to different variances and expected turns, which means different level of risks and amount of turns.

3.2.5.1 Spreadsheet Modelling

The best split (optimal share in each asset) can be estimated by spreadsheet modelling through the Excel simulation.

After simulation, a matrix table has been made (Table 7), which shows the optimal shares of each portfolio and their variances and expected returns accordingly.

Table 7: Results of Variances and Expected Returns of Different Portfolios

Portfolio	X_a	X_c	X_j	X_k	σ_p^2	$E(r_p)(\%)$
AK	1			0	0.212	6.710
AJ	0.970		0.030		0.211	6.752
CJ		0.996	0.004		0.176	6.715
CK		1		0	0.176	6.710
ACK	0	1		0	0.176	6.710
ACJ	0	1	0		0.176	6.715
AJK	0.970		0.030	0	0.211	6.752
CJK		1	0	0	0.176	6.715
ACJK	0	1	0	0	0.176	6.715

Source: Calculated and drawn by the author

3.2.5.2 Decision Analysis

Comparing the data of the matrix table, we can see that the minimum variance is 0.176 of portfolio CJ, CK, ACJ, CJK, ACJK. Moreover, in portfolio CK, ACJ, CJK, ACJK, the investment share of asset C is 100%, that means investing in the single market C. Then we compare its expected return with that of portfolio CJ, we can see that the expected return of the single market C (6.710%) is lower that of the portfolio CJ (6.715%). Since their risks are both 0.176, so it is more effectively to invest in the portfolio AJ than in the single market C.

Furthermore, the variance of single market A (Table 8) is higher than that of C, and expected return is also 6.710, so it is much less effectively to invest in singe market A than the portfolio AJ. However, the expected returns of single market J and K are 8.220, which are higher, but their risks are much higher, and their variances are 0.514 and 0.665. Because we have assumed that the investor is a risk adverse, so to invest in the single market J or K is not sensible.

Table 8: Variances and Expected Returns of the Single Market

	A	C	J	K
Variance(σ^2)	0.212	0.176	0.514	0.665
E(r)	6.710	6.710	8.220	8.220

Source: Drewry. Drawn by the author

After comparison of all the possible portfolios of the investment, we can draw the conclusion that the optimal split of the portfolio is to invest 99.6% of money in market C (VLCC, AG-NW Europe/200-300,000 DWT) and 0.4% in market J (Product, AG-Japan (clean)/50-60,000 DWT), which will bring the lowest risk (σ_p^2=0.176) with relatively higher returns ($E(r_p)$=6.715).

Chapter 4 Conclusion

This research paper has provided a portfolio analysis of market investments in oil tanker transportation.

Chapter 1 gives a background introduction of the research paper followed by the research aim and objectives, and then the literature review of studies focused on the background of the MPT and its influence on the shipping market have been put forwarded. Finally, a structure of this research paper has been presented to show the outline.

Chapter 2 sets a scene by providing a historic analysis of the oil tanker transportation market over the past few years. It gives an overview of the world crude oil market, by analysing the world crude oil stocks structure, global crude oil demand and supply balance, and investigating the change path of the global crude oil price, and then it represents an overview of the oil tanker transportation market, which is comprised the development history of the tanker transportation market and the analysis of its characteristics.

Chapter 3 gives an introduction of the MPT's model, based on the portfolio risk, correlation coefficient, the formula for calculating the expected return and the variance. Finally, the drawback of using the correlation coefficient to determine our investment appraisal has been analysed. This shortcoming has to do with the fact that while markets may tend to diverge considerably in the short-run, like periods of up to a year, they may actually be integrated over longer periods, so this research paper analyses the case study in a long run (four-year period of time) in order to avoid the distortion of the integration relationship. And then, it is followed by the key part of this research paper, which applies methodologies to analyse the oil tanker transportation market in

a real case. A real case study of the investment appraisal in eleven typical routes of the oil tanker transportation market for a four-year period of time has been conducted, based on the assumption that the investor is a risk adverse, who wants to get the maximum turns in the condition of the lowest risks, and then the variables have been defined, adopting the freight rate of oil tanker shipping as the return from physical market investments and using the IRR as the expected return. After modelling assumptions and defining variables, the MPT's modelling has been formed to analyse the case and the spreadsheet simulation is applied to calculate the data mathematically, which helps to find out the optimal portfolio choice.

In this research paper, by modelling the case by MPT, the results shows that risk reduction benefits can be achieved through diversification. Though testing the all possible portfolio combinations, the best portfolio choice has been found, and the optimal split of the portfolio shares has been calculated by the spreadsheet simulation tool. The research aim and objectives have been achieved.

Chapter 5 Recommend

However, the case study is static, which means the optimum portfolio holding at one moment in time may not be the same as that in the next. Furthermore, as a matter of fact, the potential for profit (or loss) depends on the existence of risk. Namely, the greater the level of risk acceptance, the greater is the potential for both profit and loss. The amount of risk shipowners are prepared to take in search of profit depends on individual circumstances, values, and attitudes. There thus exists no objectively optimal split of portfolio strategy. In this research paper, based on the assumption that the investor or shipowner is a risk adverse, who cares more about the lowest risk than the highest profit, which is an ideal case. Moreover, the availability of the data is so limited that restricted the degree of the accuracy of the modelling result.

The analysis contained within this article has not investigated how shipping compares to other investment alternatives. No consideration has been given to the potential role of shipping investments in the context of an industrially diversified portfolio. Hence, this problem provides huge potential for future research, especially because it constitutes an even more appropriate level of application for a portfolio approach to investment appraisal. So it may be recommended to go a further step to investigate this field.

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