1989

The Application of Modern Portfolio Theory to Hedging in the Dry Bulk Shipping Markets

Cullinane, Kevin Patrick Brendan

http://hdl.handle.net/10026.1/1801

http://dx.doi.org/10.24382/3717
University of Plymouth

The Application of Modern Portfolio Theory to Hedging in the Dry Bulk Shipping Markets

Kevin Patrick Brendan Cullinane BA MSc

This thesis is submitted to the CNAA in partial fulfilment of the requirements of the degree of Doctor of Philosophy.

Sponsoring Establishment:
Polytechnic South West
Department of Shipping & Transport

Collaborating Establishments:
Galbraiths Limited
E.D. & F. Mann (Shipping) Limited
Lyle Shipping Limited
Simpson, Spence & Young Limited
City of London Polytechnic

October 1989

I declare that while registered for the Council's research degree, I was, with the Council's specific permission, enrolled as a student on another course.

signed ....

The Application of Modern Portfolio Theory to Hedging in Dry Bulk Shipping Markets

by

Kevin Patrick Brendan Cullinane

Abstract

Risk and uncertainty have a vital impact on any business, but are particularly influential in the shipping industry. Although risk and uncertainty constitute the life-blood that courses through the veins of business, decision makers typically attempt to reduce the risks to which their decisions are subject. This is because there inevitably exists a level of risk which the decision maker is unwilling to accept.

In May 1985 a new method of risk reduction in shipping became available through the introduction of BIFFEX — the Baltic International Freight Futures Exchange. Participants in shipping can now hedge against their risks in the physical market by taking a position on the new futures market. This adds a new dimension to the situation as it existed before the introduction of BIFFEX, when the hedging of market risk was undertaken solely by holding alternative forms of physical contract.

Typically, decision makers in shipping have formulated hedging strategies on the basis of ad hoc, inconsistent and subjectively judgemental criteria. This work is concerned with the optimization of the risk reduction process by integrating the different forms of market investment in a portfolio context.

The methodology used is based on Modern Portfolio Theory (MPT). This provides a formal structure for the deduction of a subjectively optimal portfolio, in the sense that it yields the 'best' risk/return trade-off in line with a decision maker's own attitude to risk. Previously, MPT has been applied solely to the determination of optimum portfolios of stocks and shares. The theory is, therefore, refined in accordance with the requirements of shipping. Similarly, the theory has previously only been applied to investors who are 'risk averse'. In this work, it is expanded to include those investors who are 'risk prone' or 'risk neutral'. The objective of the thesis is thus the successful implementation of MPT to allow the deduction of a subjectively optimal portfolio of shipping market investments.

Acknowledgements

The analysis and results contained within a work such as this would inevitably suffer without the help, advice and support of certain individuals. As a meagre attempt to articulate my feelings of gratitude, I would like to take this opportunity to express my heartfelt thanks and appreciation for their efforts on my behalf. First and foremost, I would like to thank my supervisor, Brian Yolland, whose considerable knowledge and unique pragmatism has engendered in me a clearer perspective of how the shipping industry really works. His role as supervisor was undertaken with great credit; miraculously succeeding in achieving a fine balance of motivation, enthusiasm and ideas, together with providing a much needed outlet with his wit and conversation.

I also owe a great deal to other colleagues in Polytechnic South West. Eddie McLaney and David Moreby provided valuable advice, vision and support in their role as joint second supervisors. Harry Churchill provoked many lucrative discussions of the wider economic issues. David Harvey and Jon Pointon furnished many interesting insights into the vagaries of financial models.

The mathematical analysis which is contained in this work is largely a function of the quality of teaching in the Maths & Stats Department. I was also able to consult them on mathematical problems which arose during the course of the study. Many thanks go to: Sia Amini, John Berry, Niall Clinton, Dave Coates, Graham Crocker, Dave Graham, Kit Harbottle, Robin Horan, Barry Jeffreys, Den McGowan, Chris Ricketts, Vengcat Sastry and Dave Wright.

I would like to take this opportunity to thank the shipping companies that responded to my questionnaire, especially those who volunteered further support. My gratitude is also extended to Philippe Van Den Abeele and Camilla Wall, previously with Galbraiths and now with Clarksons, who helped a great deal in introducing me to the concepts and practice of freight futures. Gordon Gemmill of City University, Paul Veldhuisen of Shell and Joy Richardson of Simpson, Spence & Young also made useful comments.

Geoff Millward (a financially orientated oceanographer!) proved invaluable in cutting a swathe through the administrative and bureaucratic jungle that envelops academic research.

For light relief and a constant supply of diverse conversation and concentrated caffeine, I would like to extend my appreciation to members, past and present, of 'The Coffee Club' who, by alleviating the inevitable periods of depression, have succeeded in restraining my lemming-like progression towards the precipice of insanity.

Finally, I should like to express my profound gratitude to Sharon Hallett for her patience, empathy, and support over the past three years. Quite justifiably, I think she is probably more pleased to see this work completed than I am.

Contents

List of Tables

List of Figures

Chapter 1

Introduction

1.1 Defining the Scope of the Analysis

According to the Oxford English Dictionary, the verb 'to hedge' is a colloquial term meaning 'to secure oneself against a loss on a bet by betting on the other side'. In a business context, the term has a parallel meaning which can be derived by substituting the terms 'an investment' and 'investing' for 'a bet' and 'betting' in the above definition. The losses which a commercial hedger seeks to mitigate are invariably the direct result of adverse price fluctuations through time. The 'prices' referred to may relate to those which are paid, and are therefore relevant to the costs of a commercial enterprise, or equally, to those that are charged and which, therefore, affect revenue. In both instances, such losses are never manifest in the company accounts since they are measured solely on the basis of the opportunity cost incurred in not taking advantage of some available alternative. Thus, a company which actually made $1 million profit out of a particular deal would be deemed as having incurred a $1 million loss if, had they adopted an alternative strategy, they would have made $2 million profit.

In a shipping context, a shipowner suffers losses (in the sense of opportunity cost) if, for example, he is locked into a lengthy time charter while the returns which could be earned on the voyage charter market have increased to a greater level than those pertaining in the time charter market. Similarly, a shipowner who has arranged a forward voyage contract for some time in the future at a certain freight rate will be exposed to the risk of a rise in the freight rate for such a voyage during the interim period. The same examples but with opposite price movements illustrate the potential losses or opportunity cost accrued to the charterer.

It is the potentiality for such losses that is inherent in the term 'risk'. However, when working within the confines of a capitalist economy (in a global sense), it is imperative that such risk exists. It is due to the existence of risk, that there is potential for profit. At the same time, individual enterprises endeavour to limit, at least to some extent, their exposure to this risk. It is this aim to which the practice of hedging directs itself.

Gray (1987) points to the fact that the commercial risk which shipping companies have to face can be broadly classified into four categories:

1. Interest rate risk

2. Exchange rate risk

3. Bunker price risk

4. Market risk

The original intention of this work was to assess how members of the shipping community decide on the need to hedge their costs and revenues and to then determine which methods they should use in order to best fulfil their requirements. It is clear that the fundamental raison d'etre for hedging is the existence of risk. The available methods of hedging depend upon the form of that risk. Thus, if an unrestricted analysis of hedging in shipping is undertaken then it also needs to be classified into the four categories outlined above. Apart from the potentially Herculean nature of this task, there are several other justifications for limiting the area of interest.

Interest rate risk and exchange rate risk are not peculiar to the shipping industry. Many companies in a plethora of different industries are faced with the same problems. Because of this feature, methods which may be employed for hedging against such risks are well documented. Brown (1979) and Heywood (1984), for example, have suggested a variety of methods for hedging currency or exchange rate risk when dealing in different international commodities. Similarly, Rebell, Gordon & Platwick (1984) discuss the way that an interest rate hedging strategy needs to be incorporated into investment decisions. The conclusions drawn in their work are supported by, for example, those of Beenstock & Brasse (1984) and Figlewski (1986). In addition to the vast array of work on currency and interest rate risk, the possible methods of hedging against these two risks have not altered dramatically over the last decade.

Bunkers can be looked at as a specific product submarket of the oil industry. Oil companies, amongst many others, are forever hedging against adverse movements in the price of oil. Because of the influence exerted by oil on the state of the world economy, the methods that are used are again well publicized. These methods are directly analogous to those used for hedging bunker price risk in the shipping industry. In general, there are no peculiar options available solely to shipping companies. Clubley (1986) describes various strategies for hedging against adverse oil price changes and, therefore, risk.

Although bunkers are specifically associated with the shipping industry, it is theoretically possible that certain large and, therefore, important members of the shipping community may never need to become involved in the hedging of bunker prices merely because they never have to buy bunkers. This is true of charterers who adopt a policy of hiring ships purely on a voyage basis. Bunker price movements are more than likely incorporated in the freight rates that they pay, but the bunker price risk which they face then becomes veiled by the shroud of market risk.

It is, in fact, the type of market risk faced by members of the shipping community that is the only truly generic form of risk which pertains solely, wholly and exclusively to that shipping community. In this context, of course, the shipping community can be regarded as consisting only of the primary dealers in the market *vis a vis* the shipowners and the charterers. A further interesting aspect of analysing the hedging of market risk is the fact that on May 1st 1985, a new mechanism for potential hedgers was introduced in the form of the Baltic International Freight Futures Exchange (BIFFEX). This makes its analysis especially timely. Further support is provided by Gray (1987p5) who writes:

> "Market risk is the first, and arguably the most important, of the risks a successful owner must learn to manage and control."

With these justifications in mind, it was decided to concentrate solely on the hedging of market risk in the shipping industry. Market risk refers to the potentiality of adverse freight rate movements. Obviously, what constitutes an adverse movement depends upon what side of a particular shipping contract one considers. An adverse freight rate movement for a charterer will be a beneficial movement for the shipowner and vice versa. Thus, it could be inferred that an optimal hedging strategy for a charterer will be the analogue of that of a shipowner. In order to assess the validity of such an inference, it is necessary to consider what exactly constitutes a hedge of market risk.

It is widely accepted that when freight rates are generally high, but are expected to decrease in the near future, shipowners will, where possible, negotiate long-term time charters in order to lock in those high rates. It is clear then that a time charter constitutes a physical hedge against generally declining market rates and, therefore, against the rate pertaining under voyage charter. At the other end of the market, a shipowner with, for example, two ships and who is locked into a time charter at a relatively low freight rate will seek to employ his other ship on voyage charters if the freight market is expected to rise. Thus, a voyage charter may constitute a hedge against the market risk incurred by a time charter.

These are just two, somewhat simplistic, situations from a welter of possibilities. However, they do illustrate that what constitutes a hedge under one incumbent situation may not under another. The particular hedging strategy that is adopted, if it is to be proved beneficial, depends upon a relatively clear and accurate view of the future. As in the theoretical examples quoted above, the existence of such a view would, however, implicitly remove the risk and allow the decision maker to achieve an optimal hedging strategy very easily as his accurate view of the future changes through time. Assuming, very realistically, that the future cannot be accurately predicted then the shipowner is left in a position where he has to hedge against all possible future situations given his current one. Consequently, the problem the shipowner faces becomes not one of hedging against particular future circumstances, but one of holding a particular mix of physical contracts such that, whatever future situation arises, he has hedged his market risk to the extent that he wishes.

The recent addition of freight futures has provided yet another tool for hedging market risk. This new addition also needs to be blended with the available physical contracts in order to achieve a mix which the individual shipowner regards as optimal. This statement alludes to the concept of subjective optimality. This is an important idea. Since the potential for profit (and loss) is dependent on the existence of risk, the greater the level of risk acceptance, the greater the potential for profit and for loss. The amount of risk the shipowner is prepared to take in search of profit is dependent upon his individual circumstances, values and attitudes. Thus, there exists no objectively optimal mix of shipping contracts.

If the commitment of resources in general, and costs in particular, are allocated to the physical contracts available to the shipowner and to the freight futures contracts, then it is possible to consider time charters, voyage charters, freight futures contracts etc. as 'investments'. Thus, in determining a shipowner's optimal 'hedging' strategy, one can consider the problem as being the identification of a shipowner's subjectively optimal portfolio of market investments.

Returning now to the question raised earlier as to whether a charterer's optimal portfolio of investments will simply be the analogue of the shipowner's. As has been shown, it is the mix or portfolio of available shipping investments which is important in attempting to reduce risk to the level required. The charterer, however, is dealing not only in shipping markets, but also in the market of the commodity for which he seeks a ship for transportation purposes. Indeed, his risk exposure is usually far greater in the commodity market than it is in the shipping market. This is purely and simply a function of where his overall cost and, therefore, investment is allocated.

In order to subjectively optimize a charterer's portfolio of investment, the decisions made with regard to shipping must be integrated with those made in, for example, the commodity markets. The resultant optimized portfolios will differ, therefore, depending upon whether the charterer is moving steel, coal, grain, bauxite, etc, etc.

In order to constrain the breadth of this analysis and also to concentrate *only* on the hedging of risk in *shipping*, it is necessary to limit the study to the subjective optimization solely of the shipowner's portfolio. It is intuitively obvious that the market risk faced by a shipowner affects only his revenue, thus it is the hedging of shipowning revenue which forms the core of the analysis. Hemming (1986) supports this implied view that, in the maritime industries, the most important uncertainties affect revenues rather than costs.

By analogy with the comments made with regard to the charterer, it could be construed that an investment portfolio approach to the analysis is only relevant to those companies who have shipping as their only commercial interest. Such a conclusion is theoretically correct. However, many traditional shipowning companies, particularly the larger ones, have diversified away from shipping. For example, P & O have vast property interests and Christian Salveson are now a major road haulage firm. It is clear that for a portfolio based methodology to be properly applied, all possible market investments must be treated as an integrated whole. Nevertheless, it could be argued that for those companies who have maintained a major interest in shipowning, the approach is still valid since by optimizing their investments in the shipping markets they stand a better chance of achieving overall optimality or very close to it.

Thus far, justification has been given for limiting the analysis contained within this work to the subjective optimization of the market investments of shipowners. There remains one further theoretical constraint to explain. The fact that BIFFEX has provided an innovative and novel alternative market investment, in the form of freight futures, has already been alluded to. These contracts, however, were designed expressly for the dry bulk sector. The use of freight futures, in their current form, as a hedging mechanism for tanker operators, for example, is extremely ill-advised. As a consequence, it has been found necessary to further limit the analysis to the investments available in the dry bulk sector.

There are a number of methodologies available within the sphere of financial economics which theoretically cater for the subjective optimization of investment portfolios. Arguably the most important, and certainly the most widely used, methodology for undertaking this task is Modern Portfolio Theory as attributed to Markowitz (1952). In its broadest sense, this methodology involves the measurement of returns, risk and risk attitude in order to derive an optimal portfolio which meets the requirements of individual decision makers. From this methodology, two other mainstream alternative approaches have been developed. Arbitrage Pricing Theory (see Ross (1976)) and the Option Pricing Model, as expounded by Bookstaber (1950) and Black, Fisher & Scholes (1973), have both been suggested as viable alternatives to Modern Portfolio Theory in explaining and/or prescribing investor behaviour. However, all three of these methodologies have nearly always been applied to the area of pure investment relating to stocks and shares. Their application to the markets of particular industries are few and far between.

Because both Arbitrage Pricing Theory and the Option Pricing Model can merely be regarded as refinements of the original Modern Portfolio Theory, it was decided to attempt to apply the original methodology to the study contained within this work. This decision is supported by the fact that the two alternatives were originally devised in order to overcome the computational difficulties inherent in applying Modern Portfolio Theory. In these times of sophisticated computerized technology, such difficulties are more easily surmounted.

1.2 Setting the Objectives

Having established the precise area of study, it is now necessary to describe the objectives which the ensuing analysis seeks to meet. The analysis attempts to determine the optimal portfolio of market investments in the dry bulk shipping sector under certain market conditions and for shipowners of a certain risk attitude. However, such specific results are inevitably open to criticism by virtue of the assumptions that have been made in achieving those results. The inaccessibility of privileged information also detracts from the results achieved. By virtue of these potential shortcomings, the primary purpose of this work is not to discover the definitive optimal portfolio that a dry bulk shipowner should hold, however interesting and relevant the results might be, but rather to assess whether Modern Portfolio Theory provides a practical methodology for such a company to deduce a portfolio which satisfies their own subjective criteria for optimality. In a wider sense, therefore, the study constitutes a macroeconomic assessment of what is fundamentally a microeconomic methodology.

The originality of this work is derived from a number of features. As has already been alluded to, the application of the Modern Portfolio Theory methodology to the market investments of a particular industry is extremely rare. As far as this author is aware, it has never been done, in any formal sense, for the market investments of shipowners. Indeed, even if there were a previous application, this would now be redundant with the recent development and introduction of BIFFEX.

Inevitably, the original Markowitz (1952) exposition of the theory will have to be adapted to facilitate an application to shipowning. Certain adaptations may not be absolutely vital to the successful implementation of the theory to a practical application, but may simply be preferred because they improve the analytical tractability of the procedures invoked to obtain the required results. Since the ultimate aim of this research is to provide a workable technique which can be practically applied by shipowners to aid in their market investment decision making, the minimization of the time and effort required to instigate the methodology further justifies such adaptations. The specification of these various adaptations and their successful incorporation into the original theory constitutes more evidence to support the originality of this work.

The question now arises as to why it is important that shipowners do optimize their market investment portfolio. Remembering that the optimization process espoused by Modern Portfolio Theory takes into account the subjective risk attitude of the company, any deviation away from the optimum portfolio holding will mean either:

- that the company in question is allocating resources to the market in too conservative a manner, so that they are overcompensating for risk.

Thus, they are not generating as high a profit as they might if they took greater risks.

or

- that the company in question is exposing itself to risks that are definitely unwanted and perhaps even dangerous to its continued survival should circumstances prove disadvantageous.

Both of these situations have wider implications for the industry and, indeed, for society as a whole. The probability of shipping bankruptcy is greatly increased if individual companies are not operating at the optimum level. This is important for a number of varying reasons. Employment is obviously affected, but so are national income through foreign currency earnings, trade itself and even defence. The development of third world countries is often pinned on the success of its shipping industry. Where the companies that compose that industry are not operating at the optimum level, the nation's development may be hindered. There are potentially numerous other multiplier affects caused by an unhealthy shipping industry which are even more difficult to assess. The importance of its role is suggested by Stopford (1988p2) when he writes:

> "The progression from a world of isolated communities to today's integrated global community was made possible by shipping and sea trade."

The risks that this study is primarily concerned with are those pertaining to specific potential contractual transactions which are available as investment choices to decision makers in the shipping arena. As such, they are strategic in nature and as a consequence are of major import to the survival and well-being of any enterprise involved in the shipping industry. If the methodology assessed herein could lead to an improvement in the efficiency and effectiveness of shipping companies then it should be applauded, valued and adopted for the benefit of all. As Zannetos (1972) so pragmatically puts it:

> "What I plead is for better analytical models and better data to support managerial decisions. Intuition is great, but intuitive solutions must be tested for validity!"

The major objectives of this study can thus be enumerated as follows:

1. To determine whether Modern Portfolio Theory provides a practical and useful methodology for the analysis and selection of market portfolio holdings for shipowners in the dry bulk sector.

2. To determine the changes to the original methodology that are necessary to facilitate its successful application to shipping.

3. To assess the potential usefulness of the methodology in other sectors and for other types of market investor.

4. To find the theoretically prescribed portfolios of dry bulk market investments for investing companies with differing risk profiles.

In attempting to achieve these objectives, there a number of important questions that need to be answered which have interesting implications in their own right. These include the following:

- How can attitudes towards risk be ascertained and measured?
- How can risk be measured and, if so, what is the best measure?
- Are there any differences between the risk attitudes of different types of shipowning company, different countries etc?
- Is BIFFEX a viable hedging tool and, if so, who is using it as such?
- Is the Capital Asset Pricing Model (see Harrington (1983)) a useful tool for the measurement of risk in shipping?

The number of possible questions which could be posed during an analysis of this type is enormous, but these few represent some of the questions that this work, during the course of seeking to achieve its primary objective, has sought to answer.

1.3 Chapter Development

An introduction to the concepts of risk and uncertainty is provided in Chapter 2. In order to alleviate some of the problems of definition which are apparent in other works in the same field, it provides an outline of the terminology which has been adopted for the purposes of this work. This includes a definition of the type of investment opportunity with which the ensuing analysis concerns itself. Certain psychological aspects of risk and uncertainty are discussed, most notably the importance of the decision maker's attitude towards risk. The chapter concludes with some general background to the underlying philosophy of risk reduction and stresses the need for a formal structure within which risk assessment can be undertaken.

Chapter 3 seeks to provide some insight, for the relatively uninitiated, into the shipping industry as a whole and to explain the inevitability of the environment of risk and uncertainty which surrounds it. In order to place this study into context and to set the scene, a detailed outline of how dry bulk shipping has developed over the past twenty years is given. The fragmented nature of dry bulk shipping is described in terms of ships, cargoes and trades and the interaction of supply and demand in determining freight rates is explained. The formulation of expectations on the basis of forecasts is discussed as is the difficulty in deriving such forecasts from an analysis of the determinants of supply and demand. The almost impossible task of developing accurate freight rate forecasts reinforces the prevalence of risk and uncertainty in shipping and again justifies the need for a methodology which adequately deals with its existence.

The inadequacy of judging investments on the basis of Expected Monetary Value (EMV) is proved in Chapter 4. Implicitly, this decries the value of profit maximization as a corporate objective. The importance of incorporating risk attitude into decision making is stressed and the concept of utility, as a natural prerequisite to the application of Modern Portfolio Theory, is introduced. Risk aversion, risk proneness and risk neutrality are defined in terms of the concept of marginal utility and the process for measuring utility is expounded. This chapter concludes by establishing that utility analysis will form the basis of measuring the prevalent attitudes towards risk amongst shipowners. These measurements will then contribute to the final analysis of investment choice as described by Modern Portfolio theory.

Chapter 5 begins by illustrating the technique used for undertaking a utility analysis of shipowners. It relates the theory that has been discussed in Chapter 4, to the practice of deriving precise utility functions for shipowners. The necessary data is collected from a survey and a general methodology of the survey procedure is provided together with statistics which relate to response rate etc. The data collected via the survey is then analysed and the results of that analysis, in the form of the appropriate modelled utility functions, are presented.

How utility analysis fits into the overall Modern Portfolio Theory methodology can be seen in Chapter 6, where the traditional form of the theory is presented. A detailed guide to how the methodology is theoretically implemented and the reasons why it works are also present. Particularly important is the interaction of the necessary inputs to the Modern Portfolio Theory model. These inputs are utility functions and measures of both risk and return. The assumptions that underlie the theory are discussed and the changes or alterations to these assumptions, which are necessary to an implementation for shipowners, are itemized.

In order to implement Modern Portfolio Theory, it is necessary to obtain measures of risk and return for all the portfolios that might be constructed. Said portfolios can be composed of a number of individual investments in different proportions. Chapter 7 delineates the individual market investments that are available to a shipowner. In so doing, it becomes evident that certain individual investments differ from others solely on legal or operational grounds. A consideration of the different individual investments purely on the basis of financial aspects, leads to the conclusion that certain of the traditional shipping market investments may be omitted from the ensuing analysis. Most importantly, this chapter provides a detailed introduction to freight futures and how they work. The fact that BIFFEX constitutes a comparatively new and innovative potential market investment makes this exposition especially relevant. Chapter 7 concludes with an exact justified specification of the universal set of possible market investments available to a shipowner which will be analysed using the general principles of Modern Portfolio Theory.

Chapter 8 establishes the rules which govern the calculation of returns in dry bulk shipping from different market investments. It is shown that a building block approach to modelling the pertinent returns is the best method available for this sort of application. Details of these modelled returns for each market investment are presented and the implications for the implementation of the theory are discussed.

It can be seen in Chapter 9 that, in order to estimate the risks associated with a particular market investment, it is absolutely necessary to have estimates of return at hand. It is shown that there are numerous available methods of quantitative risk estimation. This analysis employs just four, however, and the risk estimates of each individual investment are presented and discussed. Particularly important in this respect is their consistency and logicality. The problems associated with risk estimation for portfolios are enumerated and a general comparison of the adequacy of each risk measure in achieving this aim is undertaken.

Chapter 10 knits together the various component inputs to the Modern Portfolio Theory methodology and graphically illustrates a novel means of finding a solution to the subjectively optimal portfolio. The fact that the results differ when different measures of risk are employed is highlighted and the implications of this for a practical implementation of Modern Portfolio Theory to the shipowning industry are alluded to. Additionally, this chapter illustrates the practical problems which are not immediately apparent when discussing the underlying theory as in Chapter 6 and precisely explains how each part of the theory can be practically applied in attempting to achieve a solution.

The final part of the work, Chapter 11, starts with a pragmatically orientated discussion of the results achieved from the practical application of the theory. Comments are made with respect to the viability of Modern Portfolio Theory as a management tool in the shipping industry. The implications of adopting such an approach are discussed and the advantages and disadvantages of the methodology are pointed out. The chapter concludes with a general overview of the further research possibilities which are indicated by the analysis undertaken within this work.

Chapter 2

The Concepts of Risk and Uncertainty

2.1 The Nature of Decisions, Risk and Uncertainty

Decisions are made in all aspects of life and in a variety of different circumstances. This work, however, is concerned primarily with those decisions made within a business environment, and more specifically with those relevant to the higher eschelons of management where high capital, high risk decisions are normally taken. The relative importance of any particular decision in such an environment may range from the 'life or death' decision to the extremely mundane. However, the common string which ties all types and levels of decision together is the existence of risk and uncertainty. It is frequently stated that 'the only certainty in life is death.' The obvious corollary of this truism is that the very process of making a decision necessitates taking a risk. Indeed, risk and uncertainty, taken together, can clearly be seen as an all-pervasive influence. Knight (1921) even goes so far as to suggest that human consciousness itself would disappear in their absence.

One major difficulty in discussing a topic such as risk and uncertainty in relation to business decision making is the lack of a uniform terminology. Particularly apparent in this respect is the variety of different definitions which have been attributed to the two terms. Some authors in the area seemingly make no better justification for the definitions which they adopt than does Lewis Carroll's character of Humpty Dumpty in 'Alice in Wonderland':

> "'When I use a word', Humpty Dumpty said in a rather scornful tone, 'it means just what I choose it to mean - neither more nor less'."

Previous work in the field shows that a paradox exists, in that while certain authorities stress the differences between risk and uncertainty, others use the terms interchangeably. Within the confines of this work, the definitions of risk and uncertainty will as far as possible follow the former philosophy. Thus, a distinction will be drawn between the two terms. However, precedent suggests that the freedom exists to precisely 'tailor' definitions to the methodological needs of the analysis.

Rowe (1977p17) states that:

> "Uncertainty exists in the absence of information about past, present or future events, values or conditions. Although there are various degrees of uncertainty, the basis of the concept of

uncertainty is the absence of information about parts of a system under consideration."

Implicit in this statement is the fact that uncertainty necessitates the complete 'absence of information about parts of a system under consideration.' This description of uncertainty will be refined to incorporate those instances where there is merely a partial absence of information about parts of the decision making system. The term 'general uncertainty' will thus be used henceforth to describe the existence of partial or total absence, incompleteness or imprecision of information with respect to the area of decision making.

Again according to Rowe (1977), there are basically two types of information which need to be deduced in order to accurately define any system under study. These can be summarized as follows:

Descriptive Information This relates to the identification of the variables that explicitly define a system.

Measurement Information This relates to the specification of a value to be assigned to each variable (already identified as descriptive information) within a system.

It is from this exposition of the composite elements of information that the definitions of risk and uncertainty to be used within this thesis will be further derived. In relation to this aspect, it can be said that general uncertainty occurs where there is a total or partial shortfall in either or both of the two composite elements of information, i.e. descriptive and/or measurement information. The term 'general uncertainty' can, therefore, be regarded as an all-encompassing concept which can only not be applied to those (few) occasions when both descriptive and measurement information are known with absolute and definite certainty.

General factors which on an individual basis, and through interaction, contribute to the existence of general uncertainty include; human, natural and random events, which all occur to some degree in most systems of interest but are especially pertinent to the area of business decision making.

It is clear from the previous discussion that, in any given decision making situation, there may exist either descriptive and/or measurement uncertainty. The term 'general uncertainty' has been defined to cover every combination of these two elements. Risk can be defined as being that part of general uncertainty which is capable of being enumerated and evaluated in some manner. Consequently, risk can be regarded as that part of general uncertainty which has the potential for formalization and measurement. Specifically, the risk element of general uncertainty must entail no descriptive uncertainty and the measurement uncertainty must be capable of some degree of formalization.

To summarize the definition, risk relates to those circumstances where the possible outcomes of a decision can be identified with certainty but where there exists a possible potential unwanted consequence or loss. Further, the uncertainty in the occurrence of the potential outcomes must be capable of being expressed in the form of a probability of occurrence.

This definition of risk raises two important issues which need to be clarified before proceeding any further.

1. Although in absolute terms, there exist certain instances where the possible alternative outcomes of a given decision may all be of benefit to the business in question, when looked at relatively then certain of them become unwanted consequences in the sense that they are less preferred. Hence, given at least two alternative outcomes where a preference can be expressed, this definition of risk can be applied.

2. Once all potential outcomes have been identified, i.e. there exists no descriptive uncertainty, it is always possible to attach probabilities of occurrence to the alternatives. This may be done on an extremely inaccurate and ad hoc basis, but importantly it can always be done in some form or another. If this were the case, it would simply mean that the outcome of a particular decision is more uncertain than would otherwise be the case.

The policy of differentiating between risk and uncertainty in the manner expounded thus far in the discussion is supported either implicitly or explicitly by authors sush as Willett (1901p6) and Knight (1921p4) who respectively define risk as being:

> "The objectified uncertainty regarding the occurrence of an undesirable event"

and

> "Measurable uncertainty."

Justification, therefore, exists for a definition which regards risk as constituting the measurable subset of general uncertainty.

As has been seen, where there exists descriptive information, measurement information can always be determined no matter how inaccurately. Conversely, where there is no descriptive information, there cannot exist any measurement uncertainty, since there exists no information that can be measured. This category of general uncertainty is, therefore, a totally random phenomenon where as McLaney (1986) puts it:

> "...the possible outcomes cannot be even identified let alone their likelihood assessed."

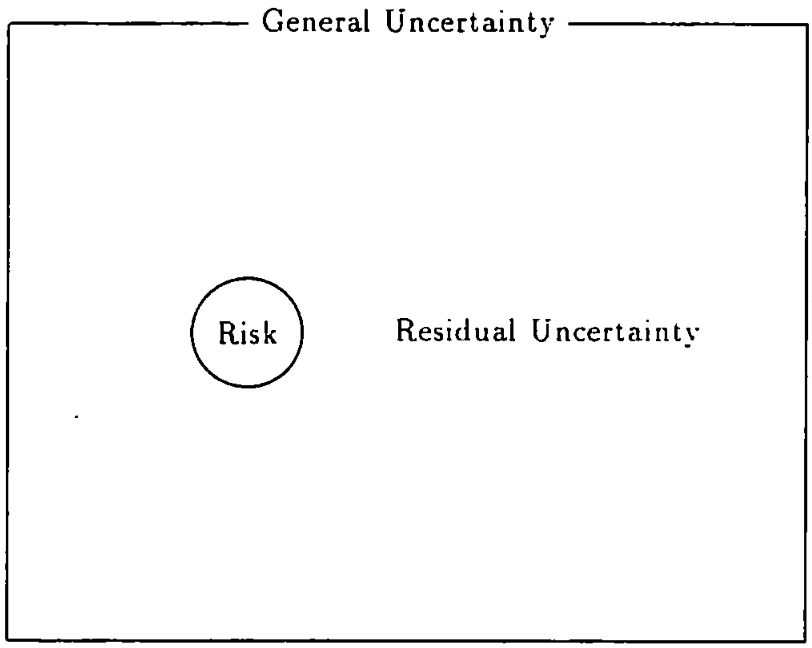
The corollary of such an argument is that there are only two circumstances which arise in the practice of business decision making. Taken together, therefore, they constitute overall general uncertainty with the former providing a definition for the term 'risk'. If that part of general uncertainty which cannot be classified as risk is now defined as 'residual uncertainty', it is clear that:

$$General\ Uncertainty = Risk + Residual\ Uncertainty$$

The obvious interaction between the level of risk and the level of residual uncertainty is a vital one. The level of residual uncertainty is actually determined by how far the decision maker can determine the level of risk present within a given decision choice; i.e. by how well the decision maker can collect and collate descriptive information and how exhaustive and accurate is the associated measurement information. The more inaccurate the decision maker's estimates of risk measurement, then the greater will be the level to which residual uncertainty impinges upon the risk evaluation process and the final decision choice. Thus, the situation can be fully described, with regard to the terminology employed within this thesis, by the schematic shown in Figure 2.1.

There are a number of important reasons why risk and uncertainty have been distinguished in the way previously outlined. Firstly, by treating risk as a specific subset of general uncertainty, it is now feasible to discuss the level of general uncertainty facing a decision maker in such a way that it incorporates the level of risk that is faced. Alternatively, it also allows specific independent investigation of the level of risk and the level of residual uncertainty faced by a decision maker.

Figure 2.1: Conceptualization of Risk and Uncertainty Terminology



Another advantage in the use of such terminology lies with the fact that it provides limits within which an analysis of risk reduction in the shipping industry may be undertaken. Since a decision maker should always seek to enumerate as much general uncertainty as is feasible, thus enabling its estimation as risk, the level of residual uncertainty is ipso facto reduced to as low a level as is possible. From that point on, the totally random nature of residual uncertainty belies attempts to avoid or reduce it further. Consequently, while decision makers can go no further in minimizing residual uncertainty, they do have the option of implementing policies which attempt to reduce the effects of risk. It is to this aspect that the rest of this work will address itself.

2.2 Risk, Uncertainty and Investment

As has been stated in the foregoing discussion, this work is primarily concerned with the reduction of risk, since it is risk that the decision maker can take conscious action to avoid or reduce. Specifically, this work concentrates on that technique of risk reduction known as 'hedging'. This term relates to the taking of a particular course of action which seeks totally or partially to offset the actual effects or consequences of a potential unwanted outcome that has a risk associated with it.

Within this broad context, it is business investment that is of particular interest. This again raises a question of definition. What exactly is meant by the term 'investment'? This requirement is of vital importance in that it both defines the scope of the ensuing analysis and yet, at the same time, constrains the area of interest. Specifically, a definition of investment provided by Bierman & Smidt (1984p4) will be used as the basis for further discussion. They use the term to refer to:

> "...committment of resources made in the hope of realizing benefits that are expected to occur over a reasonably long period of time in the future."

As will be discussed in greater detail at a later stage, for the purposes of this thesis, the phrase 'committment of resources' will be held to relate specifically to the committment of financial resources to particular shipping contracts. Typically, the measure of the net level of financial committment to a particular contract is made on the basis of opportunity cost. Financial committment, therefore, takes into account potential costs or benefits which could have accrued had not alternative courses of action been foregone. Although not the practice in industry, from the point of view of this work, a good investment, therefore, is looked upon as being one that increases the wealth of the owners of the company's securities over and above the increased wealth that would have accrued had the next best alternative been opted for.

Reekie (1975) describes investment as:

> "...the outlay of funds today in anticipation of a return at some later points in time. The investment decision can be looked at in the general and in the particular. At its broadest level the manager is faced with the decision of whether or not to invest, and if so, what quantity of funds should be committed."

It is the contention of this work that when considering the question of what quantity of funds should be committed, it is important to recognize and evaluate the opportunity cost of making the particular investment choice. Potential monies foregone, in addition to the prospective cash outlay, are what really constitute the true financial committment. The need to accurately assess this committment is especially relevant to the shipping industry. This is supported by the view of Hemming (1986p1) that:

"The decision whether or not to invest in a particular venture is of fundamental importance to the success of any enterprise. In a highly capital intensive industry with very unstable market conditions like shipping, the importance and timing of the investment decision is even more paramount."

Given a specific availability of investment funds, Gitman, Joehnk & Pinches (1985p209) argue that:

"Investors, because of their preference for higher rather than lower returns and lower rather than higher risks seek investment opportunities offering the highest return for the least risk."

Although authors such as Lorange & Norman (1970) and Devanney (1971) have brought into question the validity of this statement as regards the shipping industry, it does serve to highlight the fact that risk and return are the two overriding criteria upon which investment opportunities may be judged. This justifies the use of Modern Portfolio Theory as an investment methodology since it bases its evaluation of alternative portfolios on these two criteria.

For every investment opportunity, the decision maker may hope for a particular level of return, but cannot be certain ahead of time as to its actual value. The degree of possible deviation away from the expected level of return is embodied in the level of general uncertainty affecting the decision. As Bierman & Smidt (1984p189) put it:

"The difficulty of specifying unique cash flows derives from the fact that there are future events that will effect the cash flows.

> But we do not know in advance which of these events will occur. For each possible event, we have to make a somewhat different forecast of the cash flows from the investment. The uncertainty arises because we do not know with certainty which of the possible events will occur, and thus cannot be sure which cash flow will actually occur."

The general uncertainty about future cash flows associated with a particular investment decision derives from uncertainty about some other events; usually related in some way to general business conditions. Because the future state of these general business conditions cannot accurately be forecast, the outcome of the investment cannot be precisely predicted.

Although attempts can be made to predict, say, general business conditions which can then be incorporated into the investment appraisal as risk, the omnipresent residual uncertainty inevitably materializes as inaccuracies in the forecasting process.

2.3 Psychological Aspects of Risk and Uncertainty

Once general uncertainty has been enumerated as risk, the emphasis is then placed upon the decision maker to react to that risk. This feature brings into consideration one further important aspect of decision making under conditions of risk and uncertainty; the values and attitudes of the decision maker.

As Singleton & Hoveden (1987) suggest, changing technologies or environments are always altering the frame of reference for risk. However, one constantly dominating factor exists in the part played by human nature and human behaviour. In support of this precept, Arrow (1971) points out that uncertainty is a phenomenon that exists in the mind of the decision maker opting for a choice amongst alternatives. He partly qualifies this view by suggesting that such subjective uncertainty or risk may well stem from actual objective physical observations, but reiterates that the fine tuning is a task undertaken by the perceptive senses. This does not simply mean that a decision maker's perception of risk should be of interest since, as Brehmer (1987) points out, this implies the actual physical existence of an object called risk. Rather, it implies that various features of decision problems are perceived and it is these that then lead to feelings of risk: A subtle, but important, difference in interpretation.

It is important to recognize that the risk perception of an individual decision maker inevitably depends upon the existence and combination of several different factors such as:

- Vicarious experience.
- Intuitive theory.
- Direct personal experience.

It seems clear, therefore, that the process of risk estimation is context dependent and that inevitably, there are many other influences besides the three outlined.

At this point, it must be reiterated that the psychological perspective outlined thus far and the consequent importance attached to subjective risk estimation, does not negate the requirement for collecting information related to objective risk. As Singleton & Hoveden (1987) point out:

> "The place of facts in a world of ethical values should be set by the values, but facts cannot be changed by values."

Within the confines of the decision making process, the influence of human nature, values and attitudes goes beyond merely its influence over how risk is regarded. The very practices of investment and decision making exist because of human nature. This point is most eloquently illustrated by Keynes (1936p150) who writes:

> "Business men play a mixed game of skill and chance, the average results of which to the players are not known by those that take a hand. If human nature felt no temptation to take a chance, no satisfaction (profit apart) in constructing a factory, a railway, a mine or a farm, there might not be much investment merely as result of cold calculation."

The situation is, however, perhaps more realistically summed up by Rowe (1977p1) who states:

> "Although every activity involves some risk, there are some kinds of risk and some levels of risk that members of society are unwilling to assume."

The question as to whether a particular type or level of risk is acceptable to a specific individual depends upon that person's perception of and attitude towards the risk. Rowe (1977p23) goes on to describe this risk assessment process as follows:

> "Risk agents often willingly expose themselves to risks to obtain some possible gain, when in their individual deliberation, the possible gains outweigh the possible losses. If one substitutes 'probable' for 'possible' in the foregoing statement, quantitative balancing of probable gains and losses is possible within limitations of meaurement uncertainty. This arises from the ability to express probabilities on cardinal scales between zero and unity."

The corollary of this view is that human behaviour is typically risk averse. While risks are sometimes taken to obtain desired gains, similarly action taken to reduce a risk can be considered a gain in the sense that possible loss is reduced. It is with this latter action that the strategy of hedging is most closely aligned.

The technique which decision analysis employs so as to systematically incorporate the values and attitudes of the decision maker is known as utility analysis. This procedure, which will be dealt with in some detail in Chapters 4 and 5, leads to a decision that is theoretically consistent with the feelings of the decision maker about the likelihood of the possible outcomes and the effect of the various potential outcomes on the investor's financial position.

A lot of work has been done on the application of decision theory to investment decisions. A differentiation has tended to be made between decisions involving risk (where probabilities of all alternatives are known and given) and those involving, what herein has been termed, residual uncertainty (probabilities not known). These decision theory approaches are fundamentally statistical in nature and are well documented by authors such as Schlaiffer (1969) and Luce & Raiffa (1971). They invariably depend upon subjective probability functions in the form of expected value or expected utility of various outcomes. As Rowe (1977p6) points out:

> "The process, once utility values are assigned to outcomes, is mechanistic."

The question as to how much importance should be attached to either objective or subjective probability is, however, a matter of great controversy. While one school asserts that probabilities are primarily reflections of the actual frequency of occurrence of events (probabilities are, therefore, objective), another school asserts that the assignment of probabilities primarily reflects the assigner's belief or confidence that the event in question will occur. In the arena of practical decision theory applications, the seminal work of Bayes (1763), developed and applied at a later date by authors such as Jeffreys (1931)and Lindley (1965), has led to popular usage falling on the side of the latter philosophy.

This controversy between objective and subjective probability seems, at first sight, to be merely a methodological argument. However, Lee (1976p139) goes so far as to suggest that:

> "The long-running dispute over the interpretation of probability measures is of central, if unacknowledged importance for the definition of risk."

A problem arises in that the subjective view, if adopted, does blur the difference between risk and the actual danger of failure. Conceptually, therefore, probability and judgement become intertwined and cannot be separated.

Despite the philosophical argument between those who advocate the use of subjective probabilities and those who advocate the use of objective probabilities, there is general agreement that the decision maker's attitude towards risk should be incorporated into the decision analysis at some point. It is widely accepted that this is an important factor that must be taken into account when considering any investment opportunities that are subject to general uncertainty. As Bierman & Smidt (1984p215) suggest:

> "Under conditions of uncertainty, subjective attitudes towards risk bearing should play an important part in investment policy."

The necessity for doing this is illustrated by Hemming (1986p61) who writes:

> "The risk preference of an individual should be taken into account with other critical evaluation factors when investment appraisals are being made. The variation of individual risk preference leads to the situation that the 'best' decision for one manager may not be the same for another."

One final justification for emphasizing the importance of subjective attitudes towards risk (which can be, and often are, summarized as subjective probability) is purely a pragmatic one. This simply lies with the fact that in the case of business investment, similar decisions under similar circumstances are not made enough times in order to assess objective probability.

2.4 A Background to Risk Reduction

Although the discussion thus far intimates the necessity for business to reduce the influence of risk, a paradox exists insofar as the decision maker does not wish to eradicate it completely. Indeed, risk is a fundamental prerequisite of capitalism in that the act of taking a risk is indefatigably linked to making a profit. Many authors, including Arrow (1971), agree that many contemporary institutions are shaped by the existence of risk. Indeed, some directly attribute the growth of the free enterprise system to the existence of general uncertainty. However, as Arrow (1971) points out, since the phenomenon of general uncertainty must certainly have preceded the capitalist era, the difference between the present and the past which brought about this particular social organization has yet to be explained, The maxim 'you need to speculate to accumulate' implies that a risk is accepted in return for the potential of making a profit. Consequently, the really important aspect of good decision making is, first of all, to be as aware as possible of the risk associated with different decision alternatives and then, once the decision has been taken, to limit the risk associated with that alternative in order to increase the likelihood of a successful outcome. It is in this latter sphere that the strategy of hedging has traditionally had a part to play.

As has already been alluded to, in order to accomplish this objective, no matter what a decision maker's attitude to risk, it is vital that it be taken into account in making or analysing a business decision. As McLaney (1986) points out, this should be done in as formal a way as possible.

In relation to the terminology employed within this work, this means that the decision maker must attempt to identify the risk involved in a given decision by the collection, collation and processing of information so that as much general uncertainty as possible can be enumerated as risk, thereby reducing to as low a level as is feasible the influence of residual uncertainty. However, as Rowe (1977p22) points out:

> "Reduction of uncertainty does not in itself reduce risk. Resulting information can be used to direct action to control risk, which is the objective sought. The value of information can be measured only by the degree of control of risk gained by separate subsequent action."

In fact, the increasing concern with risk and risk systems is aimed primarily at its control. This is a relatively new concept in the history of humanity and has developed concurrently with the scientific revolution.

As can be inferred from the discussion so far, risk implies something unwanted or to be avoided by virtue of the fact that the existence of risk is associated with potential consequences that involve losses to the person taking the risk. On a general level, Rowe (1977p24) provides a succint definition that:

> "Risk is the potential for realization of unwanted, negative consequences of an event."

Risk aversion, therefore, constitutes action to control risk. In this sense, the action to reduce the potential effects of risk may be motivated either through deliberate, formal efforts for the reduction of uncertainty, or alternatively, by the intuitive perception of the risk taker.

In order to attempt to reduce the influence of risk over any investment decision, it is important to have a structure within which the decision maker may work to that end. Both Otway (1973) and Kates (1976), working independently, have developed a three stage process which composes what they term 'risk assessment'. This process includes;

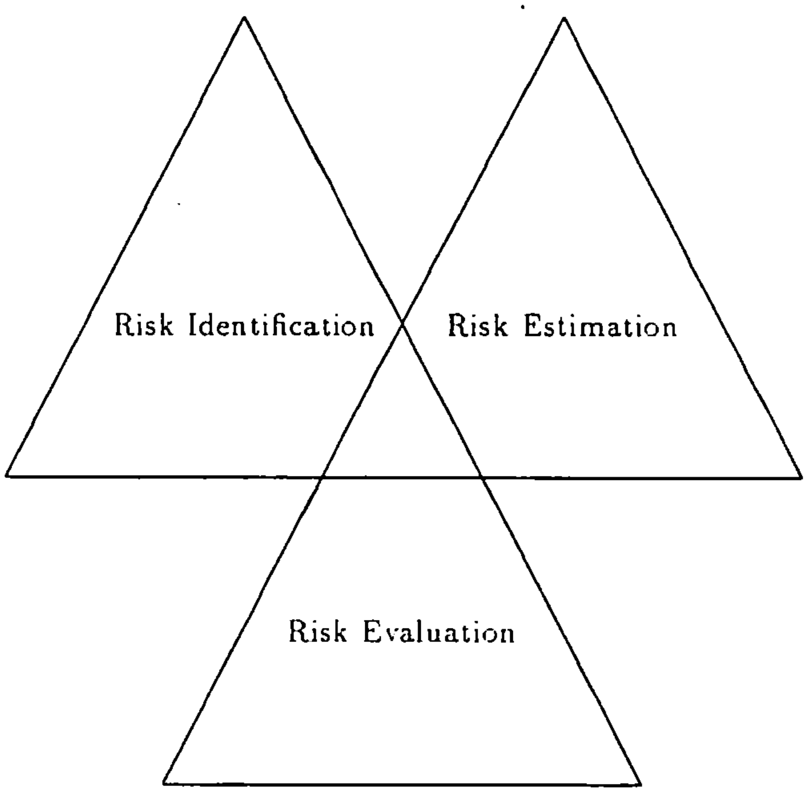
Risk Identification which reduces descriptive uncertainty.

Risk Estimation which reduces measurement uncertainty.

Risk Evaluation which involves the anticipation of the particular subjective response to estimated risk. In other words, a determination of the specific risk aversive action that should be taken.

The particular risk aversive action can obviously be in the form of risk reduction or simply in the form of risk acceptance or denial. A schematic which illustrates this conceptualization can be seen in Figure 2.2 below.

Figure 2.2: The Elements of Risk Assessment



Rowe (1977) provides a further refinement of these elements as follows:

Risk Identification	Risk Estimation	Risk Evaluation
Reduction of descriptive uncertainty.	Reduction of measurement uncertainty.	Risk-aversive action.
		Aversive.
Research.	Revelation.	Balances.
Screening.	Intuition.	Benefit-risk.
Diagnosis.	Extrapolation.	Cost-benefit.

Chapter 3

Dry Bulk Shipping

3.1 General Background

This part of the work seeks to put into perspective some of the points raised in the previous discussion of risk and uncertainty. The shipping industry is not unique in being prone to risk and uncertainty since these phenomena materialize whenever any decision is made. However, it could be argued that there are a number of special factors relating to the industry which make it an interesting, almost unique, environment for the analysis of risk and uncertainty.

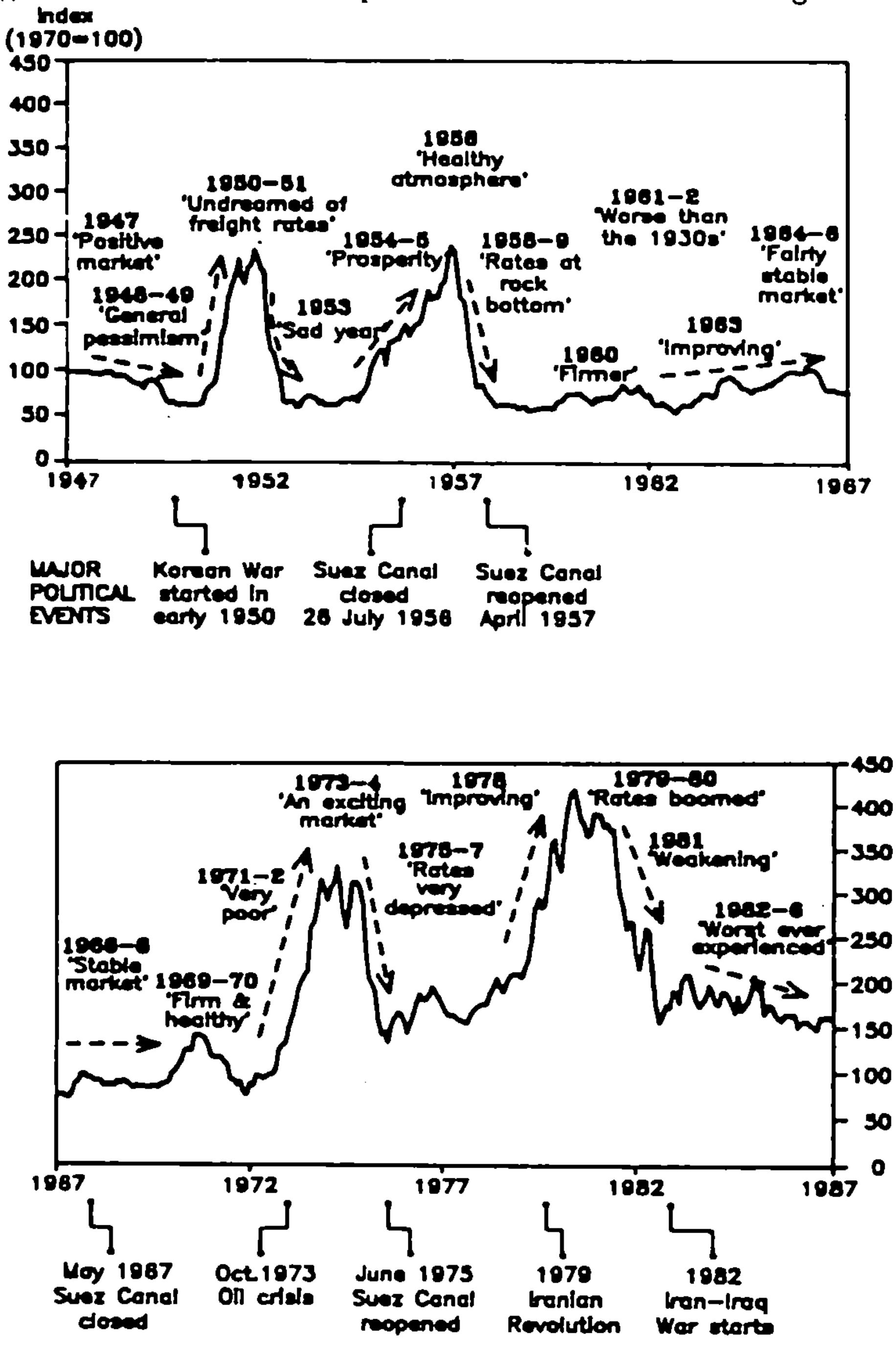
Behind the oil industry, shipping is the second most capital intensive industry in the world. This is reflected in the fact that one estimate of the total outstanding commercial debt has been put at $85 billion and that this amount is expected to grow to $100 billion by 1992.

Shipping markets have traditionally been regarded as cyclical with volatile movements present within the general cyclical trend. Although the degree of fluctuation in the shipping market makes the industry very prone to risk, the situation has not been helped by the fact that the capital intensity of the industry has, in the past, promoted the availability of finance. Because shipping companies are typically searching for investment opportunities involving the purchase of ships, their loan applications to banks have consequently increased and so the level of debt exposure to banks has increased concurrently. Similarly, at a somewhat simplistic level but relevant nevertheless, because banks like the idea of receiving quite substantial interest payments while maintaining security in the form of the shipping company's assets, they are quite willing to make such loan funds available.

The internationalism of the marketplace in terms of shipownership, trade, manning, shipbuilding etc. means that the environment is typically uncertain. This is evidenced by the fact that random disasters are generally good for shipping. The relationship between world "disasters" and peak shipping markets can be seen clearly in Figure 3.1. This figure also serves to illustrate the cyclical and volatile nature of shipping markets.

Every year, shipowners seem to wait with baited breath for a Soviet grain failure. This international aspect has, in the past, promoted a free market for shipping. However, in the past two decades this laissez-faire situation has gradually become eroded as capital has become more difficult to raise (thus

Figure 3.1: The Relationship Between 'Disasters' and Freight Rates



Source: Stopford (1988)

constituting a barrier to entry), and as the influence of politics, bilateralism, flags of convenience etc. have become more acutely felt.

The diversity of the general shipping market and the various submarkets within it adds to the degree of risk and uncertainty to which it is prone. Shipping companies may vary between multinational conglomerates such as Hapag-Lloyd and owner-operators with just a single ship at their disposal. The industry is similarly diverse with respect to the type of ports being used, the cargoes being carried, the routes, the types of ships employed etc.

Further support for the argument that shipping faces an almost unparalleled level of risk and uncertainty is provided by Abrahamsson (1980) who comments:

> "The huge capital needs of modern ships makes it very difficult, if not impossible, for most operators to continue to rely on retained earnings. Moving to external financing, they rely on a worldwide market affected by government support programs for both shipping and shipbuilding in the form of investment grants, low interest loans, tax relief, accelerated depreciation, and other subsidies, all of which must be evaluated in the light of differential rates of inflation in a system of floating exchange rates."

Despite these various contributing factors to the level of risk and uncertainty within the shipping industry, by far the most important influence is the fact that shipping is merely a service industry. It is dependent upon the level of trade for its survival and prosperity. Because shipping merely adds value to goods by providing a transportation service, it is subject to the whims of the world's manufacturing, processing and consumption industries. As suggested by Heaver (1976), the upshot of this feature is that the demand for shipping services is purely a derived demand. Consequently, there is an automatic implication that the level of general uncertainty which the shipping industry faces is greater than would be the case in the non-service sector because of the fact that it seems not to have any control over its own destiny.

Despite this, members of the shipping community do attempt to mitigate against the potential adverse effects of this derived demand. For example, from a microeconomic point of view, successful marketing on one company's behalf may have the effect of accruing a larger slice of the available demand at the expense of its competitors. On a more macro level, attempts by shipowners to corner a particular submarket of the shipping industry has led to the development and employment of highly specialized vessels. This has had the effect of even further emphasizing the different submarkets which together comprise the shipping industry. Many companies in shipping have sought to reduce the risk to which they are exposed by following in the footsteps of the major shipping companies. As Hardy (1979p61) puts it:

> "To most business men, opportunity is how to make money, and risks are quite simply all about how to lose it. In the shipping industry we have in the past been accused of acting 'lemming' fashion in much of our decision making, each one of us following hard on the heels of a particular entrepreneur, of whatever

nationality, whose words and deeds are in vogue at the time."

One further strategy which may be instigated is that of hedging against potential adverse movements in either costs or revenues which inevitably occur as the result of quirks in the derived demand. As has already been mentioned, this type of strategy provides the main impetus for the analysis within this work. It has been found necessary to concentrate on one particular sector of the shipping industry in order to facilitate such an analysis. To this end, the tramp dry bulk shipping market has been chosen. As Abrahamsson (1980) points out:

> "Ocean shipping is divided into the carriage of liquid and dry cargoes. This is reflected in most maritime trade journals, which provide separate analyses and reporting of the tanker and dry cargo markets and the liner and tramp markets. For analytical purposes it is important to bear in mind that the first category of markets refers to the general kinds of cargo carried, while the latter refers to the types of service contracts and the terms on which the cargo is carried."

One major influencing factor in choosing the tramp bulk market as the focus for the analysis held within this work is that, as Marlow & Gardner (1980) point out, it approximates very closely to an unrestricted competitive situation where freight rates (prices) and quantities demanded and supplied are largely determined by the interaction of market forces. Such a proposition does have its opponents, however, for example Dabrowski (1981p85) states:

> "The present depression in the world shipping market disclosed weaknesses in the market mechanism developed by the capitalist system during the past century and its inability to quickly restore the balance between the demand and supply factors. There also came into play new elements which contributed significantly to this situation."

Taking a balanced view, it would seem that this freely competitive market situation is certainly not as true today as once was the case, particularly in the light of the increased influence of world politics on trade and the transportation process. However, even insofar as the freely competitive situation does or does not persist today, focussing solely on the theoretically market determined tramp market may prove to be beneficial in facilitating the analysis of hedging methods within the industry. Certainly more so than would be the case if the liner trades were considered in that these are definitively not held as examples of the laissez-faire ethos, but rather are monopolistic in nature and consequently that much more difficult to analyse using an economics-based methodology.

It has already been stated that another important motivating factor behind choosing to concentrate on the tramp dry bulk market is that on May 1st 1985, a new freight futures market came into being in London, known as BIFFEX, which seeks to provide a novel and viable alternative to traditional hedging methods. This market is aimed specifically at the tramp dry bulk sector, especially insofar as the index upon which it is based is composed of the 12 major dry bulk trades.

The bulk carrier market, which services the dry bulk trades, has developed over the last century. As Rinman & Linden (1978) attest, the modern ocean going bulk carrier, however, dates from the mid-50's when the first ones were built for Swedish shipping companies by the Kockums and Gotaverken shipyards. As Alderton (1984p37) points out:

> "Although there have been colliers for centuries carrying bulk coal, the modern concept of bulk cargo being loaded and discharged quickly into single deck dry cargo ships from modern automated terminals dates only from about 1957. Like container ships they were born of economic necessity. Tramp freight rates were very depressed in 1957 so a cheaper means of carrying bulk cargoes had to be found."

The dry bulk cargo market is nowadays purely a generic title attributed to a set of separate markets differentiated by both specific ship type and specific commodity. These markets have been produced over the years by the concurrent expansion of both routes and cargoes. Indeed, the expansion of the dry bulk cargo market in the past 30 years has been considerable. According to Croxson (1985), in 1960 only 7.03% of dry bulkable cargo was transported in bulk carriers, whereas the equivalent figure in 1980 was 29%. In terms of ton miles, which represents a better picture of total trade, this amounted to a growth of 3147% during this period.

This phenomenal growth in the relative importance of the bulk carrier in the facilitation of trade is linked inextricably to a growth in the average size of the bulk carrier. This increase in the average size has been brought about as the result of various technological innovations both at sea and in ports and as the result of the increasing economic viability of such ships associated with economies of scale. According to Goss & Jones (1971), these economies of scale are brought about by the volume and value of cargo carried and the distance between load and discharge ports and materialize in terms of a per ton carrying cost. However, the overall dry bulk market is most usefully split in terms of ship size as shown in Table 3.1.

Table 3.1: Ship Categories and Sizes

Ship Type	Size Range (DWT.)
Handy-sized	25-35,000
Handymax	40,000
Panamax	55-65,000
Large	65-120,000
Suezmax	120-150,000
Cape-sized	150,000+

Ships less than 25,000 Dwt. are known as minibulkers, but this type of ship contributes little to the overall market situation. As well as a market division based on size of ship, another division may be made in terms of cargo and respective trade routes. The most important dry bulk cargoes are ranked in Table 3.2.

Today, the principal bulk cargoes such as iron ore, grain, coal, bauxite, manganese ore, alumina and phosphates are usually carried in Panamax or

Table 3.2: Important Dry Bulk Cargoes

Major Dry Bulk Cargoes	Iron Ore Coal Grain Bauxite & Alumina Phosphates
Minor Dry Bulk Cargoes	Forest Products Cars Livestock Steel Sugar China Clay Cement

Source: Fearnleys, World Bulk Trades

larger ships, while the smaller handy-sized bulkers now tend to carry the less prevalent bulk cargoes. However, a large handy-sized trade in grain to developing countries does still exist.

Despite the increase in the average size of bulk carriers over the years, the most important trend in recent times in the dry bulk sector has been the increased reliance upon specialized ships. As Yolland (1978p21) puts it:

> "Post-war years have seen a growth of technological activities via national research associations, shipping and shipbuilding companies, governments, academic institutions and consulting organizations. This has contributed to the development of highly specialized ships. These have been demanded in the search by shippers and shipowners alike for more efficient transport operations."

The bulk carrier is sometimes fondly known as the "workhorse of the seas". As the trade journal 100A1 (1986p3) eloquently points out:

> "The workhorse of the seas is a bit like Cleopatra in its infinite variety. In order to maximize cargo carrying capacity in as many trades as possible all sorts of hybrid or versatile bulk carriers have evolved."

Although there are now many types of specialized bulk carriers such as the conbulker, which carries containers or bulk cargo, the bulk/vehicle carrier and the pure car carrier, by far the most important type of ship in the dry bulk market is the combination carrier. Its importance is derived from its flexibility in that it can switch between dry and wet cargoes depending on which yields the most advantageous freight rate. This has massive implications for the supply of tonnage in a particular market, and as a consequence, ultimately on the prevailing freight rate of that market.

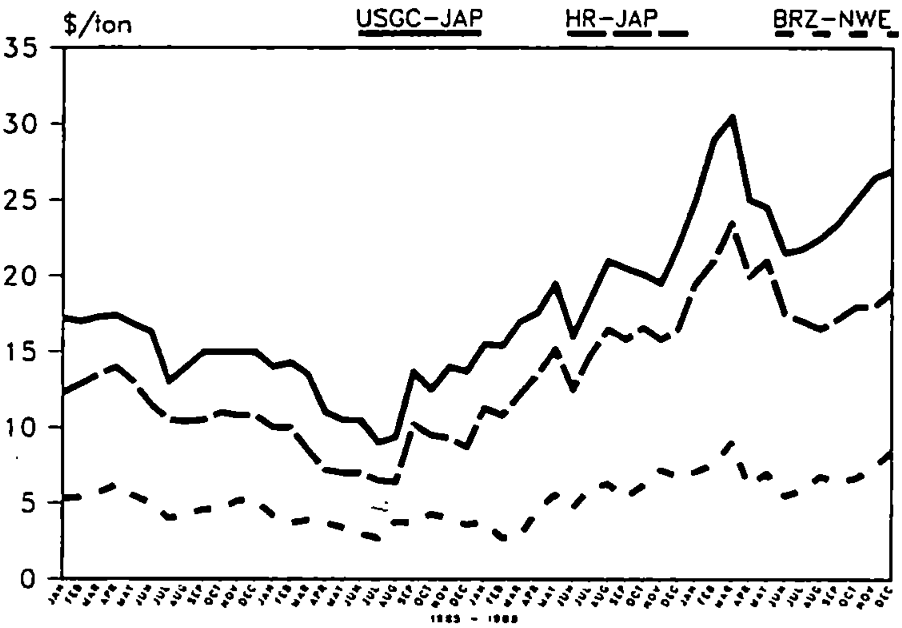
Basically, the combination carrier can be described as a ship which can carry either oil or dry cargo in bulk. However, it does take many forms. For example, the ore/oil carrier (the O/O), the ore/bulk/oil carrier (the OBO), the ore/slurry/oil carrier (the OSO) and the highly innovative products/ore/bulk/oil carrier (the PROBO). The combination carrier was initially designed as the solution to the problem of a long ballast leg or back haul. However, because many of the import areas for iron ore, coal and grain are also the major import areas for oil, the full oil and dry cargo carrying potential of a shipowner's combined fleet is not always utilized. Therefore, since there are very few natural combination trades or natural balances of freight values between one leg of a voyage and another, the real value of the combined carrier lies in the switching of capacity from dry to liquid cargoes and back again as freight rates dictate. As a consequence, combination carriers have confused the whole issue of identifying a dry bulk carrier for the purpose of examining world tonnages, and therefore the supply, of the various types of ships. Their role will be looked at in more detail at a later point in this chapter.

3.2 Freight Rates

The costs of a shipper and the revenues of a shipowner are determined primarily by the freight rate payable by the shipper or charterer to the shipowner. Consequently, the objective of the shipowner in providing a vessel for the carriage of goods is to obtain a freight rate that is sufficient to ensure his continued operation and perhaps even to be able to make a profit. The shipowner, therefore, seeks the highest possible rate. The shipper or charterer, on the other hand, seeks to agree on the lowest rate compatible with the safe arrival of its cargo at its destination in good and merchantable condition.

As is the case with all markets in any industry, it is intuitively clear from the above that the actual level of the freight rate depends on the services being offered and those demanded. Thus, the forces of supply and demand are the relevant determining factors. A picture of the movement of the voyage freight rates in each of the three general dry bulk markets which shall be analysed in this work is provided in Figure 3.2.

Figure 3.2: Freight Rate Movements of the Three Trades Analysed in this Work (1985-1988)



Source: Lloyd's Shipping Economist

From this diagram, Penfold (1982) is obviously correct in proclaiming that:

> "No one can deny that the bulk market is notoriously volatile and particularly unpredictable over the short-term."

Even though such movements are inevitably a function of the demand and supply features of the particular individual dry bulk sector of the overall market, in general de Borger & Nonneman (1981p156) point out that:

> "In the shipping market short-term variations of freight rates are due more to shifts in the demand curve than to shifts in the supply curve. For example, during 1979 the coefficient of variation of monthly supplied capacity for dry bulk was 2.4%, but the coefficient of variation of monthly capacity demanded was twice as high at 5.1%."

This implies that the shipping markets are more sensitive, and therefore more prone to risk and uncertainty, on the demand side. This is important because, as has already been mentioned, this is the one area which is singularly out of the control of the members of the shipping fraternity.

Freight rates in the tramp market, with which this work is primarily concerned, are agreed rates between the parties to the contract of carriage. As such there are no classifications or tariffs for this type of service. Consequently, the tramp market has generally been held to be freely competitive with rates set by market forces. If one accepts this view as being correct, then the importance of the demand and supply side functions is emphasized.

Fluctuations in the prevailing freight rate for a particular submarket within the shipping industry are due to a variety of reasons. Firstly, as previously expounded, freight rates may be liable to sporadic fluctuations merely as a result of the demand and supply functions moving towards new equilibria. Also, however, shipping markets are prone to movement as a result of seasonal and cyclical fluctuations. Seasonal fluctuations are caused primarily by climatic conditions which effect harvest and ice-bound ports for example, while cyclical fluctuations relate to the general business cycle which is a feature of Western Capitalist economies.

Apart from the pure risk of adverse freight rate movement to which an individual shipowner or charterer is exposed, there is also another aligned risk which is very important. Because in the vast majority of cases, freight or hire is paid in U.S. Dollars, the individual shipowner or charterer may be faced with an exchange rate risk which could, depending on the relative strength of the host company's accounting currency against the dollar, serve to either exaggerate or cushion the risk which is faced with regard to freight rates. Because this work is concerned merely with the hedging of freight rate risk, foreign exchange risk will only be referred to when relevant to the primary discussion and will not be dealt with in any analytical manner.

There follows a discussion of the factors which compose the supply and demand for shipping services, where hopefully it will become apparent that as Branch (1982) puts it:

> "... the pricing of a cargo ship's services is dependent on the forces of supply and demand, but the factors underlying them are perhaps more complicated than is the case with most other industries."

3.3 The Demand for Shipping

As has already been made perhaps painfully obvious in the foregoing discussion, the demand for shipping services is almost directly related to the level of general economic activity in the world. Because of its service role, shipping is dependent for its very existence on international trade. As O'Loughlin (1967p41) has described it:

> "The demand for carriage of goods is a derived demand in that shippers are primarily demanding the goods themselves and demanding the transport services as a means to get the goods. Nobody would desire space in a ship's hold for its own sake and without the demand for the goods carried, there would be no demand for the space. It has also been held that transportation is essentially a part of production."

The development of shipping is very much aligned to the growth of the world economy. This is evident in Table 3.3 which shows the growth of world seaborne trade since 1937.

These figures, however, provide an insight into the expansion of world seaborne trade merely in terms of volume. The most useful measurement of world trade to the shipping enterprise is that of ton miles since this provides a more accurate assessment of the state of the demand for shipping functions. It is not only increases in the volume of world trade that determine demand but also the pattern of that trade. For example, the requirement to move 100 tons of cargo over 2,000 miles rather than over 1,000 miles means that there

Table 3.3: Total World Seaborne Trade

Year	Tonnes(m)
1937	750
1950	598
1960	1080
1970	2482
1975	3047
1976	3312
1977	3399
1978	3466
1979	3714
1980	3606
1981	3461
1982	3199
1983	3090
1984	3292
1985	3293
1986	3385
1987	3418

Source: Fearnleys, World Bulk Fleet

is a net increase in the demand for shipping. However, demand statistics in the form of ton miles are somewhat harder to collect and collate than they are merely in terms of volume.

Since the demand for shipping is dependent upon world trade, it may be advantageous to determine what world trade depends upon. The growth in international trade is a function of the growth in the Gross National Product of the countries that are participating in international trade. Because of the nature of the world economies, what this really boils down to is that shipping demand is really dependent on the relative success of the world's major economies such as the U.S.A., Japan and the E.E.C. Although the influence of the U.S.S.R. and China have short-term effects on shipping demand, especially where the U.S.S.R. is seeking to supplement inadequate grain harvests, they will not have a significant effect on overall shipping demand until they participate permanently in the world trade arena. The aforementioned relationship between shipping demand and world trade is implicit in the mathematically derived demand function developed by Marlow & Gardner (1980) and given by the expression:

$$Q_d = -6603.68 - 2.24F_t + 3.28GNP + 39.84EFF$$

Where:

Q_d = Demand for Shipping

F_t = Voyage charter freight rate index deflated by an index of wholesale prices and with 1963 = 100.

GNP = Gross national product of OECD countries in \$US billions at 1963 prices.

EFF = An index to reflect the efficiency of OECD countries in converting raw materials into a given tonne of output (1963 = 100). This index was derived from the annual steel statistics published by the Iron and Steel Statistics Board and measures the ability to convert raw materials into pig iron.

As we have seen, net shipping demand is dependent on the volume of cargo that is moved and also on the distance that it moves. These two features do, however, have a significant effect on how that demand materializes. For instance, increases only in the volume of world trade would result in demand for more ships. On the other hand, changes in the pattern of trade which result in cargos moving greater distances, or which result in greater volumes and distances, means that larger ships will be in greater demand.

Two commodities which have an overbearing influence on the level of demand for shipping are oil and steel. Although they may have a direct influence on demand through the necessity of transporting them, by far their most important influence lies in the realms of macroeconomic dependancy. First of all, growth in industrial production necessitates increased energy requirements which has not only an obvious direct effect on the oil, gas and coal trades, but also the relative prices of say oil and coal determines the relative levels of demand in the separate tanker and dry bulk sectors individually. Similarly, this has influence over which trades the combination carriers are utilized within. Steel production requires coal and iron ore and the level of that production, therefore, determines the level of the coal and iron ore shipping sectors. The interrelationships between and the potential net effects of all these aspects are too numerous to quantify.

It is apparent that whatever the situation with regard to the differing factors that eventually lead to a demand for shipping services, once they filter through the system they will have differential effects upon different submarkets within the shipping sector. For example, within the dry bulk market, the demand for handy-sized vessels is so diffuse, in terms of the trades that they service, that the market for these particular ships typically does not show the same massive fluctuations that can and often do occur in the markets of larger vessels. The amount of this diffusion within the handy-sized market is illustrated by the fact that apart from grain, no single commodity accounts for more than 10% of demand and most add up to little more than 1%, or at best 2%.

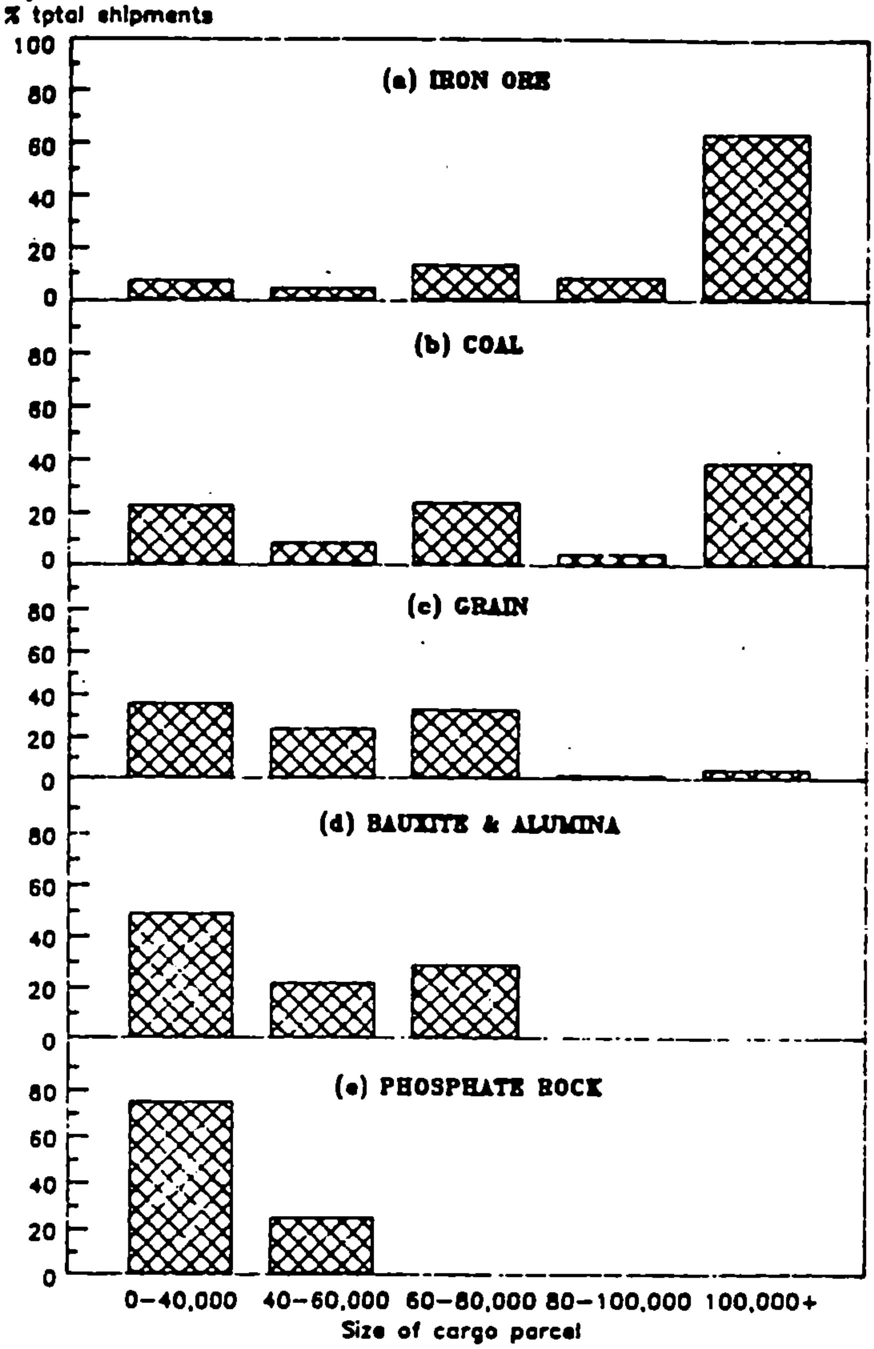
A differential effect can be seen when this situation is compared to that of the large, or Cape-sized bulk carrier, which is almost solely dependent upon the fortunes of the steel industry. This is due to the inordinate effect that this industry has on the carriage of coal and iron ore. 70% of the seaborne coal trade is in coking coal used in steel production rather than in steam quality for heating. The same is true of Panamax ships but to a lesser extent in that only half of this sector's demand is linked to steel. An additional influencing factor over the market for large bulk carriers is the state of the oil cargo market since when it begins to suffer relative to the dry cargo markets, combination carriers are attracted by higher freight rates into the dry cargo sector, thus having a knock-on effect throughout all the dry cargo markets but particularly in the Cape-sized sector. The influence of particular cargo trades over individual sectors of the bulk market can be implied from Figure 3.3.

With reference to the dry cargo markets, the situation is summed up by Ratcliffe (1979) who writes:

> "For the very big ships, there are, therefore, only two giant industries of interest, steel and oil, whilst for Panamax, steel and grain. Handy sizes, on the other hand, are dependent on every conceivable business involved in dry bulk commodities."

On the demand side, it is important to remember the overt relationship between the level of trade and the requirement for shipping services. However, it is equally important to emphasize the two-way relationship between shipping and trade. As Chrzanowski, Krzyzanowski & Luks (1979) put it:

Figure 3.3: The Influence of Particular Cargo Trades Over Individual Sectors of the Dry Bulk Market



Source: Fearnleys; World Bulk Trades

> "International trade is closely linked to developments in shipping. The prosperity or depression in sea transport reflects, like a barometer, the international economic situation."

The very existence of shipping and its markets has provided the political economies of the world with a medium for the facilitation of trade equally as important, if not more so, than the foreign exchange markets. It could undoubtedly be argued that the existence of efficient and effective shipping services have actually been the raison d'etre for a large part of contemporary trade. The dependance of trade upon the shipping industry is illustrated by the fact that ships carry some 95% of international trade in volume terms and almost 80% in value terms. It is this ultimate dependance of trading nations on shipping as well as the relatively small contribution of sea transportation to industrial cost that has resulted in various research, such as that by Marlow & Gardner (1980), proving that shipping has a relatively inelastic price elasticity of demand. This provides more evidence to justify the concentration of this analysis on the hedging of shipowners' revenue rather than charterers' costs.

3.4 The Supply of Shipping

In determining the level of supply in shipping, there are a number of aspects which need to be looked at. The issue is complicated by the fact that these aspects tend to interrelate, not only between themselves, but also with the level of demand. The most obvious feature of the supply of shipping is the determination of the number and total tonnage of ships of each type. Transportation of dry bulk cargoes ie. raw materials, farm produce and certain industrial intermediates such as forest products, accounts for a rapidly growing proportion of world shipping. The rapid growth in the size of the world dry bulk carrier fleet (excluding combination carriers) is shown in Table 3.4.

Table 3.4: The Growth of the World Dry Bulk Carrier Fleet

Year	Size of Fleet (DWT.)
1968	39m
1972	70m
1978	130m
1982	162m
1986	184m
1988	184m

Source: Shipping Statistics Yearbook

It can be seen from the table that the increase between 1982 and 1988 has not been as dramatic as previous years. Indeed, there has been no growth at all over the last two years. However, this must be looked at in the light of the fact that there has been a net fall in the size of the total merchant fleet for each of the years 1983 to 1988. It is interesting to note that over the last ten years or so the fleet of general bulk carriers has remained fairly steady, but the provision of specialized ore carriers has expanded at a rate second only to container ships. The flags under which the pure bulk carrier and the combination carrier fleets operate can be seen in Tables 3.5 and 3.6.

Table 3.5: Dry Bulk Carriers by Country Groups as of Jan 1988

Country	Number of ships	DWT	Percentage of total (DWT.)
OECD	1038	53m	28.9
of which			
-EC	679	28m	15.4
CMEA	403	11m	6.2
OPEN REG.	1681	61m	33.0
THIRD WORLD	1050	47m	25.6
OTHERS	358	12m	6.4
TOTAL	4530	184m	100.0

Source: Shipping Statistics Yearbook (1988)

Table 3.6: Combined Carriers by Country Groups as of Jan 1988

Country	Number of ships	DWT.	Percentage of total (DWT.)
OECD	75	10m	24.9
of which			
-EC	44	5m	13.7
CMEA	52	1m	3.8
OPEN REG.	187	15m	48.7
THIRD WORLD	72	8m	21.6
OTHERS	3	0.4m	1.0
TOTAL	359	38m	100.0

Source: Shipping Statistics Yearbook (1988)

The overwhelming feature of the shipping markets over the last fifteen years or so has been the level of overcapacity, ie. the excess of supply over demand, within those markets. In relation to the dry bulk sector, the current estimated levels of overcapacity, according to Lloyd's Shipping Economist (April 1989), are 8.5m Dwt. in the Handy-sized market, 4.2m Dwt. in the Panamax market and 7.1m Dwt. in the Cape-sized market. Although high, these values are much smaller than they have been in the not too distant past.

If merely knowing the total number and tonnage of ships were all that was needed in order to determine the supply of shipping, there would be no problem in assessing that level of supply. However, the issue is complicated by the fact that supply of shipping really relates to the level of active tonnage. When the freight rate within a particular market is depressed, there is a tendency towards the laying-up of uneconomic ships, where even variable costs cannot be covered, and towards slow steaming on trade routes.

Given a certain freight rate, laying-up and slow steaming are both measures which save on the expenses incurred in running and operating a ship. As a consequence of these two features, when there is an improvement in the freight rate pertinent to a particular trade, due to say increased demand, after improving space utilization the first step that owners will take is to increase the speeds of their ships. This has the effect of increasing the supply of shipping services in terms of ton miles. In order for ships to be brought out of lay-up, the relevant freight rate needs to rise above a certain level where not only increased speeds of already active tonnage does not completely soak up the short-term excess demand, but also where it becomes economically feasible for shipowners or operators to incur the extra expense involved. Thus, with respect to these aspects of supply, Chryzanowski (1985) describes the situation as follows:

> "In the short-term, there are only limited possibilities of increasing supply. Only ships operating in other trades or laid-up can quickly be added to the existing supply if demand for tonnage increases. In the long-term, it is possible to increase supply by constructing new tonnage or repairing and converting older ships. The elasticity of supply in the long run is greater since owners tend to place new orders with shipyards when the rates show an increase. However, there is always a lapse of time between the intended and actual increase of supply in the long term, since it takes time to build a new ship."

If freight rates continue rising due to continued expansion in demand, the situation may be reached whereby the level of active tonnage is equal to the total stock of ships. Thus, there is no slow steaming and no ships in lay-up for a particular trade. As a result of the existence of an excess demand, the stock of ships then needs to be built up. The three factors which actually effect the stock of ships directly are: the level of newbuilding, the level of scrapping and casualties at sea. Obviously, the latter is, in most cases, totally beyond the control of the shipowner or operator and is, therefore, not a matter of policy. However, newbuildings are often ordered during times of improving freight rates. A problem arises in that this does not constitute an immediate response to the prevailing excess demand in the market because of the time lag involved between ordering and receiving new ships, usually between nine and eighteen months. If the excess demand in the market has not survived the period of this time lag, which is typically the case, again the situation becomes one of drastic oversupply and even lower freight rates than would have been the result of a straight fall in demand. This is one feature which has served to exaggerate the cyclical nature of the shipping industry.

A further complication arises in that newbuilding prices are inevitably linked to the level of the freight rate. Consequently, increased levels of newbuilding, in line with the theory of supply and demand, invariably occur at times of high newbuilding prices. Similarly, demolition prices are also linked to freight rates. So when a reduction in the stock of ships would be beneficial to the shipping industry, ie. where there are high levels of oversupply and consequent low freight rates, there does not exist the motivation, in terms of prices, for scrapping ships. The one saving grace with respect to demolition prices is that these do also depend upon the level of demand for scrap in the steel and associated industries. However, given low freight rates, a low level of general economic demand is implied and so it is unlikely that demolition prices will be bolstered by such demand in times of depression.

One alternative, open to the individual owners/operators, to ordering newbuildings when freight rates are rising is to buy secondhand ships. However, this is merely a policy which is relevant at the microeconomic level since it does not, on its own, increase the stock of ships to meet excess demand. It may be an appropriate move for some companies, given such a situation, but secondhand prices too are aligned to the freight rates. Consequently, careful consideration must be given to the choice between a newbuilding and an old ship.

One further complication must be added to this list of factors affecting the supply of shipping and that relates to the connection that each submarket of the industry has with others. In the dry bulk market, the most obvious influence of this type is that of the role of the combination carrier. This type of ship can trade in either oil or in dry bulk. They are typically large and technologically sophisticated. Consequently, when freight rates are high in dry bulk relative to oil, they will be attracted into the dry bulk market to compete in the Cape-sized sector. Because of their technological advantages, they will displace the traditional large bulk carriers who will then attempt to seek part cargoes in the Panamax sector. There is an inevitable domino effect through the whole of the dry bulk market.

Whether or not dry bulk provides greater revenue to the combination carrier than does the tanker market depends to a large extent on the price of oil. When the price of oil is low, freight rates rise in the tanker market because of an increased propensity to import oil on the part of the industrialized nations. Consequently, combination carriers are more likely to trade in oil. However, low oil prices means reduced bunker prices which has a consequent effect on the level of laid-up tonnage and slowsteaming in all shipping markets. Thus there is a tendency towards oversupply in the dry bulk sector. Conversely, when oil prices are high, trade is quelled and combination carriers may be attracted into the dry bulk market even where freight rates are not particularly high. Even where capacity is at a minimum in the dry bulk sector through laying-up and slowsteaming, their entry even further exacerbates the problem of excess capacity. Thus, the very existence of the combination carrier has a dampening effect on the dry bulk market in the sense that when rates are improving, they will enter the market, further increasing the supply which then has a consequent constraining influence over how high the rates rise.

The final influence over the level of supply of shipping is certainly the most nebulous and probably the most important of all the aspects that have thus far been discussed. The expectations of the shipping community have a major influence over market behaviour. The translation of expectations into actual behaviour on the part of individual shipowners, operators or charterers may have either adverse or beneficial effects on the markets as reflected in freight rates. Because this aspect is of such central importance it will be discussed in much greater detail at a later stage in the chapter. The time lag between expectations embodied in concurrent behaviour and its actual effect upon the market is again illustrated mathematically by the equation which was developed by Marlow & Gardner (1980) to represent the supply function:

$$Q_s = -79.87 + 1.67F_t - 0.83F_{t-3} + 0.55Q_{t-1} + 0.69Q_{t-3}$$

Where:

Q_s = The supply of shipping.

F_t = Voyage charter freight rate index deflated by an index of wholesale prices and with 1963 = 100

F_{t-3} = F_t lagged by three years.

Q_t = Total shipments of the five major dry bulk cargoes per annum measured in thousand million ton-miles.

Q_{t-1} = Q_t lagged by one year.

Q_{t-3} = Q_t lagged by three years.

3.5 Future Prospects

The relative importance of dry bulk shipping as compared to other sectors of the industry has grown tremendously over the last decade. Indeed, Ratcliffe (1979) suggests that:

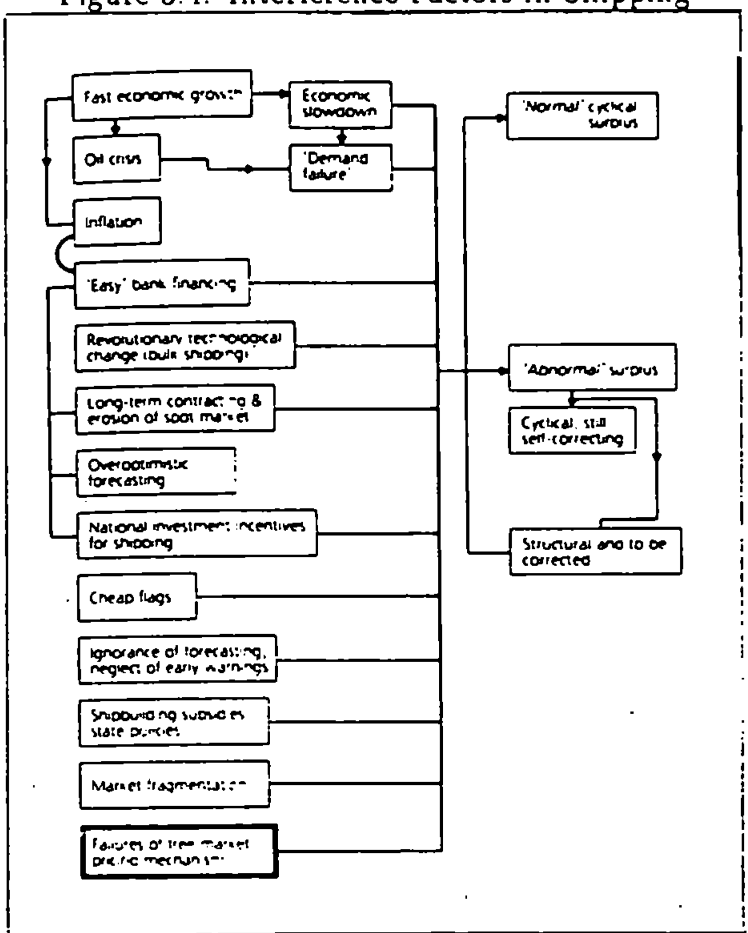
> "By the year 2000, the dry bulk carrier could have displaced the tanker as the single most important ship type on the high seas."

The biggest problem which faces dry bulk shipping, as it does every other sector in the shipping market, is that of overcapacity. Newbuildings ordered during periods of high expectations are now accentuating this problem as their delivery come onstream. This massive overcapacity exerts supply side pressure on freight rates keeping them at very low levels. It is with this in mind that Richardson (1986) has warned:

> "With a certain amount of slack surplus still existing in the world fleet and despite some current upturns in the spot demand for tonnage, owners should hesitate to order ships and continue to scrap over-age units while the present imbalance between cost and earnings potential remains so extreme. Only a cautious approach to this issue will ensure the eventual return of the shipping industry to a healthy condition."

This problem of overcapacity is widely recognized as being the chief cause of the recent shipping malaise which is exemplified by the fact that mid-1986 saw the lowest ever freight rate levels in the dry bulk sector. Certain industry specialists, notably Molenaar (1987), have suggested that the responsibility for finding a solution to this problem should be taken out of the hands of individual companies in the shipping community. He suggests that the only feasible method for restoring the balance between supply and demand in the bulk markets is to introduce an internationally coordinated, enforced capacity planning system. Objections could be levelled at this proposal on the grounds that such a policy would involve interfering with a relatively free market. However, Molenaar (1987) preempts such complaints by arguing that so many interference factors currently already exist within the market, as shown in Figure 3.4, that it can no longer be regarded as being freely competitive. Indeed, he further suggests that the placing of faith in the theoretically free and self-correcting markets of shipping is extremely misplaced.

Figure 3.4: Interference Factors in Shipping

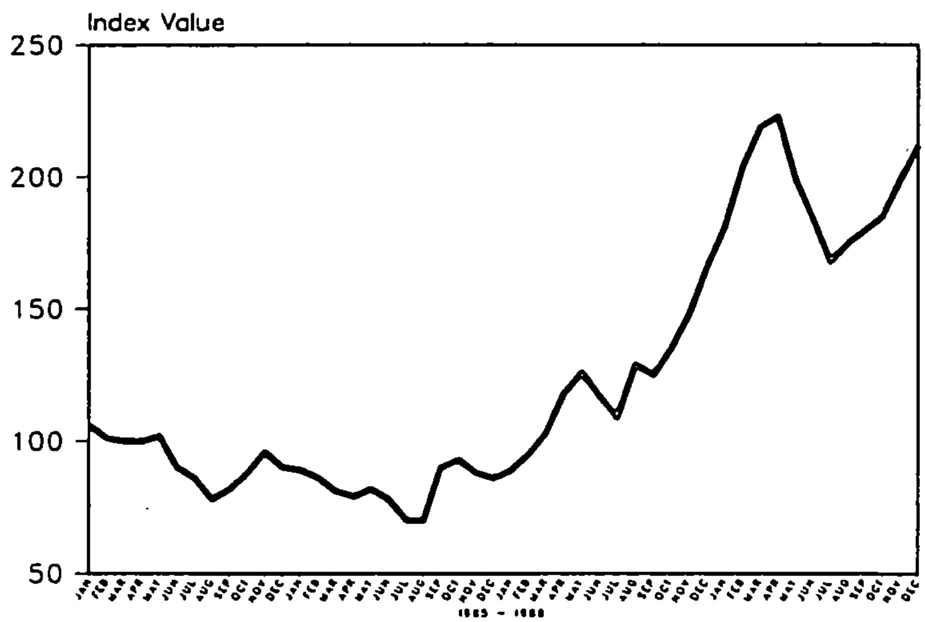


Source: Molenaar (1987)

Whether the centralization of shipping is regarded as beneficial or not, the amount of international cooperation required, as well as the logistics involved, must surely mitigate against the introduction of such a concept.

It is because of overtonnaging that the shipping industry has not really been able to take advantage of the greatly reduced price of oil in recent years. In fact, lower bunker prices have merely served to worsen the situation in the dry bulk trades as ships are able to speed up and come out of lay-up. However, the situation has improved over the past two years and is reflected in the GCBS combined tramp trip charter index which is shown in Figure 3.5.

Figure 3.5: The GCBS Combined Tramp Trip Charter Index



Source: Lloyd's Shipping Economist

It is important to recognize that the problem of overtonnaging has meant that the potential benefits which the bulk market could have derived from lower oil prices providing a stimulus to world trade through lower production costs have been muted.

The strain which the general shipping market finds itself under is exemplified by the financial difficulties which a lot of companies find themselves in. Hong Kong based groups CH Tung and Wah Kwong consistently made the headlines with the rescue packages that they were seeking to make with their creditors before finally going to the wall. Japan had already seen the fall of Sanko in 1985, but has now witnessed the withdrawal from shipping of the Nissho-Iwai trading house writing-off $320m of oustanding shipping loans. Similarly, Nakamura has filed for bankruptcy leaving its parent company, Sankyu Inc., to write off another $320m of shipping debt. The financial collapses are not limited to the Far East, the whole shipping world is being rocked with the demise of several notable companies. Lyle shipping and US Lines are just two of the many examples from the western world.

Despite all the gloom and despondancy that has recently pervaded the shipping community, there are some glimmers of hope, particularly for the future of the dry bulk market. The first sign of such a recovery in the bulk trades was a massive involvement of Greek shipowners in the secondhand purchase market towards the end of 1986 and start of 1987.

In the third quarter of 1986 alone, Greek shipowners invested $100m in buying 33 modern secondhand bulkers, including 6 panamax and 2 Cape-sized vessels. All 33 were less than fifteen years old and the majority less than ten. At the same time, the Greeks despatched 38 pre-1970 bulkers to the scrap yard. Even after the inevitable firming of prices in the secondhand market, the Greeks continued on their buying spree, taking delivery of 47 more bulkers in the final quarter of 1986, mostly at the expense of insolvent or bankrupt Far East owners such as Sanko, Tung and Wah Kwong.

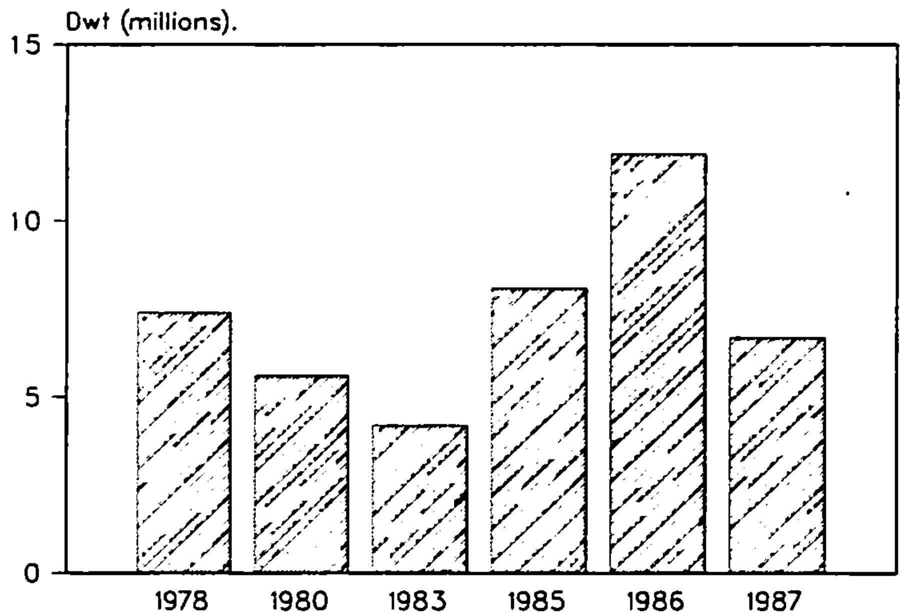
Further evidence of an improvement, hopefully a long term one, has been seen in the recent rise in freight rates. However, what is even more important to the long-term prospects of the market is that the supply and demand fundamentals, from which long-term freight rate trends are derived, seem to be taking on a more favourable disposition. For instance, Clarkson Research Studies (1987) have estimated the dry bulk surplus as being 20% in January 1987 as compared to a tanker surplus of 28%. Even more hopeful is the fact that this surplus is predicted to be down to just 9% by 1990 as compared to a figure of 16% for the tanker sector. The one fly in the ointment is that of the current 19.8m Dwt. surplus in the dry bulk market, only 4% is laid-up as compared to 8.8% in the tanker market. This has the effect that any prolonged improvement in the bulk trades will be a slow and tortuous process since required tonnage will come in the short-run from the potential 19.1m Dwt. currently slow steaming.

Other factors which may have a positive influence over a potential recovery of the bulk market are:

- The dry bulk orderbook of 11.1m Dwt. represents only 4.9% of existing tonnage.

- The recent very high level of scrapping, shown in Figure 3.6, which approached record levels in 1986 during the period when shipping was suffering a major depression, provides further justification for optimism.

Figure 3.6: Scrapping Levels in the Dry Bulk Market

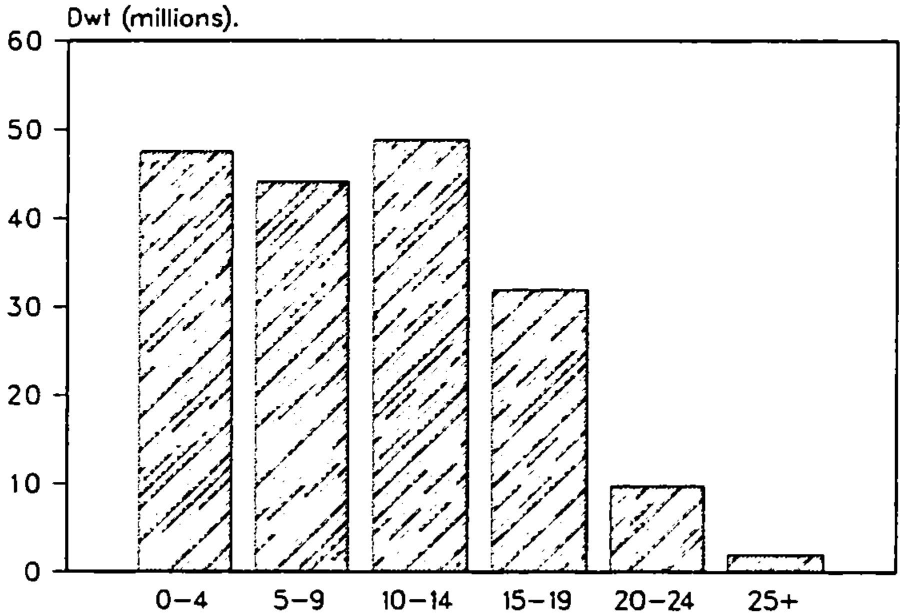


Source: Fearnleys, World Bulk Fleet

- The dry bulk fleet is relatively young with 49.8% of the fleet under 10 years old (Shipping Statistics Yearbook (1988)), thus negating the absolute requirement for replacement tonnage.

- The age composition of the fleet in terms of size categories, as shown in Figure 3.7, is favourable in the sense that the lack of scrapping in Panamax and Handy-sized ships has not had as detrimental an effect on supply as one might have imagined.

Figure 3.7: The Age Composition of the Dry Bulk Fleet



Source: Fearnleys, World Bulk Fleet

Unfortunately, although the supply side looks relatively bright for the future, the demand side is nowhere near so rosy. Apart from the grain trades, the mood is generally bearish. Most depressing is the prospective outlook for the world steel industries which, as has already been pointed out, have a major impact on the carriage of iron ore and coal, the two biggest dry bulk commodities, comprising 37% and 32% respectively of the "major" bulk trades. The recent freight rate recovery has generally been regarded as being grain led, though this strength in grain demand is accepted as being merely short-term. Among the minor bulk commodities, fortunes ebb and flow, though their impact hardly seems likely to lead to a swing in the fortunes of the demand/supply balance. Overall, the situation is summed up by Oakes (1986) as being:

> "In short, though the picture is hardly dramatic, many would argue that the dry bulk market could have quite a lot going for it over the next few years. And curiously enough, as long-term contracts decline, it could well be the traditional tramp operator - sometimes written off as a thing of the past - who has most to gain. Perhaps that's why the Greeks, still tramp operators par excellence, seem to have spent less time swanning about tankers recently than courting last year's ugly duckling."

This view of the potential trend in the dry bulk markets is supported by the latest forecast from the Japan Maritime Research Institute (1988) who predict that the current imbalance in demand and supply will remain fairly constant during the 1990's as this sector goes through a period of adjustment, but that there will be a very gradual upswing in the market during this period.

Having provided an insight into the nature of the dry bulk market, especially with respect to the degree of risk and uncertainty which it faces, it is now necessary to place these aspects within the more globally applicable sphere of risk reduction. To this end, the following section attempts to highlight certain general approaches to the reduction of risk in shipping.

3.6 A General Perspective on the Reduction of Risk and Uncertainty in the Shipping Industry

The specific purpose of this work lies with the analysis of how shipowning companies can and should attempt to reduce the risk and uncertainty which arises as the result of adverse freight rate movements. There are a number of specific methods which may be employed by the shipping community in order to reduce the potential impact of risk and uncertainty on their decisions. However, as Chrzanowski, Krzyzanowski & Luks (1979) point out:

> "Shipping is part of that sector of the economy which is characterized by a large degree of risk and uncertainty. In recent times the degree of risk connected with new investments has been increasing and thus, in turn, has lessened the stability of shipping companies."

The reason why the level of risk pertaining to new investments in the shipping industry has been increasing in recent years is probably best explained by Stopford (1988p76) who writes:

> "In economic terms, it is evident that during the postwar period larger and more efficient ships have progressively pushed their way into the market and depressed rates for smaller sizes. It is also clear that investment for specialization, as in the case of car carriers, and for lateral mobility played an important part in

> the development of the fleet during this period. That these two are apparently conflicting objectives serves to emphasize the complexity of the investment decisions facing the modern shipowner."

In attempting to offset some of the risk which they face, some shipping companies have entered into joint service agreements. The initiative in this matter was largely taken by the Scandinavians in the 1960's. The effect of such a policy is to reduce costs so that the risk to which a company is exposed is lessened. Such policies are particularly notable in the container trades where, for example, ACL and Hapag-Lloyd have such an agreement as do TFL and Nedlloyd. Such agreements are becoming increasingly popular in the bulk trades as well. Similarly, throughout the world the trend of flagging-out continues as does the trend to diversification into non-maritime sectors. These too have proved to be effective methods of minimizing the adverse effects of the recent shipping recession.

Those methods outlined above are general one-off policies which have been implemented by shipping companies in order to cut costs. There are a number of other similar examples from shipping practice. However, this work is primarily concerned with hedging strategies which tend to be much more operational, tactical and repetitive in nature. The single factor which is common to such strategic policies as those outlined above and to pure hedging strategies is that they are all based on some expectation of future events. The process by which such expectations become engendered may be either formal or informal. Since the latter is impossible to analyse, it is the science of formal decision making which will remain of primary concern to this work, although this does not negate the value of informal analysis in practical decision making. The formal process upon which expectations are most usually based is that of forecasting. Forecasting itself is one of the elements within a wider process which Hardy (1979) defines as the "Risk Management Process". He describes it as follows:

1. Identify the risk exists at all - a none too easy task in some areas susceptible to change.
2. Quantify the extent and cost of the risk, the expected return on taking the risk and the probability of success or failure.
3. Assess the possible action to minimize the risk element.
4. Decide what risk to take, and decide when if possible to take avoiding action altogether.

Forecasting is embodied in steps 2 and 3 of this process. This resumé does, however, serve to disguise the difficulty involved in forecasting. As the Japan Maritime Research Institute (1983p1) so succintly point out:

> "Essentially long-term forecasting is understood to be far from easy not only concerning the shipping market, but also all other spheres of activity."

As has already been earlier stated, the costs of a charterer and the revenues of a shipowner are unavoidably linked to the freight rate. It is the risk inherent in possible adverse movements of the freight rate that is of the upmost importance to each of these parties to the shipping contract whatever form it may take. This risk can, however, be reduced through accurate forecasting. Thus, forecasting itself takes on a new importance for as Alderton (1980) suggests:

> "Ultimately nearly all important decisions in sea transport operations depends on the ability to judge the future trend in the freight rates."

Although notoriously difficult, a number of academics have attempted to derive aggregate forecasts of shipping trends. Since they seek to forecast freight rates, they have almost all tended to concentrate on an analysis of the determinants of supply and demand. Wergeland (1979), for example, has derived a very aggregate model which aims at evaluating medium and long-term trends in the shipping industry in general. It also attempts to assess the relative importance of different supply and demand factors. One weakness of the model is the fact that it assumes that dry bulk trades are a homogeneous market where any bulk carrier can carry any bulk commodity to any port. Another weakness lies in the fact that certain of the relationships employed within it are based on limited empirical knowledge. However, one suggested advantage of the model is that it portends to forecast the qualitative trend of the market with a fair degree of accuracy. As Wergeland (1979p91) himself contests:

> "...the model provides a useful basis for empirical research within an area where knowledge is far from impressive: The economic determinants of bulk shipping supply and demand."

The difficulty of forecasting for the shipping industry is well documented in the work of Yolland (1981) who points to several hurdles which need to be overcome if a forecast is to be both accurate and, therefore, useful. On the supply side, he points to the complexities involved in evaluating the supply of ton miles, notably the determination of an allowance for fuel, the problem of evaluating ship speed and the problem of calculating the typical number of days in service for any given year. Similarly, on the demand side, the influence of technological, political, financial and social factors are highlighted together with the problem of collecting accurate information from trading nations other than those in the OECD. The biggest practical complexity on the demand side must, however, be the reliance of the industrial nations on value rather than volume figures for the reporting of their trade. Even where such volume figures can be determined, as Ratcliffe (1979) puts it:

> "The fortunes of shipping are inextrixably linked to the business cycle."

As a consequence, attempts at forecasting the prospects for shipping markets necessarily entails a forecast of world industrial production and economic growth. Obviously, this is no simple task. In practice, it has often been found much more useful to concentrate on the forecasting of a very specific sub-market, where the level of detail attainable improves the accuracy of such attempts. However, perhaps the best summarizing comment that could be made with regard to any forecasts that are prepared for the shipping industry is that provided by Yolland (1979):

> "Under conditions of economic uncertainty, severe over-tonnaging, global shipbuilding crises and increasing political interference, all things are possible, however extreme their nature."

This chapter has highlighted the risks that pertain in the shipping industry and has also pointed to some general methods of reducing those risks. However, irrespective of what objective risks exist in any industry, it is the subjective perception of those risks that is vital in explaining the ultimate decision that is taken. The following chapter seeks to provide a foundation of knowledge which allows the study and analysis of those attitudes towards risk.

Chapter 4

Utility Theory

4.1 General Introduction and the Rejection of the Expected Monetary Value Criterion for Investment Appraisal

Copeland & Weston (1980p64) define Economics as follows:

> "Economics is the study of how people and societies choose to allocate scarce resources and distribute wealth among one another and over time."

Within the confines set by this definition, the study of investment behaviour could be viewed as the purest materialization of the principles of economics. Elementary financial economic theory suggests that the comparative assessment of alternative investment choices should be made on the basis of expected profit (sometimes referred to as expected return or expected monetary value). This evaluation procedure is illustrated in the following example:

Option A: This investment possibility has a 50% probability of yielding \$50 profit and a 50% probability of yielding \$10 profit. The Expected Monetary Value (EMV) of the investment is thus \$30. i.e.

$$(0.5 \times \$50) + (0.5 \times \$10) = \$25 + \$5 = \$30$$

Option B: This investment possibility has a 25% probability of yielding \$100 profit and a 75% probability of yielding \$10 profit. The EMV of this investment is thus \$32.50. i.e.

$$(0.25 \times \$100) + (0.75 \times \$10) = \$25 + \$7.50 = \$32.50$$

On the basis of an EMV assessment, Option B would be the preferred investment since it yields a greater overall expected profit (EMV) than does Option A. However, if an analysis is undertaken of the absolute individual probabilistic possibilities, it can be seen that Option A contains a 50% chance of earning only \$10, while Option B contains a comparatively high 75% chance of earning only \$10. A given individual looking at the two choices may well opt for Option A rather than Option B because of the greater attached probability of earning a higher rather than lower return. If the probabilities which are attached to the possible outcomes within each investment possibility can be regarded as measures of risk, then it would seem clear that people's attitude towards risk have an effect, not only upon the decision that they make but also, upon the criterion which is used to arrive at that decision. Emphasizing this point in a different way, Gough & Hill (1979p28) use the following illustration.

> "...suppose someone offered you, for just $1, a lottery ticket with a 50/50 chance of winning $10. You would then probably think in terms of expected profit and make the bet as the expected return $10 × 0.5 = $5 is greater than the cost. Even if you lost, the loss of $1 would not effect you significantly.
>
> Suppose then someone else offered you the same chance of winning $10,000 for a cost of $1,000. Then the expected value of the gamble is still greater than the cost, but you would have to think very carefully about it, because to you the loss of $1,000 would be so painful as to be unacceptable as an outcome. $1,000 may be too much to lose, despite the chance of winning $10,000."

As a consequence of the two previous illustrations, it seems clear that the results of an investment appraisal made on the basis of Expected Monetary Value may be altered by the influence of at least two factors potentially incorporated within the analysis:

1. The absolute level of probability attached to unwanted possibilities within the investment choice.

2. The absolute size of the potential unwanted possibility within the in-

vestment choice.

There is, however, a third factor which may divert an investment decision away from a judgement based on EMV and this relates to the potential deviation of returns. This influence is again best shown with the help of a theoretical illustration.

Option A: This investment possibility has a 100% certainty of yielding \$50 profit. The Expected Monetary Value (EMV) of the investment is thus \$50. i.e.

$$(1 \times \$50) = \$50$$

Option B: This investment possibility has a 50% probability of yielding \$100 profit and a 50% probability of yielding \$0 profit. The EMV of this investment is thus \$50. i.e.

$$(0.5 \times \$100) + (0.5 \times \$0) = \$50 + \$0 = \$50$$

There is no difference between the two investments on the basis of EMV but it is clear that Option A would be preferred by the vast majority of investors since there is no deviation away from the certainty of a \$50 profit.

These three influencing factors, illustrated above, which result in the rejection of EMV as a valid procedure for assessing alternative investment possibilities have been and can be attributed to the overall influence exerted by risk on the investment decision. Consequently, the EMV methodology can only be sensibly applied in situations where the investor is totally immune to the potential influence of risk. Such an investor is said to be risk neutral. In most practical investment decisions, however, it is clear that the potential investor does, in fact, exhibit a non-neutral attitude towards risk. This is evidenced in the work of Friedman & Savage (1948) who point to the existence of insurance and gambling as extreme examples (at both ends of the scale) of differing positive attitudes to risk. In the former, the insured chooses certainty to uncertainty, however improbable the risk of loss, while the gambler prefers uncertainty to certainty. McGuigan & Moyer (1983p37) provide further support for this point:

> "Other more commonly observed examples of behaviour, such as investment portfolio diversification and the simultaneous purchase of lottery tickets (that is, gambling) and insurance also lend support to the observed fact that the maximization of expected monetary value criterion is not necessarily a reliable guide in predicting the actions or strategies a person will choose in a given decision making situation."

The most fundamental tenet of Modern Portfolio Theory is the idea of diversifying away the inherent unwanted risks of individual investments. As Philippatos (1973p425) points out in support of the assertion made in the above quote:

"The investor who only seeks to maximize expected return will never diversify. He will allocate all his funds to the security with the greatest expected return ... By the same reasoning, if several securities had the same (highest) expected returns, the investor would be indifferent between them."

Consequently, a strategy of maximizing EMV constitutes a complete contradiction to both the theory and the actual widely observed practice of portfolio diversification.

Historically, perhaps the most influential and persuasive critique of the Expected Monetary Value approach lies in the area of pure mathematics. The now infamous St. Petersburg Paradox gained notoriety in the writings of Bernoulli (1738) but can be traced back even further to the less well known work of Cramer (1750) who, as can be seen, published his work somewhat belatedly. The Paradox can be explained as follows: Given a fair coin which is tossed until the first head appears and a gambler then wins $\$2^n$ when the first head appears on the n^{th} toss then the expected return from the game is given by the sum of the probability of each outcome multiplied by the return from the outcome. This definition is derived from the fact that in mathematics such a game has a Binomial Distribution. Thus:

$$
\begin{aligned}
E[r] &= P[h_1] \times 2^1 - P[h_2] \times 2^2 + P[h_3] \times 2^3 + \ldots etc. \\
&= 1/2 \times 2 + (1/2)^2 \times 2^2 + (1/2)^3 \times 2^3 + \ldots etc. \\
&= 1 - 1 + 1 - \ldots etc.
\end{aligned}
$$

Where:

$E[r]$ = Expected Return

$P[h_1]$ = Probability of a head on 1^{st} toss.

$P[h_2]$ = Probability of a head on 2^{nd} toss.

$P[h_3]$ = Probability of a head on 3^{rd} toss.

$\vdots$ $\vdots$ $\vdots$

etc. etc. etc.

Thus, the expected return is an infinite sum of ones and theoretically, therefore, the value of the gamble is infinite. Consequently, Expected Monetary Value theory suggests that someone who uses EMV as the decision criterion would be willing to pay a very high price to take part in the gamble. However, logic suggests that this is extremely unlikely since the probability of winning only $4 or less, say, is 0.75. The St. Petersburg Paradox thus provides even more irrefutable evidence of the deficiency of the straightforward EMV approach to investment decision making.

The question now arises as to what methodology constitutes a more appropriate substitute for the appraisal of alternative investment possibilities. The answer lies in the application of Utility Theory. This theory was originally developed and has subsequently been largely applied in the economic theory of consumer demand. Since investors are one specialized form of consumer, it is widely accepted that investor choice now forms one distinct cornerstone of Utility Theory. It is important at this stage to point out that this theory of investor choice relates purely to the choice between timeless risky alternatives. As such, it is a static, rather than a dynamic concept. According to Douglas (1983p83):

> "Utility is defined as the psychic satisfaction which the consumer obtains from the consumption of goods and services. We postulate that consumers are basically hedonists and wish to maximize their utility. Thus, they choose products for consumption on the basis of the utility they expect to receive from each product."

Another insight is provided by Philippatos (1973p425) who writes:

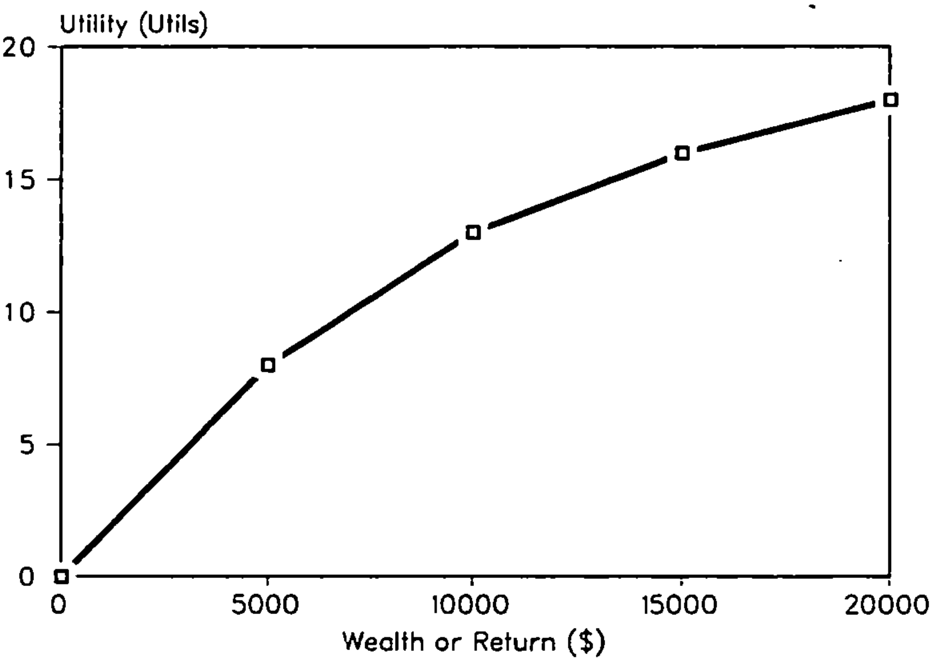
> "Utility, in a broad sense, is interpreted as want-satisfying power. As such it is a property common to all commodities wanted by an individual where commodities are defined to include both present and future consumption goods (assets). Consequently, utility is a state of mind — known to the decision-maker by introspection."

At this stage of the discussion, therefore, the focus should not be on expected profit, expected return or expected monetary value but on the utility that would be derived from different outcomes. In this sense, utility refers to the pleasure or displeasure associated with different outcomes. Within Utility Theory, the terms; profit, wealth, return, money and monetary value can, to all intents and purposes, be regarded as interchangeable.

At the heart of Utility Theory is the idea of marginal utility. Within the current context, this can be defined as the additional utility an investor receives from a change in wealth. Marginal utility is a measure of the increase or decrease in utility derived by increasing or decreasing total wealth by one unit. Thus, in the theoretical graph shown in Figure 4.1:

$$\begin{aligned} MU(0-5000) &= 8 \\ MU(5-10000) &= 5 \\ MU(10-15000) &= 3 \\ MU(15-20000) &= 2 \end{aligned}$$

Figure 4.1: A Risk Averse Utility Curve



In the theory of Financial Economics, it is generally assumed that investors make decisions consistent with Diminishing Marginal Utility (DMU). As Borch (1968p31) states:

> "In this theory we can find statements which really imply something like '3 bottles of wine contain only twice as much utility

as one bottle' or '\$2,000 contains only 50% more utility than \$1,000'."

In relation to investment theory, this phenomenon exists where investors derive less and less incremental utility from each additional increment in wealth. Investors who conform with this assumption are classified as risk averse. An individual with wealth x expects some satisfaction, or utility, $U(x)$ from the consumption possibilities that wealth x affords. It is usually assumed that the individual prefers more wealth to less (non-satiation) and that, therefore, $U(x)$ is an always increasing function of x.

The risk averse investor will prefer the certain outcome of some future wealth x made secure by a safe investment over and above some uncertain future wealth, which for simplicity shall be assumed to be either $x-h$ or $x+h$ with equal probability of 0.5 each. As such, it is clear that the utility from the consumption of a known future wealth x is greater than the expected utility from the same wealth (on average) but which is more uncertain. Consequently:

$$U(x) > 0.5 \times U(x-h) + 0.5 \times U(x+h)$$

Multiplying by 2 and rearranging the terms then:

$$U(x+h) - U(x) < U(x) - U(x-h)$$

Thus, it is clear that utility increases less rapidly at higher levels of wealth than at lower levels. Consequently, the risk averse investor displays Diminishing Marginal Utility. In other words, for the risk averse investor, the gain in utility from an increase in wealth does not make up for the loss in utility from an equal loss in wealth. Another implication of the existence of such a utility curve is that if, as a result of risky investments, wealth or income is allowed to deviate randomly around a certain fixed level of wealth or income, then there will usually be a net loss of utility on average because of the steeper slope of the utility curve for negative deviations than for positive deviations. Franks, Broyles and Carleton (1985) graphically describe this phenomenon as follows:

> "For the risk averse investor, it is nice to win but it really hurts to lose."

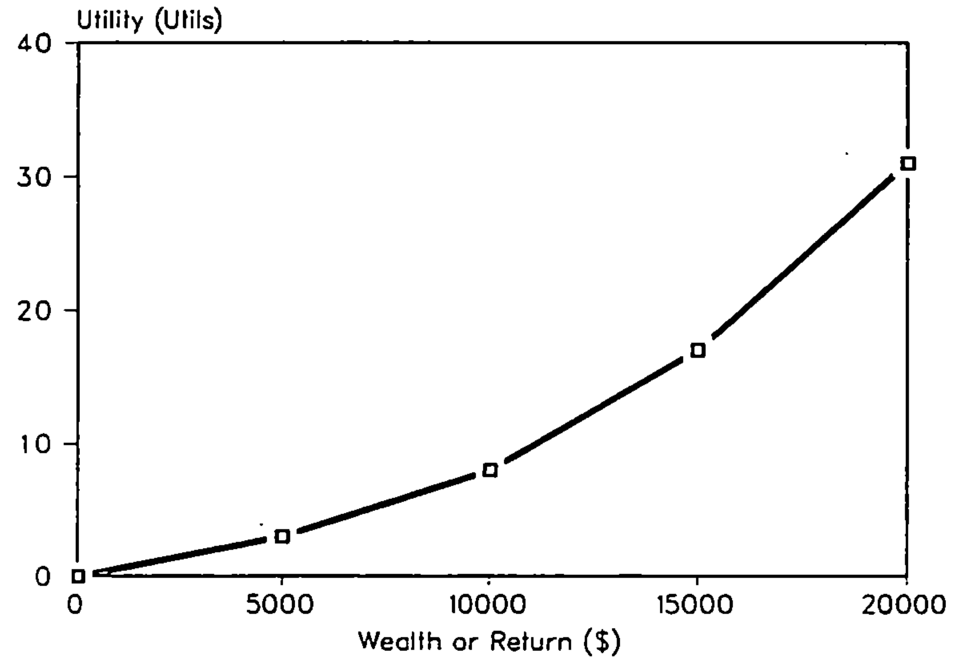
Figure 4.1, previously shown, is an example of a risk averse investor's utility curve, i.e. where such an assumption is upheld. However, any analysis of utility curves (or functions) does not fall down if this assumption is relaxed. Rather, the assumption is made on the basis of general consumer logic, in the sense that in the majority of cases the displeasure of losing large amounts is much greater than the pleasure of winning that same amount. Also, this assumption is typically made purely to facilitate the objective of using hypothetical examples to illustrate the underlying concept. The assumption of

DMU is well supported by empirical evidence in consumer demand theory which suggests that consumers derive progressively declining marginal utility as they increase their consumption of a particular product during any given period of time. As Douglas (1983p86) points out:

> "Products for which it is said one must 'acquire a taste', such as caviar, frog's legs and truffles are often suggested as contradictions to the principle of Diminishing Marginal Utility, since, as you eat more and more caviar, for example, you may enjoy it more and more. But the principle of Diminishing Marginal Utility is only contradicted if, at any one meal, you enjoy subsequent spoonfuls more than you enjoyed preceding spoonfuls. Trying caviar again a week later and enjoying it more this time is not the same as having a second serving on the first occasion. The principle of Diminishing Marginal Utility refers to the decline of marginal utility during a particular period of time when more than one unit of the product is consumed. Thus we expect marginal utility to decline as the consumer increases the rate of consumption during a given time period. Even if you like caviar more the second time you try it (for example, a week later), your marginal utility is expected to decrease as you increase your rate of consumption."

As has been suggested in the previous discussion, the assumption of DMU need not necessarily be appropriate to an investment consumer. This is evidenced in the existence of gambling. An individual who, because of an increasing rather than a diminishing marginal utility for money, has a definite tendency for undertaking highly speculative investments, such as the case with gambling, is said to be risk prone, a risk preferrer or to have a preference for risk. A typical utility curve of a risk preferrer is shown below in Figure 4.2.

Figure 4.2: A Risk Prone Utility Curve



The risk prone investor is different to the risk averse investor in that a profit will increase his utility much more than a loss of the same amount would decrease it. Such an investor would take large risks possibly feeling that a large loss would not make things worse than they already are while a large profit would be very rewarding. Perhaps the best illustration of the difference between these two attitudes towards risk is provided by a coin tossing analogy. A risk averse investor would accept $10 rather than take part in a 50-50 gamble whereby he might win $0 or $20 on the toss of a coin. The risk prone investor, on the other hand, prefers to opt for the gamble. The corollary of this illustration is that a risk averse investor has to be persuaded to accept a greater risk by the existence of an associated greater level of *expected* return. The risk prone investor chooses to accept higher risks, even with associated lower *expected* return. This is due to the fact that the *expected* return from an investment conceals the fact that there is a potential for a profit much higher than that expected. This potentially higher profit, however, has an associated small probability of occurrence.

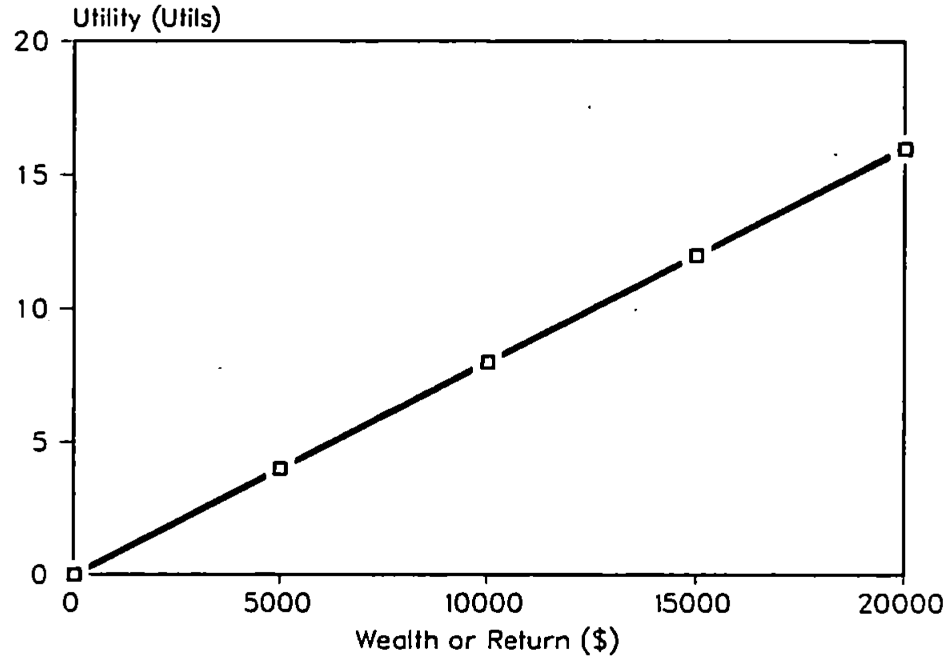
Reference has already been made to individuals who behave as if they were immune or indifferent towards risk. Such an investor is described as risk neutral. With such an investor as this, utility increases or decreases strictly in proportion to the profit or loss that is made. Because of the linearity of this individual's utility curve, he can make decisions purely on the basis of an EMV decision criteria. A risk neutral utility curve can be seen in Figure 4.3.

Whatever the assessed shape of an individual's utility curve Philippatos (1973p425) states:

> "As it turns out, the pursuit of a specific goal, be it the unconstrained maximization of expected return, or the constrained maximization of the same value through diversification, is conditioned by the shape of the utility function of the decision maker."

There exists a widely held view that in reality the shape of an individual's utility curve does not remain constant through all situations. For example, risk neutrality is probably true (i.e. the utility curve is linear) only around the origin, since the individual will probably become more and more risk

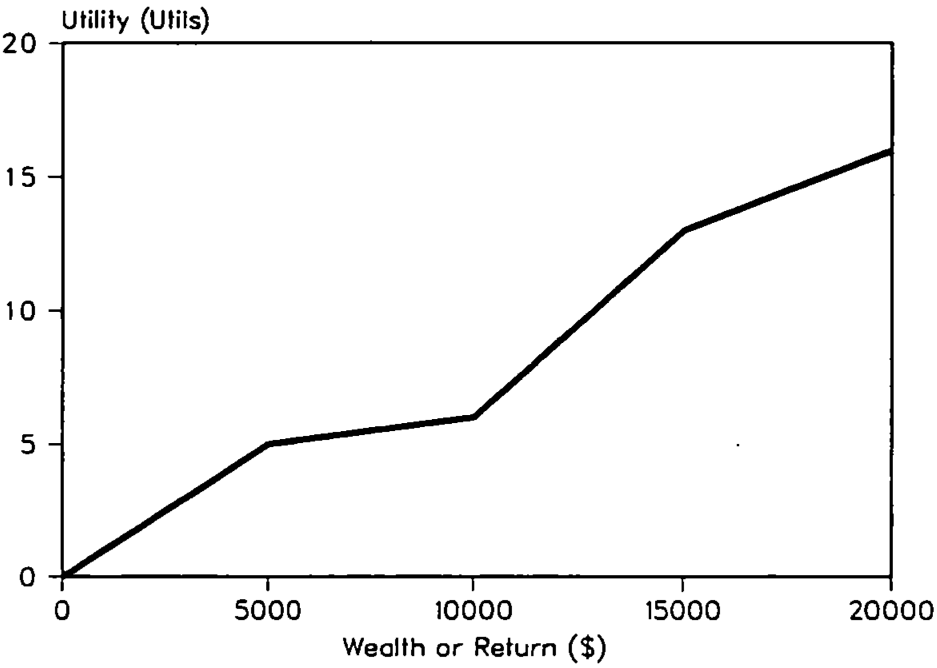
Figure 4.3: A Risk Neutral Utility Curve



averse as the amount of money involved increases. Indeed, in order to take account of the factual considerations of individual behaviour, particularly the contemporaneous investment in insurance and gambles by a single individual, Friedman & Savage (1948) suggest that an individual's true utility curve should be somewhat akin to that shown in Figure 4.4.

This generalized shape of what Friedman & Savage (1948) suggest is a truly realistic utility curve is explained by differential behaviour at various levels of income. This in turn is accounted for more or less directly by socio-economic class. However, this view of the shape of a 'real' utility curve may not be appropriate, by virtue of its analytical intractability, to an analysis of a specific decision choice as is hoped to be undertaken within this study.

Figure 4.4: The Friedman-Savage Utility Curve



The actual shape of an individual's utility curve is due to psychological factors such as expectations about the future, the decision maker's conception of his present financial position, the nature of the decision being made etc. These psychological factors can be summarized by an individual's attitude towards risk and it is this attitude which effects the shape of the individual's utility curve. Consequently, this utility curve is entirely subjective and, therefore, extremely likely to vary between individuals and even for the same individuals at different times. Somewhat problemmatically, however, it is the very shape of the utility curve that ultimately determines the alternatives that will be chosen in a decision problem involving risk. This can be illustrated in the following numerical example:

Suppose an investment costs \$4,000. If the investment is successful then a profit of \$16,000 will be made. If not, then the \$4,000 will be lost. Assume also that the probability of success is 0.2 and, therefore, the probability of failure is 0.8. A payoff matrix can be constructed as shown in Table 4.1.

Table 4.1: Hypothetical Payoff Matrix

	Invest	Don't Invest	Probability
Successful	\$16,000	\$0	0.2
Unsuccessful	-\$4,000	\$0	0.8

The expected profit from investment is then given by:

$$\$16,000 \times 0.2 + (-\$4,000) \times 0.8 = \$3,200 + (-\$3,200) = \$0$$

The expected profit from not investing is also \$0. Making a judgement based purely upon the expected value criterion, the investor would be indifferent between investing and not investing. However, if it is now assumed that this investor has a risk averse utility function then the expected utility of investment can be described as shown in Table 4.2.

Table 4.2: Expected Utility of Investment

Money	Utility
-$4,000	-1
$0	0
$16,000	1.2

Looking now at the total expected utility then:

$$
\begin{aligned}
E[U_{invest}] &= U(\$16,000) \times 0.2 + U(-\$4,000) \times 0.8 \\
&= 1.2 \times 0.2 + -1 \times 0.8 \\
&= .24 - -0.8 \\
&= -0.56 \\
E[U_{don't invest}] &= 0
\end{aligned}
$$

Consequently, with the given risk averse utility function, the investment would not be taken up since the expected utility of not investing is higher than that of investing.

4.2 Rational Behaviour and the Axioms of Cardinal Utility

In order to properly apply Utility Theory and hence, Utility Analysis, one must make the fundamental assumption that the investor, in the face of uncertainty, makes rational choices in order to achieve a particular goal. This overriding assumption of rationality can be expressed in terms of a subset of several other, more specific and very precise, assumptions about an individual's behaviour. These assumptions have become known as the Axioms of Cardinal Utility and, as Copeland & Weston (1980p65) point out:

> "... provide the minimum set of necessary conditions for consistent and rational behaviour."

The development of the Axioms is invariably attributed to the seminal work of Von Neumann & Morgenstern (1953). However, the original proof can be traced back to Ramsey (1931) though this work remains confined to comparative obscurity. Several authors have sought to adjust and further develop the Axioms, the most notable attempt being that of Friedman & Savage (1948). However, for ease of understanding, the ensuing version of the Axioms presented herein can be attributed to Fama & Miller (1972).

Axiom 1: Comparability (or completeness) [1] For the entire set(s) of uncertain alternatives, an individual can say either that outcome X is preferred to outcome Y ($X > Y$) or Y is preferred to X ($Y > X$) or that the individual is indifferent between X and Y ($X \sim Y$).

Axiom 2: Transitivity (or consistency) If X is preferred to Y and Y to

[1] The mathematical symbols used over the next few pages are not meant to represent any strict mathematical relationship. Rather, they relate to relational operators such as, 'is preferred more than', or 'is indifferent between' etc.

Z, then X is preferred to Z. Similarly, if the individual is indifferent as to X and Y and to Y and Z, then he is indifferent as to X and Z.

Axiom 3: Strong Independence Suppose a gamble is constructed where an individual has a probability α of receiving outcome X and a probability $(1-\alpha)$ of receiving outcome Z. If this gamble is written as $G(X, Z : \alpha)$, then strong independance says that if an individual is indifferent as to X and Y then he will also be indifferent as to a first gamble set up between X with probability α and a mutually exclusive outcome Z and a second gamble set up between Y with probability α and the same mutually exclusive outcome Z. i.e. If $X \sim Y$ then: $G(X, Z : \alpha) \sim G(Y, Z : \alpha)$

Axiom 4: Measurability If outcome Y is preferred less than X but more than Z, then there is a unique α (a probability) such that the individual will be indifferent between Y and a gamble between X with probability α and Z with probability $(1-\alpha)$. Thus, if $X > Y \geq Z$ or $X \geq Y > Z$, then there exists a unique α such that: $Y \sim G(X, Z : \alpha)$

Axiom 5: Ranking If alternatives Y and U lie somewhere between X and Z and we can establish gambles such that an individual is indifferent between Y and a gamble between X (with probability α_1) and Z, while he is also indifferent between U and a gamble between X (with probability α_2) and Z, then if α_1 is greater than α_2, Y is preferred to

U. Thus, if $X \geq Y \geq Z$ and $X \geq U \geq Z$ then if $Y \sim G(X, Z : \alpha_1)$ and $U \sim G(X, Z : \alpha_2)$, it follows that: If $\alpha_1 > \alpha_2$ then $Y > U$. Alternatively, if $\alpha_1 = \alpha_2$ then $Y \sim U$.

The Axioms of Cardinal Utility, as outlined above, are most fully discussed by Herstein & Milnor (1953) but are best summarized in a qualitative fashion by Friedman & Savage (1948) who point to the salient features as being:

1. The decision maker has a consistent set of preferences.

2. These preferences can be completely described by a function attaching a numerical value – to be designated "utility" – to alternatives each of which is regarded as certain.

3. The decision maker's objective is to maximize his expected utility.

Together with the basic assumption that individuals prefer more wealth to less, these Axioms provide the basis of a means of mapping preferences into measurable utility. This facilitates the application of Modern Portfolio Theory since it necessitates the inclusion of attitudes towards risk as a variable. Hopefully, this method will allow the determination of a utility function for shipowners.

This final assumption, that individuals prefer more wealth to less, can, in Economics, be defined as meaning that the marginal utility of wealth is always positive. What this implies is that although the Axioms say nothing about the shape of the final determined utility curve $U(x)$, it does mean that, as Borch (1968) points out, $U(x)$ must increase with increasing x. i.e.

$$\frac{dU(x)}{dx} > 0 \qquad \forall x$$

Where:

x = Some monetary value, profit, reward or return.

$U(x)$ = The utility derived from x.

Explaining the raison d'etre for the existence of this phenomenon of rational behaviour is a task for other areas of social science such as anthropology, psychology, political science, sociobiology and sociology. Consequently, in order to facilitate the empirical measurement of a utility function, it is necessary merely to accept, without question, the validity of the Axioms of Cardinal Utility and the assumption that an individual's behaviour is indeed rational within the definitions provided by those Axioms.

4.3 The Measurement of Utility Functions

As far as estimating utility functions is concerned, Gough & Hill (1979p32) suggest that:

> "This is very difficult at a practical level. However, it seems clear that even a subjective assessment of a utility function is preferable to ignoring the problem."

Implicit in the development of the Axioms of Cardinal Utility by Von Neumann & Morgenstern (1953) lies a proof of the measurability of utility. At the time, this proof confounded the then prevailing economic philosophy, even though now it has become the accepted wisdom. However, classical economic theory too, particularly that of the Austrian School of economic thought, did incorporate a belief in the potential mensuration of utility. However, the Austrian School's exposition of the proof of this was based on the sole existence of Diminishing Marginal Utility. As has been seen, such an assumption does not hold for all cases and so their version of the proof has subsequently been refuted. As well as deriving a mathematical justification of the measurability of utility, Von Neumann & Morgenstern (1953p8) draw parallels with the development of theories in the physical sciences in order to justify the mensuration of utility on the basis of qualitative reasoning. Their logic is expounded as follows:

> "It is sometimes claimed in economic literature that discussions of the notions of utility and preference are altogether unnecessary, since these are purely verbal definitions with no empirically observable consequences, i.e. entirely tautological. It does not seem to us that these notions are qualitatively inferior to certain well established and indispensable notions in physics, like force, mass, charge, etc. That is, while they are in their immediate form merely definitions, they become subject to empirical

> control through the theories which are built upon them - and in no other way. Thus, the notion of utility is raised above the status of tautology by such economic theories as make use of it and the results of which can be compared with experience or at least with common sense."

The methodology typically used for collecting information to facilitate the derivation of a decision maker's utility function is based on a modification of the methodology established by Friedman & Savage (1948p294). This methodology is itself based on the Axiom of Archimedes which states that to any prospect $f(x)$ in the set, there corresponds a certainty equivalent $\bar{x}$. In popular terms, $\bar{x}$ is the lowest price at which a particular investor will sell the prospect, or the highest price at which that same investor would be willing to purchase the prospect. Consequently, the decision maker exhibits indifference between owning the prospect $f(x)$ or an amount of cash equal to $\bar{x}$. By the collection of such information in relation to several different prospects within a given universal set, then a mapping of the decision maker's utility curve can be developed. As Friedman & Savage (1948) suggest:

> "Given a utility function obtained in this way, it is possible, if the hypothesis is correct, to compute the utility attached to (that is, the expected utility of) any set or sets of possible incomes and associated probabilities and thereby to predict which of a number of such sets will be chosen."

The choice of mathematical model to fit the consequent mapping is largely a matter of subjective judgement. Indeed, Philippatos (1973p427) goes so far as to suggest that:

> "The choice of a representative shape for the utility function of an investor is usually arbitrary – the final decision being conditioned by intuition and analytical tractability."

This arbitrariness is illustrated by Markowitz (1959) who chose six different possible utility functions and justified them on the basis of the measure of risk employed in the analysis of returns. These six cases are cited below:

Case 1: The investor maximizes the value of some utility function, and decides on the relevant portfolios on the basis of their expected returns and standard deviations . In this case, the investor's utility function will be quadratic.

$$U(r) = c + ar + br^2$$

For the risk averter, in this case, $b < 0$. Such utility functions reach a maximum that may occur above or below the range of relevant returns. However, in general, it is assumed that, over some relevant range of returns, the actual utility of an investor is approximated by a quadratic utility function.

Case 2: The investor maximizes the value of some utility function and decides on the relevant portfolios on the basis of their expected returns and the semivariance of returns . The semivariance (S_b) is defined as the expected value of $[Min(r - b, 0)]^2$. In this case, the investor's utility function will be of the form:

$$U(r) = [Min(r - b, 0)]^2$$

Case 3: The investor maximizes the value of some utility function and decides on the relevant portfolios on the basis of their expected returns and the expected value of loss . Expected loss is defined as the expected value of $[-Min(r, 0)]$. In this case, the investor's utility function will be of the form:

$$U(r) = c + ar + bMin(r, 0)$$

Case 4: The investor maximizes the value of some utility function and decides on the relevant portfolios on the basis of their expected returns and the expected absolute deviation of returns . In this case, the investor's utility function will be of the form:

$$U(r) = c + ar + b \mid r \mid$$

Case 5: The investor maximizes some utility function and decides on the relevant portfolios on the basis of the expected returns and the probability of loss. In this case, the probability that the expected return will be less than or equal to zero can be expressed as the expected return of the function:

$$f(r) = \begin{cases} 0 & r > 0 \\ 1 & r \leq 0 \end{cases}$$

The utility function associated with this measure of risk consists of two parallel linear segments separated by a discontinuity at $r = 0$.

Case 6: The investor maximizes some utility function and decides on the relevant portfolios on the basis of their expected returns and maximum expected loss . In this case, the investor attempts to minimize his losses for any given value of expected return, and his actions are based on a multistage utility function of returns. If the investor's actions were based on a single-stage utility function $U(r)$, then the risk measure of maximum loss would contradict the axioms of expected utility.

Compared to other authors, Markowitz (1959) exhibits an unusual degree of rigour in attempting to justify, on the basis of the measure of risk employed, the utility functions he has selected. The vast majority of applied research in this area, for example Lorange & Norman (1970), evoke no justification (apart from the goodness of fit of the arbitrarily chosen model) for the form of the function which seeks to represent the observations taken on utility.

4.4 Alternatives to Utility Theory

Apart from an axiomatic utility theory approach, Arrow (1971) points to other relevant approaches to decision making under conditions of risk and uncertainty. The three most appropriate to investment decision making, and therefore the most important to this discussion are detailed below:

1. One approach stresses an adaptive rather than a maximizing process (as is implicit in utility theory), where the adaptive investor makes decision choices on the basis of the outcomes of all the previous decisions that investor has made. Constant and progressive monitoring of outcomes through time result in a continuous process of revising the investor's expectations about the future. However, as Philippatos (1973p426) points out:

   > "As such, the adaptive approach is more appropriate in explaining the formation of expectations than in analysing the investment decision under uncertainty."

   Despite this criticism, this is invariably the approach adopted by shipowners as a matter of course.

2. Another approach stresses heuristic behaviour where simulations are used to predict investment outcomes. Again, such an approach does not suit the purposes of directly dealing with the establishment of decision rules in a risky environment.

3. A further alternative approach to utility analysis, and perhaps the most widely accepted alternative, is one which employs the economic concept of indifference curves.

Douglas (1983p82) states:

> "An indifference curve is defined as the locus of combinations of two products, or of other variables, among which combinations the consumer is indifferent. That is, each point (each combination of the two variables) on an indifference curve is equally desirable, giving the consumer the same level of utility."

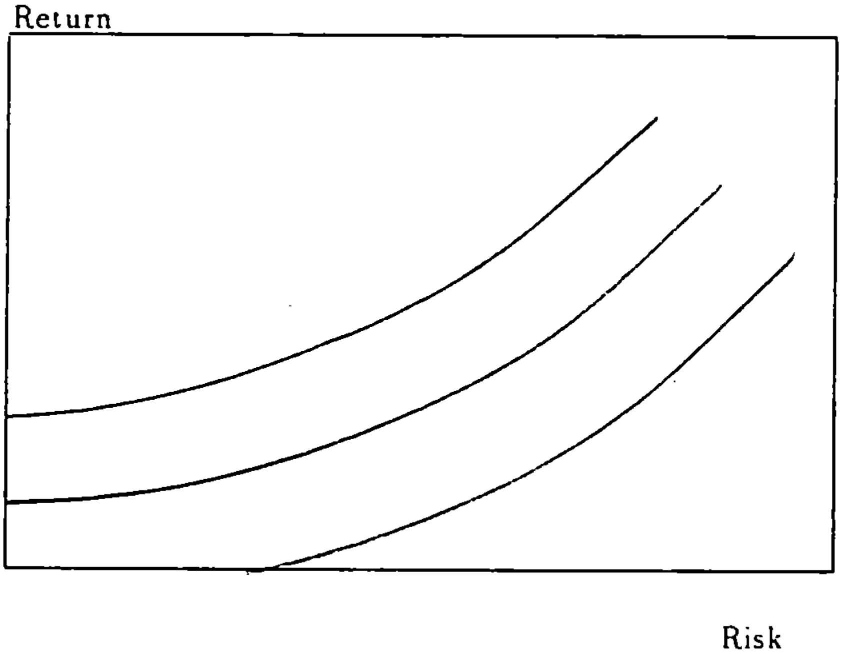
As is obvious from the above definition, a direct relationship exists between utility analysis and and an analysis based on indifference curves. Since the investor's utility function determines the relevancy, to the final decision choice, of the specific characteristics of the various portfolios available to that investor, then it follows that the investor's utility function will determine how many moments of the probability distribution of expected returns are significant to the portfolio selection process.

The relationship between utility curves and indifference curves is evidenced by the fact that each utility function contains implicitly an indifference map, where the shape of the indifference curve can be found easily by holding the utility function constant and differentiating with respect to each moment. In relation to investment decisions, alternative choices are typically considered in terms of two moments; the expected return (μ) and the variance of this return (σ^2) (the variance constituting a measure of risk). As already mentioned, indifference curves can, in theory, be found between return and variance. As is also true of utility curves, the shape of this indifference curve indicates the attitude of the investor towards risk. For example, the indifference curve of the risk averse investor would have a steep positive slope indicating that as variance (risk) increases, expected return must increase steeply if the investor is to remain indifferent. Such an indifference curve for a risk averse investor can be seen in Figure 4.5.

Because of this relationship between utility analysis and that based on indifference curves, and because the most appropriate measure of risk in shipping has not yet been evaluated, it has been decided, for the purposes of this work, that attitudes towards risk in the shipping industry be assessed with the aid of utility theory. A practical consideration also supports this choice, since as Gough & Hill (1979p31) say of indifference curve analysis:

> "This approach emphasizes that the dispersion of returns must be taken into account, but estimating indifference curves is even more difficult than estimating utility functions."

Figure 4.5: A Theoretical Representation of Indifference Curves for a Risk Averse Investor



4.5 The Use of Utility Functions in Portfolio Selection

Once investor preferences have been formalized with the aid of utility analysis, the final chosen portfolio can be determined by looking at these preferences in association with a locus of efficient portfolios. An efficient portfolio in this context relates to those which yield the maximum expected return associated with a specific level of risk or those with the minimum level of risk associated with a specific level of expected return. The chosen portfolio is calculated as that prevailing at the point of tangency between the expectations and the preferences. This is the basic methodology of Modern Portfolio Theory which is expounded upon to a much greater extent in Chapter 6.

Once the locus of efficient portfolios has been constructed, by moving along it the investor can trade-off risk and return in order to maximize his utility. This brings into question the problem of investment goals. At the most elementary level, long-term as against short-term goals may result in different portfolios being selected. This is the case since as Philippatos (1973) points out, portfolios with greater variation tend to have higher long-term expected returns than short-term. However, such problems as these are assumed to be automatically surmounted within utility analysis since such objectives are held to be implicitly contained within the investor's utility curve.

In turn, the shape of the utility function will also determine the parameters of the distribution of expected returns which are ultimately directly relevant to the decision.

This methodology for determining the choice of the final portfolio is similar to the equilibrium solution of consumer choice: An objective function, that is the expected utility, must be maximized subject to the constraint of available portfolios. As has already been stated, the solution is obtained at the point of tangency between the two functions.

Implicit in this methodology for portfolio selection are three basic steps:

1. Selection of the universal set of possible investments
2. Estimation of the risk-return properties of the individual investments.
3. Allocation of the available funds for investment among the opportunities so as to minimize risk for a specified rate of return.

The application of Utility Theory and the subsequent determination of utility functions relate to point 3 above in that they provide an input into the method of allocation of funds which is ultimately adopted. With respect to point 2 above, in an uncertain world investors cannot know in advance which investments will yield the highest returns. Investors need to make estimates of the risk and return parameters. Consequently, under conditions of uncertainty, investors make decisions that maximize expected utility. This, in itself, is determined as Philippatos (1973p426) points out, by expected return and expected risk:

> "In the selection of a portfolio, the investor relies on his expectations, which involve several possible outcomes of his actions. Expectation of returns from a portfolio are functionally determined by the distribution of returns on the individual assets."

Gitman, Joehnk & Pinches (1985p250) provide further support for this contention when they state:

> "Theoretically, investors should seek to maximize utility in an uncertain world, but in an operational sense they try to maximize expected utility."

Thus, in general, any decision model for an investor revolves about two sets of parameters:

- Those that describe the expectations of the investor about the future states of the world.
- Those that describe the preferences of the investor within the framework of available opportunities.

Having assimilated the necessary information, the investor can then look at the problem as one of maximizing $E[U]$, where:

$$E[U] = f(expected\ return, risk)$$

One implication of such a problem is that an increase in expected returns will increase the investor's expected utility if risk does not increase. Similarly, a decrease in the risk of the returns will increase expected utility if the expected return does not decrease simultaneously.

This objective of attempting to maximize expected utility is incorporated within the Axioms of Cardinal Utility and as such, should be viewed as a means for making a rational choice. As Philippatos (1973p426) avows, this rational choice amounts to:

> "The statistical maximization of the expected value of a function assigning utilities to the potential outcomes of his portfolio selection."

This statement provides us with a qualitative definition of what has become known as the Expected Utility Hypothesis or Bernoulli Principle. In mathematical terminology, expected utility is calculated by summing, over all the possible outcomes that may result from a decision, the product of the utility of each outcome U_i times its respective probability of occurence P_i.

U_i in this instance refers to the assigned utility to each potential outcome of an investment decision. The Expected Utility Hypothesis is thus represented in mathematical form by the following expression:

$$E[U] = \sum_{i=1}^{n} U_i \times P_i$$

The proof of this hypothesis, most persuasively propounded by Von Neumann & Morgenstern (1953), has as a corollary the result that such calculations can be used to determine a preference ordering over a set of differing investment prospects or alternatives.

One further factor, which should be incorporated into any investment analysis, stems from the fact that the wealth of investors is invariably limited. Consequently, investors must allocate their available funds among the possible investments available to them, taking account of the different costs and different utility expected from alternative investments so that utility is maximized subject to a wealth constraint. As is implied by the Axioms of Cardinal Utility, an investor who is seeking to maximize utility is said to be acting 'rationally'. However, this wealth constraint prevents the investor from acting rationally in an absolute sense and so results in the investor adopting an investment position which although is practical, is in fact second best and, therefore, suboptimal in a rational sense. The investment problem then becomes similar to that described by Naylor, Vernon & Wertz (1983p58) in relation to consumer choice:

> "In consumer theory, the demand functions of a single consumer are derived from the interaction of two concepts: the utility function and the budget constraint. The utility function is a formal way of expressing what a consumer prefers to have. The budget constraint expresses what a consumer can afford to buy. Assuming that a customer will select from all affordable combinations of goods (according to the budget constraint) the com-

bination he or she most wants to have (according to the utility function), we derive the quantities that the consumer seeks to buy."

Having attempted to justify the theoretical attractiveness of the utility approach, it is now necessary to highlight the potential practical drawbacks. McGuigan & Moyer (1983) point to three:

1. Whose utility function should be used as the basis of a corporate analysis.

2. Since the utility functions of different individuals are not directly comparable, how can a group function be arrived at.

3. The approaches used in attempting to empirically derive a utility function sometimes result in inconsistent utility assessments.

These are all valid problems which need to be resolved within this study. However, in response to point 3, Borch (1968p21) very pragmatically suggests:

> "There may exist persons with more or less 'perverse' preference orderings who do not fit our model, but we can ignore them as long as we do not set our level of aspiration too high."

At the end of the day, despite the obvious problems, the final justification for the use of the utility theory methodology must lie in the fact that given the lack of a suitable substitute, there seems to be no better method of incorporating the decision maker's preferences into the decision analysis. At the same time, as Friedman & Savage (1948) point out, it must be borne in mind that utility theory does not suggest that the individual decision maker consciously refers to his own utility curve in making a decision. Rather, the curve explains the actual decision taken in a logical way, and can, therefore, only be disproved where a prediction based on such an analysis proves to be inaccurate. As Von Neumann & Morgenstern (1953p20) so poignantly point out in relation to the measurability of utility:

> "The objection could be raised that it is not necessary to go into all these intricate details concerning the measurability of utility, since evidently the common individual, whose behaviour one wants to describe, does not measure his utilities exactly but rather conducts his economic activities in a sphere of considerable haziness. The same is true, of course, for much of his conduct regarding light, heat, muscular effort etc. But in order to build a science of physics these phenomena had to be measured. And subsequently the individual has come to use the results of such measurements - directly or indirectly - even in his everyday life. The same may obtain in economics at a future date."

Chapter 5

An Original Analysis of Risk Attitudes in Shipping: Results from a Survey

Previous sections of this work have shown the importance of risk as a major influencing factor in investment decision making. If an accurate model of market investment in shipping is to be developed, this influence necessitates the measurement of attitudes towards risk. It has also been shown that the theoretical and practical aspects of Utility Theory provide an appropriate foundation for the development of such a measure. It is now necessary to convert Utility Theory into an analytically tractable methodology for determining the prevailing risk attitudes in the shipping industry. For the purposes of this work, the relevant part of the shipping industry upon which the analysis will concentrate is the shipowning community, with particular emphasis placed upon those involved in the dry bulk sector.

5.1 Derivation of Survey Database and Historical Context of Survey Methodology

There have been several applications of Utility Theory to the determination of risk attitudes in non-shipping industries. Examples include Mosteller & Nogee (1951), Jackson (1960) and Green (1976), who investigated the chemical, oil drilling and food industries respectively. Indeed, due to the popularity of this approach over the last two decades, these examples are drawn from a list that is almost endless. Quite surprisingly, however, there has been only one attempt to apply the theory to the determination and subsequent measurement of risk attitudes of shipowners. This widely acclaimed study, by Lorange & Norman (1970) was aimed exclusively at proving the supposed risk prone attitudes of Norwegian tanker operators in the early 1970's. Because of their concentration on such a relatively small and specific sector of the shipping community, it is possible that the results of their study bear no resemblance to those achieved in this work. However, the methodology which was adopted by Lorange & Norman (1970) provides a valuable foundation for the development of a suitable approach for the utility analysis contained within this work. Consequently, it may prove beneficial to draw parallels, wherever appropriate, between their approach and results and those of this study.

The first step in attempting to implement Utility Theory to derive a measure of attitude towards risk, is to develop a database of potential suppliers of attitudinal information. Initially, it was thought that this study should concentrate solely on British shipowners. Consequently, because it categorizes shipowners by country, Lloyd's Maritime Directory (1987) was used to derive a list of the names and addresses of all British shipowners. This initial database contained a number of "shipowners" who could only loosely be described as such. A typical example being a County Council entered in Lloyd's Maritime Directory (1987) by virtue of its ownership of dredging vessels or sludge carriers. However, it was thought unwise to filter such peripheral shipowners out of the database at this early stage. Justification for such a policy exists because:

- The person within the organization who actually provides the information *vis a vis* risk attitudes could well be very qualified within the shipowning community, even if his company was not, to provide representative and, therefore, valuable information.

- Should reasonable responses be obtained from such relatively minor shipowning interests and consequently be included in the final database of information for analysis, it would then be possible to isolate their overall combined effect and determine whether or not they significantly changed the results had the analysis been based solely on a database of major shipowning companies.

- Given a certain overall response rate, expressed in percentage terms, then statistics dictates that several of such minor shipowners would not provide any information anyway. The potential inability of this group of shipowners to respond may lead to a group response rate which is below the overall mean. Hence, the potential problem of the replies of such shipowners being unrepresentative of the shipowning community would not arise in these cases.

- Should information that was supplied by such minor shipowners not be of the necessary quality to be included in the database for analysis, it could be filtered out at that stage with much less effort involved.

Having thus arrived at a surprisingly large database of 441 British shipowning companies, it was then necessary to determine exactly how the required information should be collected and exactly what information was needed in order to undertake a viable Utility analysis. Obviously, these two aspects are linked in that a two-way interdependence exists between them. Consequently, determining how the necessary information should be collected and what exactly constitutes that necessary information should be looked at in conjunction.

Lorange & Norman (1970) applied an approach, developed by Friedman & Savage (1948) and discussed in the previous chapter, where they collected information pertaining to a "certainty equivalent" ($\bar{x}$) , expressed in money terms, which the respondent would be willing to accept as a minimum amount in return for surrendering a probabilistic outcome or prospect $f(x)$. This is by far the most usual method employed for the collection of utility information. However, it can take either of two similar forms. As it happens, Lorange & Norman (1970) used both of the available methods in order to draw a comparison between them. The observations which they made in this respect were somewhat inconclusive, and therefore, provided no clue as to how this study should progress. Consequently, the method employed in this study will be justified on the basis of other criteria. Both methods are based on asking the respondent the following type of question:

> Q. Given a potential investment where the probability of earning $X is p% and the probability of losing $Y is $(100-p)$%, what is the minimum amount that you would be willing to accept in order to forego the investment opportunity?

The development of information in order to undertake a utility analysis progresses by asking the same question but with either varying values for p, or alternatively, varying values for X and Y. These two alternative approaches constitute the two different methods by which utility information may be obtained. At the end of the day, by mapping the various responses to each question posed, the derivation of an overall utility function relating expected returns to a utility index is possible. The final resulting function constitutes an empirical model of the respondent's attitude towards risk. Here, the risk implied by the questions is implicit in the probabilities attached to each potential outcome.

Lorange & Norman (1970) chose to derive their utility database from interviewing a sample of 17 major Norwegian tanker operators. There are a number of advantages and disadvantages to the adoption of the interview technique, as there are with any survey method, all of which are fully discussed in the relevant paper by the writers. However, using the latter method of data collection, ie. with varying values of X and Y, the first question is posed with predetermined values for X and Y, but all subsequent questions are based on the answer to the previous question. Consequently, the adoption of such a style of information gathering leads to the development of a linked chain of questions, the form of which ultimately depends upon the response to the first question posed. Lorange & Norman (1970) found that their respondents could understand perfectly well the implications of different potential returns, but could not so easily understand the implication of the differential probabilities attached to the possible outcomes. The major advantage of a technique which employs a method of data collection based on varying the values of X and Y is that it negates this conceptual difficulty, found on the part of the respondents, in dealing with varying probabilities. Typically, in a survey of this type, the value of p is held at 50% since this figure poses few of these conceptual difficulties in interpretation. Presumably, this is the case because of the existence of such well-known analogues as tossing a coin. Obviously, this approach lends itself very well to an interview-based technique for the collection of data since the interviewer having received an answer to one question may then use that answer in posing the next question. Interview based techniques thus have one advantage in promoting flexibility in the choice of methodology adopted.

The interview technique, however, was dismissed as a viable method of data collection for the purposes of this study. Because the objective of this work is the development of a generally applicable model for market investment in the dry bulk shipping industry, data sources should be as widely based as possible. Interviews place unavoidable constraints on the number and range of such sources. Said constraints typically manifest themselves in terms of budgetary, time and practical considerations.

It was decided that the most appropriate method for data collection, bearing in mind the objectives of this study, would be a postal survey. The adoption of this method has the potential advantage of achieving large numbers of responses very quickly and in a standard format. However, such a methodology precludes (without a great deal of ingenuity and expense) the use of questions where X and Y vary in accordance with a respondent's previous answer. As a consequence, the type of questions asked in order to derive utility information must be based on varying p values. This could lead to the introduction of those conceptual difficulties, previously discussed, which the respondent may have in understanding probabilities. However, Lorange

& Norman (1970) found that only 3 out of their 17 interviewees encountered such problems. Also, over the last 20 years, since the Lorange & Norman (1970) study, the promulgation of management education could well have served to mitigate the conceptual difficulties in dealing with probabilities. There are now very few management/business courses which do not include a component of probability theory. If such problems should still occur they should be apparent in the type of responses obtained, at which time some filtering or adaptive procedure could be instigated.

A further problem with the adoption of a data collection method such as a postal survey lies in assessing how much information to ask of the respondent. One should be careful in not deterring a reply. Such a problem is much less likely to exist in the intimate atmosphere of an interview. This requirement has to be balanced with the necessity of obtaining sufficient results in order to obtain significant analytical properties.

Since Lorange & Norman (1970) found that the liquidity position of the respondents significantly affected the replies made in their interviews, it was deemed necessary to incorporate this variable into an analysis based on postal survey. Consequently, two sets of the same questions were formulated; one set under the assumption of a good liquidity position, the other under an assumption of poor liquidity. It was finally decided, therefore, on balancing statistical rigour with the practical consideration of not wishing to deter respondents, that the part of the questionnaire to be sent that related to utility analysis should comprise two sets of 3 questions. Each set would contain the same questions, but one set would be placed within the context of good liquidity while the other would deal with a poor liquidity situation. A preamble to the questions was also enclosed in an attempt to make requirements clear and to set the context of the questions. The actual questions asked, together with the preamble can be seen in Section B of the questionnaire, a copy of which is provided in Appendix A.

The questionnaire and survey method were designed and implemented in accordance, as far as possible, with the Total Design Methodology (TDM) suggested by Dillman (1978). This methodology is to a large extent a formal statement of the apparently obvious. However, it does provide a formal framework to work within and also has some useful suggestions to make in many respects. For example, TDM suggests that in order to optimize the rate of response achieved on a survey, a reminder should be sent out approximately two weeks after the initial questionnaire. This reminder should be printed on a postcard for ease of despatch. Similarly, TDM suggests that the survey database should be computerized so that names and addresses can be reprinted by computer very easily. Additionally, survey forms were designed to be self-coding to lessen the effort involved in data entry for analysis. These were three examples of TDM suggestions which were implemented within this study and proved fruitful. Particularly beneficial was the use of a reminder which, on average increased the response rate by about 100% in most cases.

The sort of TDM requirements which were omitted were such features as addressing each questionnaire to the name of the Managing Director of each company in the survey, signing each covering letter individually and using certain colour questionnaires for psychological reasons. These sorts of suggestions were not adhered to because of either their impracticality in terms of the effort involved or by virtue of the additional expense incurred.

Prior to sending a pilot survey to a 10% random sample of the British shipowning community, a pre-pilot survey was undertaken by asking for local 'expert' comment on the questionnaire's structure and content. At this stage, the average time taken for completing the questionnaire was assessed at eight minutes. Having made adjustments in accordance with the advice received, the pilot survey was then despatched. After sending a reminder two weeks later, it soon became obvious that the response rate would never reach a level whereby the absolute number of reasonable responses would be such as to support an analysis which produced significant results. Consequently, it was decided that in order to achieve a significant number of responses, in absolute terms, the survey database would have to be increased. Although this would increase the complexity of the analysis, it was thought worthwhile if it simultaneously increased the significance of the results achieved. Because, therefore, the analysis was to be aimed at determining the utility functions of the shipowning community, it was decided to include the shipowners of Norway, Hong Kong and Greece. The choice of these three extra countries was somewhat arbitrary but can be justified on the grounds that they are all major traditional shipowning countries, either directly or indirectly. Their inclusion not only facilitated a larger shipowning database, it also allowed for the analysis of utility from a cultural perspective. For example, do the Norwegians have a different attitude towards risk than do the Greeks. This meant that the final database of shipowners included 441 from Britain. 234 from Norway, 117 from Hong Kong and 530 from Greece, yielding a total of 1,322.

5.2 Details of Responses Achieved

Full details of the survey responses achieved can be seen in Table 5.1.

Table 5.1: Details of Survey Responses

Country	Valid Responses Received	Non-responses Received	Non-responses Not Received	Total Number in survey
Britain:	37	66	338	441
Norway:	18	4	212	234
Hong Kong:	8	3	106	117
Greece:	32	57	441	530
Total:	95	130	1097	1322

At first sight, this Table suggests that the response rates for the different nationalities surveyed are as follows: Britain 8.4%, Norway 7.7%, Hong Kong

6.8% and Greece 6.0%. However, consideration must be given to the fact that nearly all the non-responses received were questionnaires returned to sender by the postal service because the companies concerned no longer existed. Obviously, this means that the original sampling frame as derived from Lloyds Maritime Directory (1987) was out of date before it was even published. If these companies are deleted from the original database, then the response rates achieved will rise to: Britain 9.9%, Norway 7.8%, Hong Kong 7.0% and Greece 6.8%. This yields an overall average response rate of 8.0%. In absolute terms, this represents a possible set of 95 responses to analyse.

Although the response rates achieved could be viewed as being disappointing, it must be borne in mind that according to Cragg (1987), the average response rate of *small* companies to surveys which utilize the unabridged version of the TDM is only 30%. He also found that larger companies were less likely to reply to surveys than smaller ones. The shortfall could be explained by the sensitive nature of some of the questions asked in sections of the questionnaire other than that dealing with utilities. Another explanation could be found in the infamously secretive nature of companies in the shipping industry. Many of the questions posed in the utility section could be viewed as being quite complex in nature and, hence, could well have deterred a large number of potential respondents. From a more pragmatic point of view, the fact that the British response rate is higher than that of Norway, Hong Kong and Greece suggests that there could be a language factor which tends to reduce the overall response rate.

Further analysis of the responses received led to the fact that the average asset size of the respondents was $33,207,176. This very high value suggests that it was the larger shipowning companies which tended to respond to the questionnaire. Support for this assertion is provided by the fact that responses were received from 6 of the 9 companies which are quoted under the shipping categorization on the London stock market. Clearly, the low response rates achieved imply the potential existence of bias in the analysis and subsequent results. However, it would seem that if bias is present, it is due to a weighting in the responses received in favour of larger shipowning companies. Since the study undertaken within this work is aimed at providing a decision making methodology for complicated market investment appraisal where large investments are made at regular intervals, the results of the work would seem to be more appropriate to larger rather than smaller shipowning companies. Consequently, the potential existence of size bias is not such a problem as it first appears.

Consideration of the available alternative methods for collection of the necessary data does not yield any quick solution to the problem of a low response rate. Invariably, methods of data collection involve a trade-off between the quantity and the quality of the responses received. The complex nature of the information being sought, and the diversity of shipowning companies, mitigate against the probability of an alternative method proving more efficient, especially insofar as quality is concerned. Perhaps, with hindsight, the best solution to this problem would have been the use of two separate questionnaires, one dealing with utility information and the other with structural questions.

Despite the relatively low response rate, however, the fact remains that the absolute number of reponses achieved is 95. This is much more than required in order to undertake an analysis which yields significant results. Moreover, the study of risk attitudes using utility analysis undertaken by Lorange & Norman (1970) achieved notoriety on the basis of a sample of only 17 interviewees.

5.3 Implementing the Utility Analysis

In order to facilitate the utility analysis of the responses received, the first step involved the categorization of these responses in terms of risk averse, risk prone, risk neutral and illogical responses. The term "illogical responses" is defined as those which do not conform to the axioms of cardinal utility as laid down by Von Neumann & Morgenstern (1953), or those which exhibited inconsistent risk attitudes over the range of questions asked. This categorization was achieved simply by plotting the responses against a derived utility index and then assessing by eye the type of curve which resulted. As implied by the existence of four categories, the curves could be of four forms.

For this purpose of curve plotting and categorization, the first step in the data analysis involved the definition of a utility index so that associated y values could be attached to each x value supplied by the respondents. Because of the way the questions were formulated, a utility index value of 0 was attached to an expected return of $-\$3m$ and a utility index value of 100 was attached to an expected return of $\$30m$. These (x, y) values provide the endpoints of each individual company's utility curve and are derived from the survey questions as follows:

$$E[x] = 100\% \times -\$3m + 0\% \times \$30m = -\$3m$$

Therefore;

$$U[-\$3m] = 0$$

$$E[x] = 0\% \times -\$3m + 100\% \times \$30m = \$30m$$

Therefore;

$$U[\$30m] = 100$$

The type of questions asked of the respondents follow the methodology inherent in state preference theory, as explained by Kroes & Sheldon (1988), and were all of the same general form.

> Q. Given a potential investment where the probability of earning $30m$ is 75% and the probability of losing $3m$ is 25%, what is the minimum amount that you would be willing to accept in order to forego the investment opportunity?

The expected value $E[x]$ of this investment opportunity is given by:

$$E[x] = 75\% \times \$30m + 25\% \times -\$3m = .75 \times \$30m + .25 \times -\$3m = \$21.75m$$

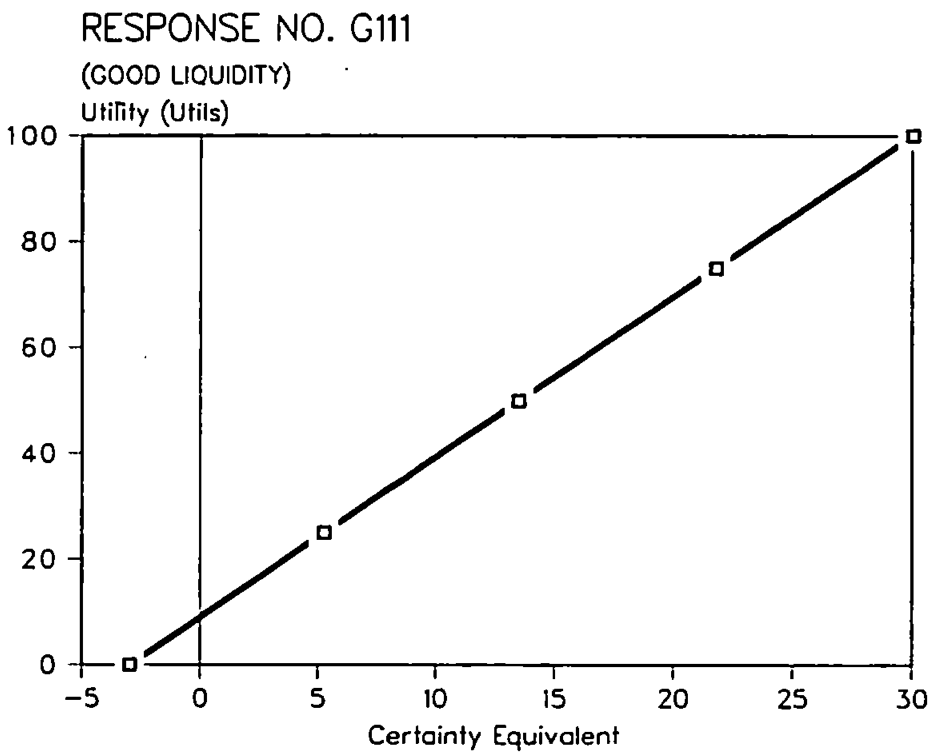
Similarly, if the probabilities are now varied as was the case with the questions asked of the respondents:

$$E[x] = 50\% \times \$30m + 50\% \times -\$3m = .50 \times \$30m + .50 \times -\$3m = \$13.5m$$

$$E[x] = 25\% \times \$30m + 75\% \times -\$3m = .25 \times \$30m + .75 \times -\$3m = \$5.25m$$

These expected values provide us with a mapping of the different opportunities in terms of an expected monetary value criterion. As mentioned earlier, if the decision maker is risk neutral then expected monetary values summarize that decision maker's attitude towards risk. Thus, if respondents gave responses to the questions asked which corresponded to the expected monetary values of the choices, then a plot of their responses against the utility index will be the same as plotting the EMV's against the index. This will take the form of a straight line as shown in Figure 5.1.

Figure 5.1: An Example of a Risk Neutral Response



The calculation of y values (which relate to the utility index $U[x]$), whatever the value of x (the response to the question asked), is performed as follows:

$$U[x] = U[-\$3m] \times p\% + U[\$30] \times (100 - p)\%$$

The values of $U[-\$3m]$ and $U[\$30m]$ have previously been defined as 0 and 100 respectively. Where the response (x) achieved is the same as $E[x]$, ie. risk neutrality is exhibited, then:

When	p	=	0%	$U[\$30m]$	=	100
When	p	=	25%	$U[\$21.75m]$	=	75
When	p	=	50%	$U[\$13.50m]$	=	50
When	p	=	75%	$U[\$5.25m]$	=	25
When	p	=	100%	$U[-\$3m]$	=	0

By plotting x along the x-axis and $U[x]$ along the y-axis, the result given in Figure 5.1 is achieved. In order to ascertain whether the curves resulting from plotting the responses (x) against the utility index values ($U[x]$) are risk averse, risk prone or illogical, therefore, the method progresses by assessing:

1. whether the curve is above the risk neutral line for all values of x. If so, then this can be classified as risk averse since for a given investment opportunity with a predetermined $E[x]$, the value quoted for the

surrendering of that opportunity will be less than $E[x]$. Thus, for risk aversion;

$$x < E[x] \qquad \forall x$$

2. whether the curve is below the risk neutral curve for all values of x. If so, then this can be classified as risk prone since for a given investment opportunity with a predetermined $E[x]$ the value quoted for the surrendering of that opportunity will be greater than $E[x]$. Thus, for risk proneness:

$$x > E[x] \qquad \forall x$$

3. whether the curve is inconsistent over the relevant range. Thus, if it exhibits risk proneness in certain responses and risk aversion in others then the curve can be classified as "illogical" and ignored for analytical purposes. The inherent difficulty in modelling such illogical responses precludes their analysis no matter how realistic such alternating attitudes towards risk may be.

Examples of data plots for each of these three situations are shown in Figures 5.2-5.4.

Figure 5.2: An Example of a Risk Averse Response

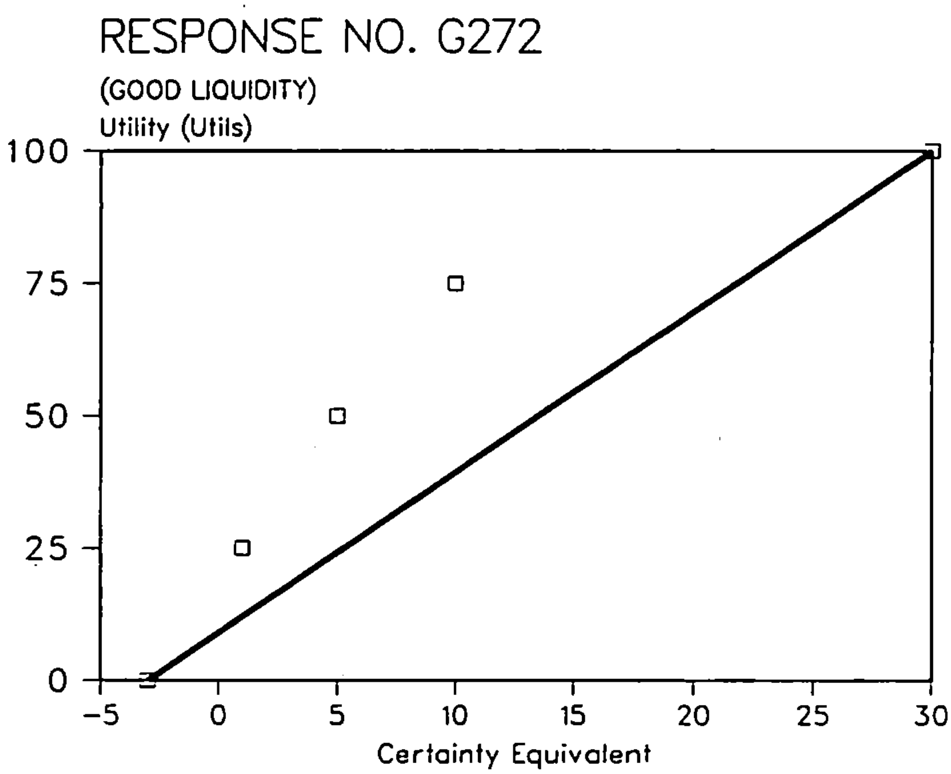


Figure 5.3: An Example of a Risk Prone Response

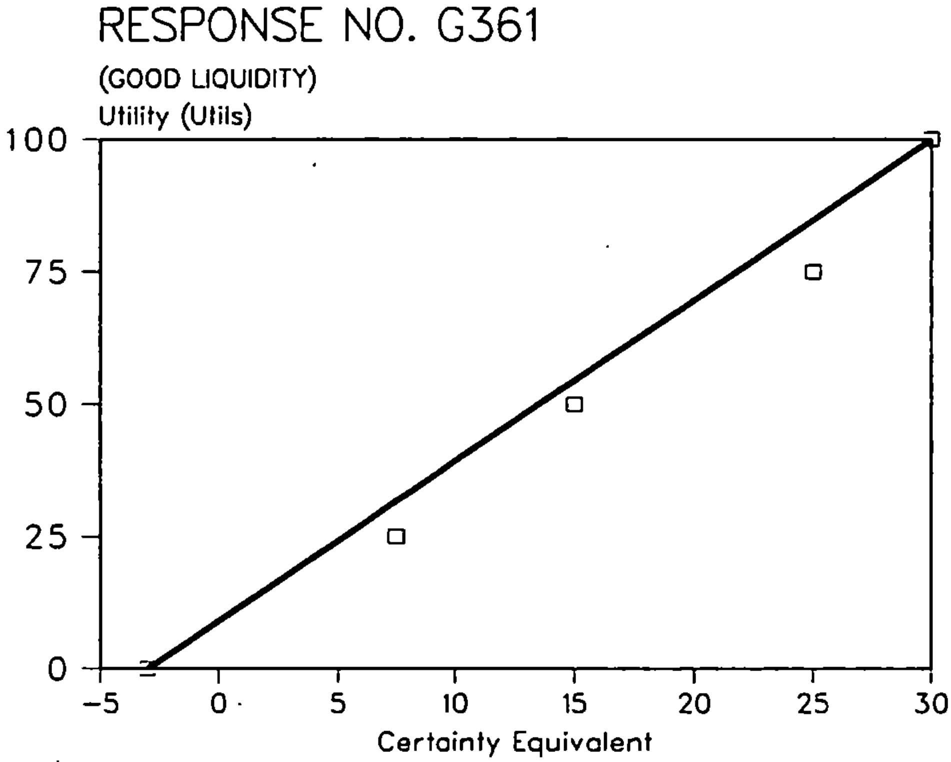
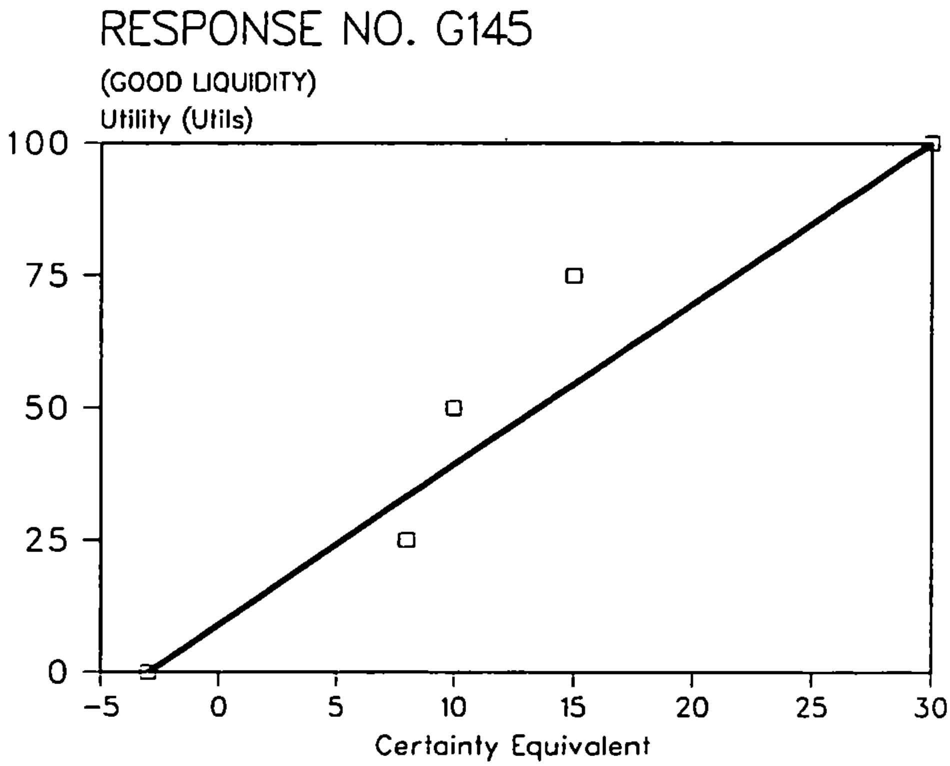


Figure 5.4: An Example of an 'Illogical' Response



This method of response classification needs to be undertaken for the responses given under the assumptions of both good and poor liquidity. The data for analysis can then be described in the terms given in Tables 5.2 and 5.3.

Table 5.2: Classification of Utility Responses Under Conditions of Good Liquidity

Country	Risk Averse	Risk Prone	Risk Neutral	Illogical Responses	Total Number
Britain:	17	6	2	12	37
Norway:	8	1	1	8	18
Hong Kong:	2	3	0	3	8
Greece:	12	3	1	16	32
Total:	39	13	4	39	95

Table 5.3: Classification of Utility Responses Under Conditions of Poor Liquidity

Country	Risk Averse	Risk Prone	Risk Neutral	Illogical Responses	Total Number
Britain:	23	1	2	11	37
Norway:	14	1	0	3	18
Hong Kong:	4	0	0	4	8
Greece:	20	1	0	11	32
Total:	61	3	2	29	95

The objective at this point then becomes to develop a mathematical model of the different utility functions under a number of situations. At the moment, information may be classified by:

- Shape of the utility function.

- Whether a situation of good or poor liquidity prevails.

- The country of origin of the respondents.

Additionally, since this study is aimed primarily at the dry bulk trades, responses have been classified in accordance with whether the respondent is mainly a dry bulk operator or not.

5.4 Results of the Utility Analysis and the Specification of Utility Functions in Shipping

The analysis progresses by deriving a mathematical model, on the basis of ordinary least squares regression, for each of the possible combinations of classification. Thus, for example, separate models are derived for Greek, risk averse, bulk shipping operators in times of good liquidity and the same in times of poor liquidity.

The form of the models to fit the various sets of data can be chosen arbitrarily in the sense that all that is required of them is that they 'fit' the data well. However, since the main objective is to fit a model which predicts utility from monetary values, then the type of model chosen to fit the data should reflect the pattern of the responses *vis a vis* risk aversion, risk proneness, and risk neutrality. Thus, the mathematical function embodied in a particular model should, when plotted, coincide with the shape of the risk attitude which is being modelled. What this means when modelling a risk averse attitude, for example, is that the relevant parameterized mathematical utility function should be concave to the x-axis, in the same way as the standard portrayal of a risk averse attitude as shown previously in Figure 5.2.

Clearly, for risk neutrality, this mathematical modelling process merely necessitates the determination of the straight line which passes through the expected values of each choice. Thus, a line is required which passes through the values for x and y shown in Table 5.4.

Table 5.4: Dataset for Risk Neutrality

x	$U[x]$
-3	0
5.25	25
13.50	50
21.75	75
30.00	100

The equation of the required line which passes through these points is given by:

$$y = 9.09 + 3.03x$$

where: $y = U[x]$

This model for risk neutrality applies to all classifications of data which are risk neutral. Risk averse and risk prone models, however, will vary depending upon the survey data classification. Bearing in mind that the function which is used to model a set of data must reflect the underlying shape of the risk attitude, because of the nature of the risk averse curve, the following models were tested for goodness of fit and, therefore, explanatory power.

1. $U[x] = a + bx$
2. $U[x] = a + bx + cx^2$
3. $U[x] = a + b\ln(x)$
4. $U[x] = a + bx^{\frac{1}{2}}$
5. $U[x] = a - b/x$

All the above models, suggested by Draper & Smith (1981), produce curves which correspond to the typical risk averse curve. ie. a curve concave to the x-axis. The number of final models which are eventually derived will relate to the number of data classifications that exist. Since this classification process was undertaken on the basis of;

- four countries;
- whether the respondent was a dry bulk shipowner or otherwise;
- whether the prevailing liquidity situation was good or bad;

...there is a total of sixteen possible categories for analysis. Additionally, models were also derived for databases where one or more of the classifications were ignored. Thus, for example, the 'best' utility curve for a Greek dry bulk shipowner with good liquidity could be compared to the utility curves derived for:

- Greek dry bulk shipowners irrespective of liquidity situation.
- Greek shipowners with good liquidity irrespective of trade.
- Dry bulk shipowners with good liquidity irrespective of nationality.
- Greek shipowners irrespective of trade or liquidity situation.
- Dry bulk shipowners irrespective of liquidity situation and nationality.
- Shipowners with good liquidity irrespective of trade or nationality.
- All shipowners irrespective of trade, liquidity situation or nationality.

What this implies is that thirty combinations are possible and that, thus, thirty utility curves were estimated and assessed. The explanatory power of the models tested were compared on the basis of r^2, t-ratios and analysis of residuals. By correlating the fits from the different models within the pyramidical structure of classification implied by the above, it is possible to determine whether the factors of nationality, liquidity or trade have any impact on attitudes towards risk. None of these tests of correlation proved to be significantly different from unity. Thus, one may conclude that the risk averse utility curve for the total database of risk averse shipowners, irrespective of any particular characteristics, is representative of every type of risk averse shipowner. In other words, the nationality of the shipowner, whether he is a dry bulk operator or not and, most surprisingly, whether good or poor liquidity prevails have no influence over his attitude towards risk.

This is a surprising result when compared to the theoretical arguments of Friedman & Savage (1948) who suggest that an investor's attitude towards risk will be governed by his liquidity situation. Similarly, this result contradicts the empirical findings of Lorange & Norman (1970) who did, in fact, find overwhelming evidence that risk attitude is affected by liquidity. They suggested that because the existence of perfect capital markets would make liquidity unimportant with respect to risk preferences, their results implied that the capital markets open to shipowners were anything but perfect. The most plausible cause of the difference between the results of this study and those of Lorange & Norman (1970) would, therefore, seem to lie in the area of a general improvement in the supply of capital markets and in a greater appreciation and understanding of their role amongst shipowners. This constitutes a very interesting conclusion in its own right.

According to the analysis undertaken, the 'best' model of a risk averse utility curve for shipowners of all types is given by the expression:

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5} \qquad r^2 = 89.0\%$$

A similar analysis was undertaken for the database of risk prone shipowners. The possible forms of the risk prone model which were investigated and which, by definition, yield functions that are convex to the x-axis; are:

1. $U[x] = a + bx$
2. $U[x] = a + bx + cx^2$
3. $U[x] = ae^{bx}$
4. $U[x] = -\frac{1}{a+bx}$
5. $U[x] = ax^b$

The general results achieved were analogous with those of the risk averse results. Again, the overall utility curve for risk prone shipowners, irrespective of specific characteristics, was found to be representative of the individual subsets. Again, nationality, trade specialization and liquidity bore no influence on the prevailing attitude to risk. The resultant risk prone utility curve with the highest r^2 of the models tested is, therefore, given by the equation:

$$\ln(U(x) + 0.5) = 0.181 + 1.21\ln(x + 3.5) \qquad r^2 = 97.6\%$$

$$U(x) + 0.5 = e^{0.181 + 1.21\ln(x+3.5)}$$

$$U(x) + 0.5 = e^{0.181}.e^{1.21\ln(x+3.5)}$$

$$U(x) + 0.5 = e^{0.181}.e^{\ln(x+3.5)^{1.21}}$$

$$U(x) + 0.5 = e^{0.181}.(x + 3.5)^{1.21}$$

$$U(x) = 1.1984152(x + 3.5)^{1.21} - 0.5$$

This form of utility equation is known as the Cobb-Douglas model. Lorange & Norman (1970), when investigating the risk proneness of Norwegian tanker operators, also found that this form of function best fitted their risk prone dataset.

The utility equations which have been derived in this way were then assessed on the basis of their analytical tractability with regard to the further use to which they will be put within the total Modern Portfolio Theory methodology. Particularly important in this respect is the need for the utility functions to be easily differentiable. They also need to be able to cope with the negative returns on investment that, unfortunately, are so common in shipping.

With hindsight, it was found that the risk averse function, outlined above, suited the purposes for which it has been estimated. However, the risk prone function proved to be inadequate with respect to the mathematics that is involved in applying Modern Portfolio Theory. This was particularly evident where returns were negative. Instead, it was decided to sacrifice some explanatory power in order to reap the benefits of potentially easier mathematical manipulation. Although the risk prone utility function, outlined above, is the best model of risk prone attitudes in shipping, it was decided that a model in quadratic form would suit better the purpose for which it was derived. This quadratic form of risk prone utility curve provided the second highest value of r^2 when the data was fitted using least squares regression to the different potential models. Thus, the risk prone utility function which has been adopted for inclusion in the remaining analysis is that given by the expression:

$$\sqrt{U(x) + 0.5} = 2.37 + 0.231x \qquad r^2 = 82.5\%$$

$$U(x) + 0.5 = (2.37 + 0.231x)^2$$

$$U(x) + 0.5 = 5.6169 + 1.09494x - 0.053361x^2$$

Therefore;

$$U(x) = 5.1169 + 1.09494x + 0.053361x^2$$

It is important to remember that statistical models, such as those that have already been specified and which will be used in the ensuing analysis, are only valid over the range for which data was collected. They thus represent merely local approximations to a shipowner's utility curve. An attempt was made to derive a generally applicable utility curve over all possible values of x (or return) for a risk averse shipowner. Castellani (1972) suggested a generally applicable utility model of the form:

$$U(x) = k(1 - e^{-\frac{x}{a}})$$

This form of model satisfies all the necessary mathematical criteria for a 'perfect' risk averse utility function. The parameters of this model were estimated, using numerical procedures, for the dataset of risk averse shipowners. The resultant parameterized function fulfilled all the mathematical requirements placed upon it, but proved to be non-robust within the interval with which this study concerns itself. Thus, it is better to use a local approximation, which behaves well within the interval of interest, than a generally applicable curve. The reason that this is the case is that utility functions are independent of scale and intercept (by virtue of the fact that they are based on an index) and consequently, can be applied to any interval of interest. This aspect will be illustrated in greater depth in a later part of this work but, needless to say, justifies the omission of a similar investigation into a generally applicable risk prone utility curve.

Chapter 6

Modern Portfolio Theory

6.1 An Historical and Conceptual Perspective

Although there have been many contributions to Modern Portfolio Theory through the years, its original conception as a workable idea can be attributed to the seminal work of Markowitz (1952). Previous to this date, traditional portfolio theory constituted purely a vague philosophy that investors should not 'put all their eggs in one basket'. Markowitz (1952) adopted this skeleton idea and attached to it flesh in the form of mathematical rigour. Thus, a scientific, or 'modern', approach to portfolio investment was born. As Sharpe (1970p3) points out:

> "Markowitz' contribution was so monumental that it must be noted explicitly. Others have extended, modified, and tested his

> original theory, but the core remains unchanged. In fact, many prefer the term *Markowitz theory* to *portfolio theory*. The terms are, for all practical purposes, synonymous."

Modern Portfolio Theory differs from what went before not only by virtue of its analytical rigour but also because it purports to incorporate the interactive effect of holding different investments. Traditional portfolio theory espouses the assessment of investments on an individual basis and ultimately led to the well known procedures for security analysis. However, it fails to incorporate the interactive effect which is present whenever a number of different investments are held. Thus, a situation may exist where traditional portfolio theory points to the holding of the, say, three 'best' investments in terms of potential return. If, however, the forecast returns from these three investments are perfectly correlated with each other and with the market, then a 20% decline in the prosperity inherent in the market will lead to a 20% fall in the value of all three of the investments. Consequently, traditional portfolio theory is synonymous with an investment appraisal based on Expected Monetary Value: It takes no account of risk, and therefore attitudes towards risk, and so is only useful for the risk neutral investor.

By accounting for the interactive effect of investment holdings, Modern Portfolio Theory explicitly incorporates the risk effect and, therefore, must necessarily incorporate a feature whereby differing risk attitudes result in the selection of different portfolios.

Fundamentally, Modern Portfolio Theory constitutes a model which, when applied to real investments, should lead to an optimum portfolio selection. As a model, the theory does not seek to reflect reality exactly. All models constitute abstractions from reality and Modern Portfolio Theory is no different. Inherent in the building blocks of such models are a set of assumptions which attempt to simplify reality to a level whereby the model then becomes feasible for application. Such assumptions are invariably totally unrealistic, but, as Friedman (1976) avows, the strength of the resultant model can only be judged in terms of how well it predicts or prescribes real behaviour. The relaxing of certain assumptions may be necessary to achieve this aim, but this need not lead to the dismissal of the overall model as a viable explanatory mechanism.

The major advantage of using a model as a loose reflection of reality is that the relationships inherent in a model can be thoroughly specified and studied, whereas the analogous relationships in the real world are unclear. The processing of inputs through a model results in clear and unambiguous outputs which is not the case in reality, though the aim is that the model outputs are closely aligned with those that do or should occur within the real environment that is being studied.

In general, models may take one of two forms. They may be either 'normative' or 'positive' models. A normative model results in an output which is a prescription for real behaviour. What should be done rather than what will be done. A positive model, on the other hand, is predictive in nature and attempts to describe what will happen if a certain course of action is adopted. Modern Portfolio Theory constitutes a model which can be either normative or positive depending upon the application for which it is used. In attempting to deduce subjectively optimal portfolio selection, as is the case within this work, it is regarded as a normative model. This work seeks to apply Modern Portfolio Theory in the determination of the market portfolio that particular types of shipowners *should* hold.

6.2 The Nature of the Markowitz Model

The model made explicit within the confines of Modern Portfolio Theory provides a tool for the selection of investment portfolios. This prescribed selection process, embodied in the model, can be regarded as part of a range of activities collectively referred to as 'portfolio management'. Ryan (1978) describes these activities as follows:

1. The definition of the portfolio's objective and the constraints under which it is held.

2. The choice of an asset universe, or opportunity set, from which the portfolio is to be drawn.

3. The formulation of the decision rules, or criteria, on which to build the portfolio.

4. The estimation of the relevant characteristics of the individual assets in the asset universe, and, on the basis of such evaluation, their inclusion in, or omission from, the portfolio.

5. Establishing the criteria for monitoring the performance of the portfolio through time, and for changing its composition whenever and wherever it is deemed necessary.

The Modern Portfolio Theory model clearly has a part to play in points 2-4 above. Its use is dependent on the objective of the portfolio (point 1) being to optimize the risk-return trade-off in line with the company's own specific attitude towards risk. Where this objective is not present, an alternative portfolio selection process may be more appropriate. The advantage of Modern Portfolio Theory as an investment selection methodology lies in the fact that this required objective can be regarded as 'positive', or in other words behavioural, in nature. Implicitly, the vast majority of companies will have this objective in mind when selecting an investment portfolio and consequently, Modern Portfolio Theory becomes almost universally applicable. This is due to the fact that the Markowitz (1952) model embodies the application of Utility Theory which itself is built upon the mathematical logic of Von Neumann & Morgenstern (1953) and their concept of 'rational behaviour'. Thus, such an objective can be regarded as merely a rational one.

The role of Modern Portfolio Theory with respect to point 5 above, in terms of monitoring the performance of the portfolio through time, is questionable because it was developed as a static model. However, the dynamicizing of the model may be possible when some of the assumptions upon which it is based are relaxed. This possibility will be addressed at a later point in this work. Nevertheless, it is clear that Modern Portfolio Theory may provide an extremely useful tool in the portfolio management process as itemized above.

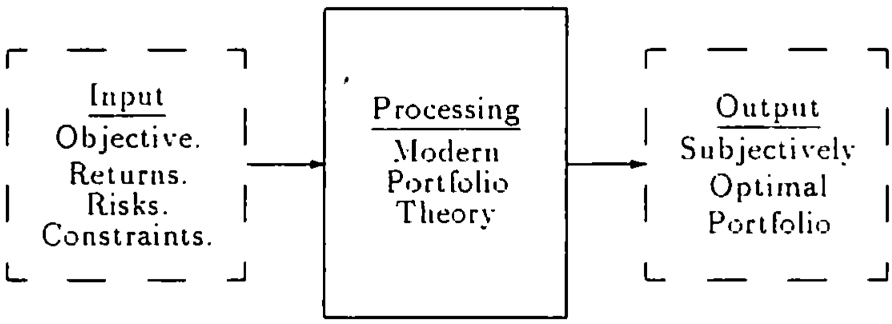
The model implicit in Modern Portfolio Theory takes the form of an algorithm which, when applied, results in the output of a subjectively optimal portfolio. An algorithm, in this context, can be viewed as a sequence of logical steps which form part of the overall model or which together compose the overall model. As Rudd & Rosenberg (1979p21) describe it:

> "An algorithm may be thought of as an explicitly defined procedure, which, when followed, leads to the resolution of a well defined problem. Thus a portfolio optimization algorithm obtains, through a sequence of steps, an optimal portfolio. The input is a set of goals (the utility function and constraints on permissible solutions); an investment opportunity set (the universe of available assets and their relevant characteristics); a formalization of the portfolio revision process (possibly taking into account transaction costs incurred in modifying the portfolio); and a mathematical specification of the solution sought (a desired optimum defined by a convergence criterion or possibly a search of the

range of optima for alternative goals)."

Conceptually, the role of the Markowitz model can clearly be seen in Figure 6.1.

Figure 6.1: Systems Conceptualization of Modern Portfolio Theory



6.3 A Critique of the Assumptions of Modern Portfolio Theory

It has already been stated that Modern Portfolio Theory, in common with all mathematical models, is based upon a set of assumptions which may or may not be realistic. Amling (1984) provides a comprehensive listing and discussion of those assumptions but for the purposes of this work only a summary is required.

1. The marketplace is efficient. That is, everything is known or knowable about each investment. This suggests that the market is perfectly competitive. The validity of this assumption with respect to shipping is implied by Couper (1972p83) when he writes:

> "Individual shipowners cannot influence world commodity supply or demand to any extent. Nor have they any real control over the deployment of the world supply of ships, or therefore on freight rates, other than when operating in close knit conferences. All that the owner can do to ensure a good average level of earnings, over poor and favourable markets, is continually to improve his efficiency and reduce operating costs to a minimum. Attention to costs is clearly of vital importance in what is an internationally competitive industry."

2. Investors are risk averse. As has already been seen in Chapter 4, this means that the marginal utility of the return declines as returns are increased.

3. Risk is measured by the variability of the rate of return using the statistical measure of standard deviation as a proxy.

4. Investors are rational in that they prefer a higher rate of return to a lower rate of return.

5. All decisions will be made on the basis of expected rate of return and the expected standard deviation of the rate of return.

6. The way in which investment returns are correlated to each other must be known.

7. The rate of return and risk are calculated for a single time period.

8. The investment units are perfectly divisible so that a risky investment can be added to or subtracted from a portfolio in any unit value amount.

9. Investors attempt to maximize returns and minimize risks from a portfolio. Natural corollaries of this assumption are:

   (a) Investors will try to obtain the highest return per unit risk.

   (b) Investors will attempt to maximize return for a given level of risk and will attempt to minimize risk for a given level of return.

10. It is assumed that the higher the return then the higher the risk and that the lower the return, the lower the risk.

11. In order to reduce risk, an investor must add another investment to the portfolio. This also reduces the return. In consequence, the risk and return from a portfolio is increased as the number of individual investments that compose that portfolio is reduced.

12. The investor must determine the *efficient* set of investments that will provide the portfolios that meet the above set of assumptions. Typically, this efficient set is composed, almost exclusively, of diversified portfolios. If this proves to be the case for shipping, it indirectly justifies the diversification policies of companies such as P & O, who, as a consequence of this policy, may well have a better risk/return trade-off than would otherwise be the case, but may still not be operating under the optimum diversified portfolio.

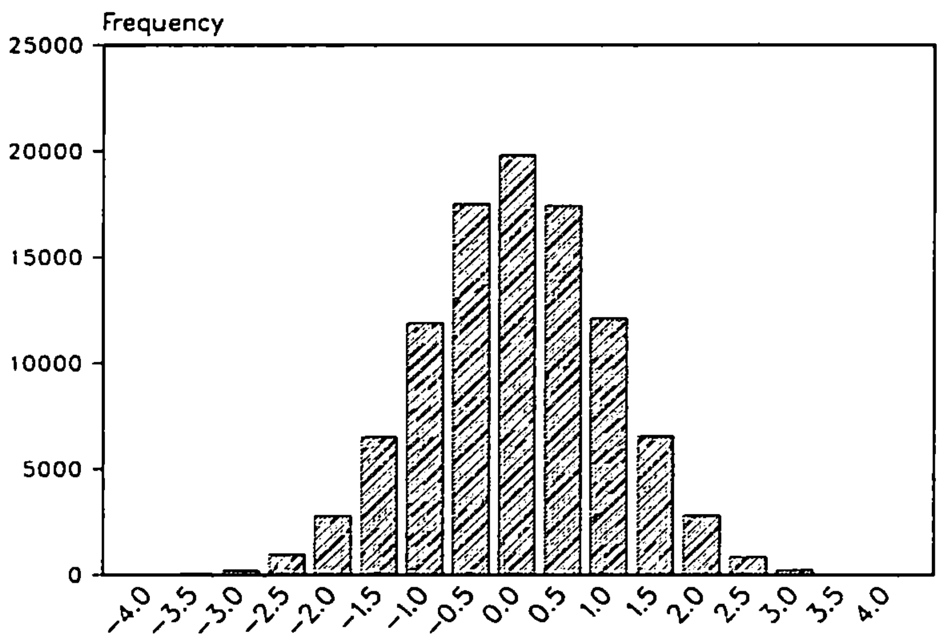
As has already been seen in Chapter 5, not all investors in the shipowning industry are risk averse. In fact, in times of good liquidity 15% of respondents were risk prone and 5% were risk neutral. Comparable figures for times of poor liquidity were 4% and 2% respectively. The assumption of risk averseness, implicit in Modern Portfolio Theory, is, therefore, highly questionable. However, as shall be seen in the following section, where the methodology is actually described, this assumption is only necessary in order to allow mathematical tractability. In fact, several of the assumptions outlined above are aligned to the requirement for risk aversion and, therefore, to the promotion of feasible mathematics. This work, as will be seen, relaxes this assumption thus allowing a more general application of the model but at the expense of greater complication in the mathematics involved. Without detracting from the normative power of the methodology, this relaxing of the requirement of risk aversion allows for the directly obvious and immediate disposal, in their present form, of assumptions 2, 9 and 12.

The dismissal of risk aversion as a necessary prerequisite to the application of Modern Portfolio Theory also results indirectly in the dismissal of assumption 10. It is only a risk averse investor who would be faced with a choice in deciding between investments or portfolios with high return and high risk and those with low return and low risk. A risk prone investor would obviously select the high return/high risk option since he would be getting the best of both worlds, while a risk neutral investor would disregard the risk factor and opt for the investment or portfolio which yielded the greatest return. Thus, when considering investors with a variety of different risk attitudes, it is necessary to allow investments or portfolios which yield high returns and low risk or low returns and high risk into the universal set of possible investments. Obviously, this results in a much more realistic environment since logic dictates that it is not necessarily true that high potential payoffs have associated high risks. One only needs to observe the high level of, virtually risk-free, returns from the recent privatizations of nationalized industry to realize that this is the case.

Another major criticism which could be levelled at the set of assumptions outlined above is the use of standard deviation as the measure of risk. The use of standard deviation and/or variance (the square of the standard deviation) is common in most applications where a risk measure is required.

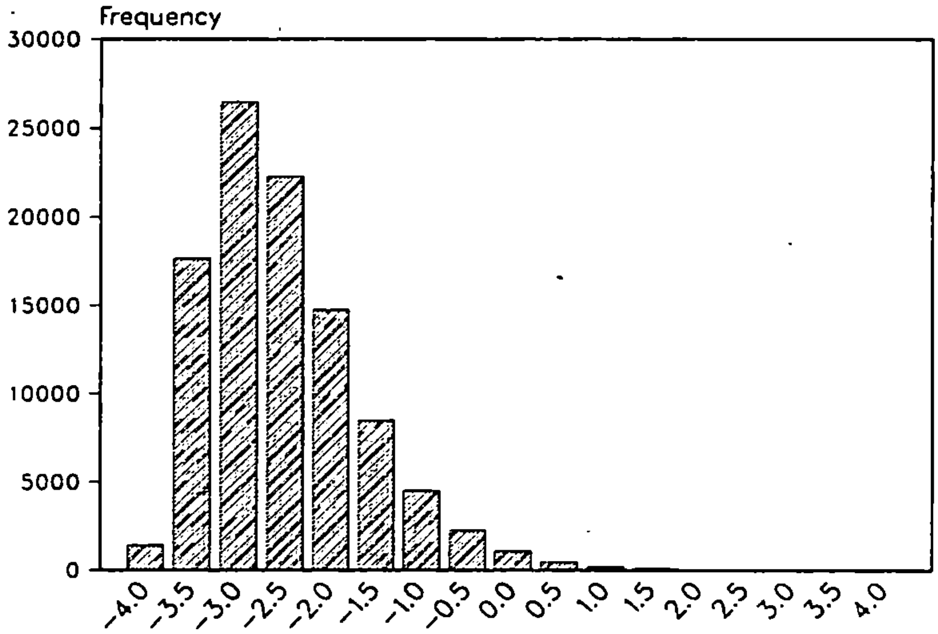
Again, the reason behind the adoption of standard deviation or variance as the relevant risk measure is the analytical properties which ensue. These properties will be illustrated in the next section where the original Markowitz (1952) methodology is outlined. However, such a risk measure is itself based on a requirement for the returns from investments to be normally distributed as shown in Figure 6.2.

Figure 6.2: An Example of a Normal Distribution



Many researchers in this field, for example Simkowitz & Beedles (1978) and Mao & Brewster (1970), have shown that the assumption of normal returns is unrealistic. Rather, the pattern of returns tend to be skewed. This tendency can be logically explained by the simple fact that the downside potential for returns from investment is limited by factors such as losing the whole investment or bankruptcy. The upside potential is, however, theoretically limitless. Thus, a skewed pattern of returns, as shown in Figure 6.3, is much more common in real world investments.

Figure 6.3: An Example of a Skewed Non-Normal Distribution



By dispensing with the absolute requirement to use standard deviation and/or variance as the measure of risk, embodied in assumption 3 of the previous list, it is possible to test much more realistic measures. However, this amounts to yet another step away from the original Modern Portfolio Theory model and again increases the mathematical complications that are present.

The effect on other assumptions, of removing the necessity of measuring risk by standard deviation or variance, can be summarized as follows:

- The term 'expected risk' should be substituted for 'expected standard deviation' in assumption 5. Thereby, permitting the assessment of an investment decision on the basis of any potential risk measure.

- Assumption 6 now becomes unnecessary, since this is related to easing the computational difficulties in calculating portfolio variance from individual investment variances. Only where standard deviation or variance is used as the risk measure would this information be useful, though even then not absolutely vital. Where alternative risk measures are used it is useless.

- Again, assumption 11 is only absolutely true where standard deviation or variance is the measure of risk employed. As will be seen, this is because of the mathematical laws that govern a linear combination of individual investments in forming a portfolio. Where other risk measures are used, it is not necessarily a 'hard and fast' rule.

As a consequence of these criticisms, the original assumptions which underlie Modern Portfolio Theory have been abridged somewhat for the purposes of the analysis undertaken within this work. By doing so, the level of realism of the model has been increased and a greater degree of flexibility in approach has been introduced. The final set of model assumptions which this work is governed by can thus be summarized as:

1. The marketplace is efficient. That is, everything is known or knowable about each investment.

2. Investors are rational in that they prefer a higher rate of return to a lower rate of return.

3. All decisions will be made on the basis of expected rate of return and the expected risk of the rate of return.

4. The rate of return and risk are calculated for a single time period.

5. The investment units are perfectly divisible so that a risky investment can be added to or subtracted from a portfolio in any unit value amount.

6. The investor must determine the *efficient* set of investments that will provide the portfolios that meet the above set of assumptions.

As can be seen from the above list, assumption 12 from the original list has been retained as assumption 6 of the new set of assumptions. However, the meaning is now completely different since many other assumptions, upon which this assumption relies, have either been deleted or changed in some way. The paramount effect of these alterations has been to fundamentally change the meaning of the term 'efficient'. As will be seen in the following section, 'efficient' in the original Markowitz sense relates solely to portfolios that are appraised by risk averse investors. Within the context of this work, an 'efficient' portfolio will differ between risk averse, risk neutral and risk prone investors. What is an efficient portfolio for a risk averse investor is invariably inefficient for the risk prone investor. Thus, the term not only has a much wider literal meaning, but also completely breaches the mathematical definition of 'efficient' provided by Markowitz (1952).

6.4 An Exposition of Modern Portfolio Theory

Remembering that the Markowitz Portfolio Theory is based on the original 12 assumptions outlined in the previous section, it is now possible to describe the methodology, or algorithm, inherent in the Modern portfolio theory model for portfolio selection. The first step in the methodology must be the establishment of the purpose for or objective of the approach. As has already been implied, the methodology should result in a particular portfolio selection which minimizes risk in accordance with an investor's attitude towards that risk. Consequently, given a universal set of n individual investments from which a virtually infinite number of portfolios may be composed, then the decision maker requires the following information:

- The expected return of each individual investment, denoted by $E[r_i]$. In most applications of Modern Portfolio Theory, the mean of a set of historical observations of the investment is used as a proxy. Obviously, there will be n values for $E[r_i]$ with $i = 1 \ldots n$. Where x_k denotes individual observations of a time series of m observations of an individual investment, then the expected return, or mean, ($E[r_i]$) is given by:

$$E[r_i] = \overline{x} = \frac{\sum_{k=1}^{m} x_i}{m}$$

- The variance of returns of each investment, denoted by σ_i^2 where $i = 1 \ldots n$, which are again typically derived from historical data analysis. For a time series of m observations of an individual investment, this is given by:

$$\sigma_i^2 = \sum_{k=1}^{m} (x_k - \overline{x})^2$$

- The covariances associated with the universal set. The covariance is a statistical measure of the relationship between two sets of observations. Because of its pairwise nature and the number of investments in the universal set, there will be $(n^2 - n)/2$ covariances which need to be calculated. Covariance is mathematically defined by:

$$Cov_{ij} = \frac{1}{m} \sum_{k=1}^{m} (x_{i_k} - \overline{x_i})(x_{j_k} - \overline{x_j})$$

The numerous covariances that have to be calculated from historical sets of data has often mitigated against the use of the Modern Portfolio Theory methodology. However, modern computer technology has greatly eased this problem in recent years.

Given this data with respect to the individual investments that compose the universal set, it is now possible to automatically determine the risk and return characteristics of any combination of these investments as represented in a portfolio. If the variable p_i (where $i = 1 \ldots n$) represents the weights or percentage holding of each individual investment within a portfolio, then it is clear that:

$$\sum_{i=1}^{n} p_i = 1.0 \qquad\qquad 0 \leq p_i \leq 1$$

The expected return from a portfolio ($E[r_p]$) composed of certain percentages of the individual investments is given by the linear combination:

$$E[r_p] = \sum_{i=1}^{n} p_i E[r_i]$$

As Sharpe (1985) puts it:

> "Since a portfolio's expected return is a weighted average of the expected returns of its securities, the contribution of each security to portfolio expected return depends on its expected return and its proportionate share of the current portfolio's market value. Nothing else is relevant."

Since variance is the measure of risk employed, one must now determine the variance of, and therefore the risk associated with, the portfolio (σ_p^2).

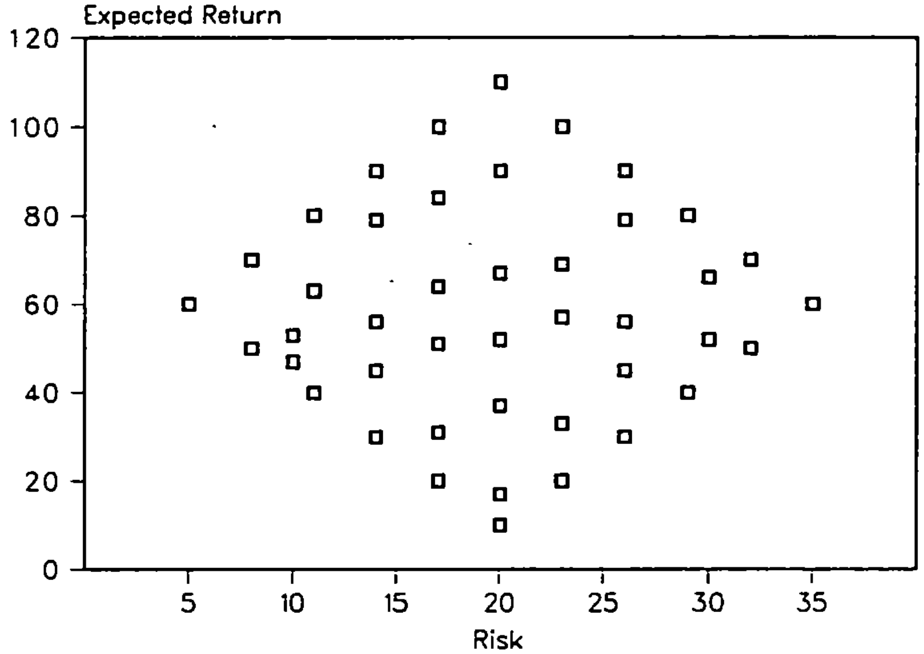
Because the returns from the different individual investments are not independent, as they would be if $Cov_{ij} = 0$ ($\forall\ i \neq j$), then the necessary calculation of portfolio risk is given by:

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} p_i p_j Cov_{ij}$$

It is in this calculation of the portfolio risk that one can see the necessity for having previously calculated all possible covariances between the individual investments in the universal set.

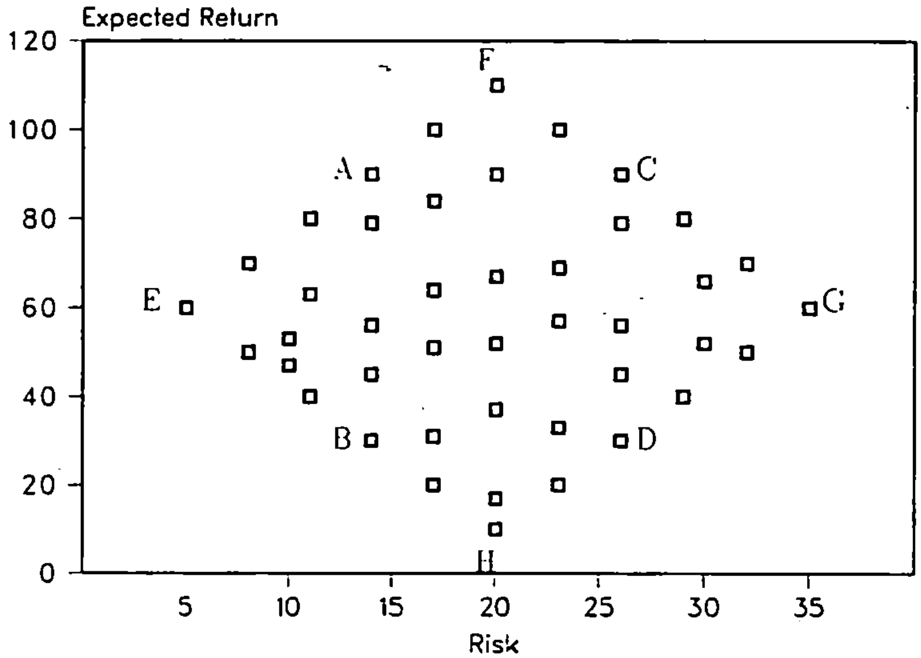
It is obvious from the above that the number of possible portfolios is vast. Even where one limits a particular portfolio holding (p_i) to rounded 1% chunks, the possible number of portfolio combinations of the individual investments increases fantastically as the number of individual investments within the universal set increases. In terms of portfolio selection, the next stage of the Modern Portfolio Theory procedure is to 'sort out the wheat from the chaff'. Theoretically, however, at this stage a measure of expected return ($E[r_{p_i}]$) and of risk ($\sigma_{p_i}^2$) can be deduced for every possible portfolio combination. It is for this reason that illustrative examples in standard textbooks are usually based only on portfolio mixes of just two individual investments. Despite the number of individual investments which are included in any real portfolio combination (this can vary from 1 to n), it is clear that each portfolio may be plotted in two-dimensional risk-return space, since every possible portfolio can be described solely and exclusively by these two characteristics. A theoretical example of such a plot is given in Figure 6.4.

Figure 6.4: A Theoretical Representation of Portfolios in Two-Dimensional Risk/Return Space



Each point in this Figure represents a separate portfolio of investments where the (x, y) coordinates represent the risk, as measured by variance, and the expected return respectively. If certain of these portfolios are now identified by the nomenclature A to H as in Figure 6.5, then a risk averse investor will prefer portfolio A to portfolio C because it provides the same level of return but for less risk. A risk averse investor will also prefer portfolio A to portfolio B since it provides greater return for the same level of risk.

Figure 6.5: A Theoretical Comparison of the Risk/Return Characteristics of the Universal Set of Portfolios



Similar comparisons can be drawn for all portfolios lying on the edge of the scatter between portfolio E and portfolio F. This frontier is what Markowitz (1952), and therefore Modern Portfolio Theory, refers to as efficient. All portfolios that lie on this edge or curve are deemed to be efficient within the original meaning of the term insofar as it relates solely to the risk averse investor. Once the efficient portfolios have been identified, the problem of portfolio selection is greatly simplified since all the portfolios that are not 'efficient' can be ignored.

By digressing from the mainstream theory for just a moment, further study of Figure 6.5 promotes a clearer understanding of how the term 'efficient' relates to the analysis *vis a vis* shipowners' market portfolios. It has already been stated that this study is not only concerned with the portfolio selection of risk averse decision makers but also with those of the risk prone and risk neutral investors. In all cases, a risk neutral investor ignores risk completely in a quest for the maximization of returns. It is obvious, therefore, that such an investor will select portfolio F for the placement of his funds. On the other hand, a risk prone investor will actually prefer portfolio C to portfolio A by virtue of the fact that there is greater risk for the same level of expected return. Also, he prefers portfolio C to portfolio D because he derives a greater expected return for the same level of risk. Similar comparisons may be drawn for any portfolios which lie on the frontier between portfolio F and portfolio G. Within the confines of this work, this curve has been deemed as 'efficient' for the risk prone investor since at any point on this curve, there exist no other portfolios with the same level of risk which give greater returns or no other portfolios which for the same level of return give more risk.

Obviously, this definition of 'efficient' for the risk prone investor is logical in the sense that it constitutes merely the analogue of that for a risk averse investor, the difference resulting purely because of their different risk preferences and, therefore, different objectives in portfolio selection. The reason why Markowitz (1952) and other notable authors in the area, such as Lintner (1965) and Archer & Francis (1979), have limited their definition of 'efficient' to that pertinent only to risk averse investors is that the mathematics of determining which portfolios lie on this frontier is far easier for the risk averse case than the risk prone. It is to this problem that the next step in the Modern Portfolio Theory algorithm addresses itself; namely the determination of the portfolios which lie on the traditionally 'efficient' frontier of the risk averse investor.

There are basically three methods which may be employed for the solution of this problem:

1. A graphical method.

2. A calculus method.

3. A quadratic programming method.

Clearly, the graphical method can equally well be applied to finding the efficient frontier of a risk prone as well as a risk averse investor. However, when dealing with a large number of possible portfolios this method quickly becomes intractable even where just two individual investments are combined with varying weights to form portfolios. Far more elegant are the other two alternatives.

The calculus solution is based on the fact that once an efficient set of portfolios has been determined, each defined in terms of expected return ($E[r_{p_i}]$) and variance ($\sigma^2_{p_i}$), then the investor will have a preference for one of those portfolios in accordance with his risk attitude. This portfolio has a unique expected return which is the maximum for a given level of risk as defined by the statistical measure of variance. Let this 'desired' expected return be denoted $E[r_p^*]$. On the efficient frontier for a risk averse investor, for every level of return the risk, or variance, is minimized. Thus, the calculus method seeks to minimize:

$$\sigma^2_{p_k} \qquad \forall k$$

Where:

$$\sigma^2_{p_k} = \sum_{i=1}^{n} \sum_{j=1}^{n} p_i p_j Cov_{ij}$$

Here, $k = 1 \ldots N$ and relates to the number of portfolios. while $i, j = 1 \ldots n$ and relates to the number of individual investments that compose the portfolios. This minimization of portfolio variance is subject to two Lagrangian constraints. The first constraint is derived from the investor's wish to achieve a desired expected return $(E[r_p^*])$ from his portfolio selection. Thus:

$$\sum_{i=1}^{n} p_i E[r_i] - E[r_p^*] = 0$$

The second constraint relates to the requirement that the proportions of individual investments that compose the portfolio should, of course, sum to unity. In other words;

$$\sum_{i=1}^{n} p_i - 1 = 0$$

By combining these three quantities, the Lagrangian objective function of the risk minimization problem with a desired return constraint is:

$$z = \sum_{i=1}^{n} \sum_{j=1}^{n} p_i p_j Cov_{ij} + \lambda_1 \Big(\sum_{i=1}^{n} p_i E[r_i] - E[r_p^*] \Big) + \lambda_2 \Big(\sum_{i=1}^{n} p_i - 1 \Big)$$

The particular 'desired' portfolio which yields minimum risk is now derived by partially differentiating z with respect to p_i where $i = 1 \ldots n$ and with respect to λ_j (the Lagrangian multipliers) where $j = 1, 2$. This results in an $n + 2$ system of equations as follows:

$$\begin{aligned}
\frac{\partial z}{\partial p_1} &= 2p_1 Cov_{11} + 2p_2 Cov_{12} + \ldots 2p_n Cov_{1n} - \lambda_1 E[r_1] - \lambda_2 = 0 \\
\frac{\partial z}{\partial p_2} &= 2p_1 Cov_{21} + 2p_2 Cov_{22} + \ldots 2p_n Cov_{2n} + \lambda_1 E[r_2] - \lambda_2 = 0 \\
\vdots & \quad \vdots \quad \vdots \\
\frac{\partial z}{\partial p_n} &= 2p_1 Cov_{n1} + 2p_2 Cov_{n2} + \ldots 2p_n Cov_{nn} + \lambda_1 E[r_n] - \lambda_2 = 0 \\
\frac{\partial z}{\partial \lambda_1} &= p_1 E[r_1] - p_2 E[r_2] + \ldots p_n E[r_n] - E[r_p^*] = 0 \\
\frac{\partial z}{\partial \lambda_2} &= p_1 + p_2 + \ldots p_n - 1 = 0
\end{aligned}$$

Since this system of equations is linear with respect to the proportions, or weights, of each individual investment within the portfolio then it can be presented in the form of a Jacobian matrix equation given by:

$$\overset{C}{\begin{bmatrix} 2Cov_{11} & 2Cov_{12} & \dots & 2Cov_{1n} & E[r_1] & 1 \\ 2Cov_{21} & 2Cov_{22} & \dots & 2Cov_{2n} & E[r_2] & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 2Cov_{n1} & 2Cov_{n2} & \dots & 2Cov_{nn} & E[r_n] & 1 \\ E[r_1] & E[r_2] & \dots & E[r_n] & 0 & 0 \\ 1 & 1 & \dots & 1 & 0 & 0 \end{bmatrix}} \overset{\underline{p}}{\begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \\ \lambda_1 \\ \lambda_2 \end{bmatrix}} \overset{=}{=} \overset{\underline{k}}{\begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \\ E[r_p^*] \\ 1 \end{bmatrix}}$$

In this matrix equation, C is a matrix of coefficients, the weight vector is $\underline{p}$ and $\underline{k}$ is a vector of constants. The purpose of the exercise is to determine the components of $\underline{p}$ so that the proportion of each individual investment which should be held in an subjectively optimal portfolio is known. Thus:

$$\begin{aligned} C\underline{p} &= \underline{k} \\ C^{-1}C\underline{p} &= C^{-1}\underline{k} \\ I\underline{p} &= C^{-1}\underline{k} \\ \underline{p} &= C^{-1}\underline{k} \end{aligned}$$

The solution to this equation will give the $n + 2$ variables in the weight vector in terms of $E[r_p^*]$ where the n weights will be of the following form:

$$\begin{aligned} p_1 &= c_1 + d_1 E[r_p^*] \\ p_2 &= c_2 + d_2 E[r_p^*] \\ \vdots & \quad \vdots \quad \vdots \\ p_n &= c_n + d_n E[r_p^*] \end{aligned}$$

Clearly, $\sum_{i=1}^{n} p_i = 1$ and the c_i and d_i are constants. The proportions of each individual investment that together comprise the overall minimum variance portfolio can be deduced from these equations merely by establishing a value for the desired return $(E[r_p^*])$. All the portfolios in the efficient set can be determined by varying the value of $E[r_p^*]$ and recalculating the p_i. Martin (1955) showed that such a process would lead to the same efficient set as that which is derived graphically.

Similar techniques for determining the efficient set of portfolios have been devised which use areas of mathematics such as Cramer's rule or maximization, as opposed to minimisation, of Lagrangian objective functions. However, the process just outlined is illustrative of the general foundations of such methods as embodied in differential calculus. For application to the determination of an efficient frontier for a risk prone investor, the methods need to be adjusted somewhat.

A totally diverse approach to solving the efficient set problem is that provided by Quadratic Programming. This is the method which Markowitz (1952) actually used in his original exposition of the theory. According to Fischer & Jordan (1983p514):

> "Markowitz (1952) devised an ingenious computational model designed to trace out the efficiency locus and to identify the portfolios that make it up. In other words, he produced a scheme whereby large numbers of feasible portfolios could be ignored completely where they were dominated by more efficient portfolios. In the calculations, Markowitz (1952) used the techniques of quadratic programming. He assumed that one could deal with N securities or fewer. Using the expected return and risk for each security under consideration, and covariance estimates for each pair of securities, he is able to calculate risk and return for any portfolio made up of some or all of these securities."

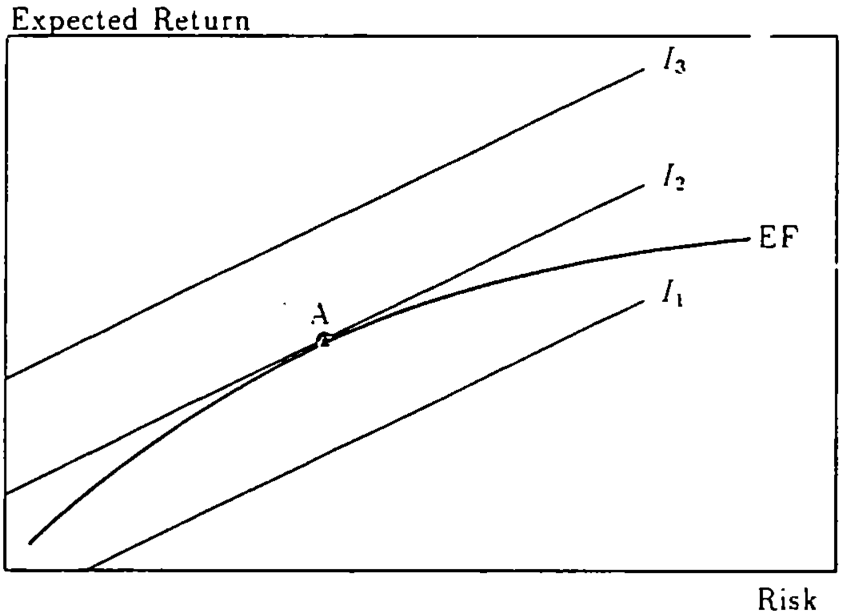
Quadratic Programming is a technique based on iterative numerical analysis and consequently, therefore, is only feasible through the use of a computer. The Quadratic Programming algorithm starts by finding the portfolio with maximum $E[r_p]$ and progresses through all possible portfolios one at a time adding and removing portfolios from an interim efficient set in accordance with the rules of 'efficiency' until the total and absolute efficient set has been identified. However, again, such a method needs to be adjusted if the location of the 'efficient' portfolios of a risk prone investor is the objective.

Needless to say, all three methods for identifying the efficient set of portfolios lead to the same conclusions. For the purposes of this work, the methods have been given merely the briefest description but for a fuller discussion of the various methods and their relative merits see Alexander (1976).

The final stage of Modern Portfolio Theory involves the selection of a particular investment portfolio from the set of efficient ones. As has been implied, this is a question of applying individual preferences, i.e. individual attitudes towards risk, to the efficient set. The efficient set of portfolios involves the choice between trade-offs. In the risk averse case, the efficient portfolio will contain a maximum return/maximum risk portfolio and other portfolios which yield lesser return for less risk. As has been mentioned in Chapter 4, attitudes towards risk are encapsulated in measures of utility as represented by a particular utility curve. It has also already been stated that embodied in every utility function lies a set of indifference curves. It is these latter which invariably are employed as the basis for selecting from an efficient set of portfolios. Each indifference curve represents trade-offs of risk and return which yield equal levels of satisfaction or utility. Thus, the investor is indifferent between all the trade-offs that lie on a particular indifference curve. The interaction between a risk averse investor's indifference curves and the efficient frontier of portfolios available to him is shown in Figure 6.6

As mentioned in Chapter 4, the rational investor seeks to maximize his expected utility. Thus, the rational investor prefers to lie on indifference curve I_3 to I_2 and on I_2 in preference to I_1. It is important to remember that there are an infinite number of indifference curves which could be placed on this graph since they are independent of intercept. As long as they remain paral-

Figure 6.6: The Interaction Between Indifference Curves and the Efficient Frontier



lel to I_1, I_2 and I_3 they can, in effect, move wherever they like. I_3, however, is an impossible indifference curve for the investor to lie on since there are no physical investment portfolios which he can select in this position. By implication, the risk averse investor seeks to lie on the indifference curve which is farthest away from the x-axis and yet, at the same time, lies on the efficient portfolio. Thus, he will select portfolio A, where the indifference curve is tangential to the efficient frontier, as his subjectively optimal portfolio. It can be concluded that this portfolio has the following characteristics:

1. From the definition of an efficient portfolio, there are no other portfolios which yield greater return for the same level of risk.

2. From the definition of an efficient portfolio, there are no other portfolios which yield less risk for the same level of return.

3. The decision maker does not wish to sacrifice return for the sake of reducing his risk still farther.

4. The decision maker does not wish to increase his risk in the hope of achieving greater return.

The mathematics involved in assessing this subjectively optimal portfolio selection usually revolves around the modelling of the efficient frontier in functional form. All the portfolios which lie on the efficient frontier are uniquely characterized in terms of their expected return and their variance as a measure of risk. An estimation procedure, such as least squares regression, can be used to determine the approximate relationship which links the expected return of the portfolios which are efficient to their variance. Thus, the expected return from a portfolio can be approximated by a function of its risk. If this functional relationship is denoted $\phi(\sigma_p^2)$ and the equivalent functional relationship implicit in the indifference curves, is denoted $I(\sigma_p^2)$, then the solution to the overall problem is given by:

$$\frac{d\phi(\sigma_p^2)}{d\sigma_p^2} = \frac{dI(\sigma_p^2)}{d\sigma_p^2}$$

The solution of this equation provides a value for risk which is uniquely associated with a single portfolio (and, therefore, a unique value of expected return) on the efficient frontier. It is this portfolio which represents the subjectively optimal portfolio selection. As Phillips & Ritchie (1983p247) say of the solution procedure:

> "This point represents a solution to the problem in the sense that the rate at which the investor in question is just *willing* to exchange expectation for risk is precisely equal to the rate at which his or her opportunities will allow. The resulting solution, moreover, identifies a portfolio that lies on the efficient frontier. That is, the tangency condition identifies an efficient portfolio."

Having thus explained the nature of the algorithm inherent in Markowitz Portfolio Theory, it only remains to explain why the methodology is based solely on the use of variance (or standard deviation) as a measure of risk. This is an important point insofar as variance may not constitute an appropriate measure of risk for shipowners. A later chapter of this work will examine various measures of risk within the context of the shipowning industry, but it is important to recognize that the use of a risk measure other than variance or standard deviation will invalidate certain aspects of the strict Modern Portfolio Theory approach to optimal portfolio selection. The use of an alternative risk measure will, therefore, necessitate an adjustment to the procedure previously outlined.

The use of variance or standard deviation as the appropriate measure of risk can be justified logically on the grounds that they are measures of the dispersion of returns. This has an obvious psychological impact on the perception of risk. However, there are other, equally sound, methods of measuring dispersion. As has already been alluded to earlier, in instances where returns are not normally distributed, alternative measures may be even more appropriate. The real justification for the use of variance and standard deviation as measures of risk lies in the existence of a particular statistical characteristic which they exhibit.

The final stage of the Markowitz (1952) portfolio selection procedure involves determining the mathematical interaction of the efficient portfolio with an individual investor's indifference curves. The indifference curves represent that investor's attitude towards risk. As stated in chapter 4, they are notoriously difficult to estimate. The preferred methodology for determining risk attitude is to undertake a utility analysis. It has been stated that in every utility curve, there is an implied set of indifference curves. The practical evaluation of indifference curves from utility functions is only possible when variance is the measure of risk used. The proof of this fact vindicates the exclusive use of variance (or standard deviation) as the measure of risk in Modern Portfolio theory. The proof also explains why, quite unrealistically, utility functions are usually in the form of a quadratic. Given a quadratic utility function where x represents a particular level of return, then:

$$U(x) = \alpha + \beta x - \gamma x^2$$

As has been seen, in accordance with the expected utility hypothesis, an investor will attempt to maximize his expected utility. This is equivalent to determining the point of tangency between an investor's risk preferences, as contained in his risk-return indifference curves, and the efficient portfolio. However:

$$\begin{aligned} E[U(x)] &= E[\alpha + \beta x - \gamma x^2] \\ &= \alpha - \beta E[x] - \gamma E[x^2] \end{aligned}$$

Now, since:

$$\begin{aligned} E[x^2] &= (E[x])^2 + Var[x] \\ &= (E[x])^2 + \sigma^2 \end{aligned}$$

Then:

$$E[U(x)] = \alpha + \beta E[x] - \gamma\{(E[x])^2 + \sigma^2\}$$

This equation shows that the expected utility of a quadratic utility function is determined by the first two moments: $E[x]$ and σ. It is for this reason that standard deviation and variance are virtually always chosen as proxies for risk in real applications. By fixing the value of $E[U(x)]$ in this equation and solving for varying values of $E[x]$ and σ^2 a set of indifference curves linking risk and return can be determined. Variance and standard deviation are the only measures of risk where this mathematical tractability is obtained. Alternative measures of risk do not allow the same relatively easy transformation from a utility function to a set of indifference curves. Thus, the application of Modern Portfolio Theory is inappropriate, in its standard form, to cases where other risk measures are utilized.

This work does, in fact, investigate other measures of risk which may be more applicable to shipowners in the dry bulk sector. Because of this facet of the work, it is necessary to adjust the Modern Portfolio Theory methodology in order to cope with the potential risk measures employed in the portfolio analysis. With this aspect in mind, the rest of this work is devoted to a portfolio analysis (utilizing several different risk measures) of the market investments available to dry bulk shipowners and the development of a suitably adjusted Modern Portfolio Theory procedure which can be practically applied by shipowners for the determination of their subjectively optimal market portfolio.

Chapter 7

The Available Market Investments in Dry Bulk Shipping

Before proceeding with the details of portfolio analysis, it is necessary to define the market investments that are available to shipowners in the dry bulk sector. As has already been implied, said market investments may take the form of the traditional physical shipping contracts, but additionally these may now be supplemented by freight futures contracts since the opening of BIFFEX on May 1[st] 1985. This chapter seeks to define the pertinent characteristics of each available market investment and to discuss their respective differences within the context of a Modern Portfolio Theory approach to optimization of the portfolio investment decision. The final corollary of the discussion contained within this chapter will be the specification of the potential market investment set, or set of individual investments, that will be used as the basis for the formation of portfolios.

The traditional contracts between two parties for the physical carriage of goods can take many specific forms but are generically known as charter-parties. According to Packard (1986):

> "A properly signed and authenticated charter-party states in written form the contract between a shipowner and a charterer and should factually record their negotiated agreement and the terms and conditions therein."

Charter-parties relate to those situations where a single cargo owner or a single charterer enters into a contract with a shipowner for the hire of his ship. Such contracts are by far the most common in bulk shipping. Although it is permissible for a charterer of a ship to then subcharter to some third party, for the purposes of this analysis, it is assumed that the shipowner is the actual owner of the ship (thus incurring capital and other associated costs) and that the charterer actually provides the cargo either directly or as agent.

Merely within the dry bulk sector of shipping, there exist numerous 'standard' form charterparties which may constitute the basis of this contract between a shipowner and a charterer. UNCTAD (1975) discovered that up to 70 such standard forms are in general use as the basis of physical contracts governing dry bulk trades. In commercial practice, these standard forms are inevitably altered by the addition and deletion of clauses and conditions in accordance with the individual requirements of either the charterer or the shipowner. Clearly, a complete and comprehensive specification of the details contained within a charter-party is, therefore, impossible. Nevertheless, it *is* possible to identify the major features and characteristics of the basic elements which differentiate the general types of charter-party within the shipping industry. The following sections seek to achieve this task without becoming too involved in the legal and operational niceties which can, and do, pervade the different forms of charter-party. For a fuller discussion of the minutiæ, the reader is recommended to a standard text such as Branch (1989) or Hardy Ivamy (1979).

7.1 Voyage Charters

Under a voyage charter, the shipowner agrees to provide the vessel and her crew while the charterer provides the cargo. This form of charter involves the carriage of cargo (which is usually, but not necessarily, identified) between specified ports by a named ship for a prearranged freight. As Nersesian (1981) puts it:

> "The most common contractual arrangement between a charterer and an owner is the single-voyage charter. The owner receives a freight payment for the movement of a cargo between two or more ports, from which he must pay all voyage and operating costs. Cargo-handling charges are paid by the owner if gross terms apply and by the charterer if free in and out (FIO) terms apply."

The freight receivable by a shipowner under a voyage contract is, in the vast majority of cases, expressed in terms of $/ton of cargo. However, implicit in this *price* is the requirement that the ship be fully laden. Consequently, the charterer is obliged, to the best of his ability, to fully load the ship within certain prescribed limits. According to Metcalfe (1959p122), the amount of cargo a vessel is capable of carrying is determined by:

> "... a vessel's deadweight carrying capacity in long tons at her summer load line."

The one area where the accrual of costs may vary dramatically between particular voyage charters has already been intimated. This area relates to the costs incurred in handling cargo. Under *gross* terms, the shipowner is responsible for the payment of all loading and discharging costs. It is much more usual, however, that voyage charters, particularly in the bulk trades, contain free in and out (FIO) or free on board (FOB) terms. There are other variations of these two terms, for instance FIOT (free in and out trimmed), but basically they all relate to the fact that loading and discharging costs are deemed to be the responsibility of the charterer. The difference between these various terms arises with respect to who is liable for cargo damage sustained at different points in the carriage of the cargo. Because of the prevalence of charterer responsibility for cargo handling costs, FIO terms have been assumed for the purpose of comparing charters.

7.2 Consecutive-Voyage Charters

To all intents and purposes, this form of charter is exactly equivalent to a single-voyage charter except for the fact that, as the name implies, the ship makes the same voyage on a number of occasions on a round-trip basis. The shipowner is still usually paid in terms of $/ton of cargo for a named ship on a specified route. Similarly, the costs incurred by the shipowner are analogous. Obviously, such charters can very easily be perceived as a number of separate single-voyage charters which just happen to be consecutive. It is only the fact that the number of trips required is specified in the original contract that differentiates this form of contract from that perception.

7.3 Contracts of Affreightment

This form of charter is closely related to the consecutive voyage charter and hence, is again very similar to the single-voyage charter. The two major differences between this form of charter and a consecutive voyage charter is that firstly the actual ship is not precisely designated, although the technical details of the type of ship required usually are, and secondly, the voyages are not undertaken on a round-trip basis. Instead, the total amount of cargo to be lifted over a certain time period is specified. As long as that amount of cargo is transported between the nominated ports by the end of the period, then, within reason and subject to individual negotiations, it does not matter when the shipowner fulfils his obligation or in what ship as long as it is technically capable of carrying the cargo. The shipowner, under a contract of affreightment, is still paid on the basis of $/ton of cargo and is still responsible for the same costs as incurred under a straightforward voyage charter.

7.4 Period Time Charters

As Hudig (1975) points out:

> "Whereas on a voyage charter, the owner undertakes to carry the cargo from point A to point B and, within the terms of the charter-party, pays all of the expenses so incurred, the time charter is quite different. Here, the vessel is let to the charterer from the actual time and place of delivery, and, consequently, the vessel's Master is under time charterer's orders as to movements, ports of call and bunkering, and cargoes to be carried. The time charterer pays, among other things, for all port charges, loading, stowing, and discharging costs, and fuel oil etc., consumed during the period of the charter, until the vessel is ultimately redelivered to her owners. The ship, however, remains at all times the property of the shipowner who is responsible for insurance of the hull, crew wages and, of course, the upkeep of the ship."

Under a period time charter, therefore, a shipowner agrees to hire his ship to a charterer for a specified period of time. The shipowner provides the crew to man the ship. What the charterer then does with it is, up to a point, his business. The shipowner will receive remuneration on the basis of a price quoted in $/day and referred to as the daily hire rate. Occasionally, he may receive his revenue in terms of $/Dwt./month, but this can easily be converted to a $/day basis for the purposes of comparison. Clearly, such revenue can only be fairly earned when the ship is fully operational for the whole period of the time charter. As a consequence, in order to protect the interests of the charterer, provision is invariably made within a time charter, in the form of an *off-hire* clause, for hire revenue to cease should a ship prove to be, or become, temporarily unfit for service at sea.

The time charter constitutes a major deviation from a voyage charter with respect to the responsibility of costs. Under a time charter, the charterer becomes responsible not only for the day-to-day operation of the ships, but also for the voyage costs. Most importantly, under a time charter, fuel costs become the responsibility of the charterer rather than the owner. Given the different basis of revenue earning and the different responsibilities for the payment of costs, it is clear that there is an enormous financial divide between a time charter and a voyage charter.

7.5 Trip Time Charters

This form of charter-party represents only a slight variation on the provisions of a period time charter. In this case, rather than hiring a ship for a prespecified period of time, the charterer instead hires a ship to undertake a certain prespecified trip, described in only general geographic terms, but where usually some indication of the time involved is given. The cost responsibilities of the shipowner remain the same as under a period time charter and the revenue basis of $/day is also similar. These forms of charter are most widely used in the liner trades, to fill gaps in the service when problems arise.

7.6 Bareboat Charters

A bareboat charter is sometimes referred to as either a demise charter or a time charter by demise. Under this form of charter, the shipowner delivers a ship to the charterer which is totally bare. It is the charterer's responsibility to provide a crew and to pay all operating costs as well as voyage costs. In effect, a bareboat charter constitutes a lease of the ship by the shipowner to the charterer. The charterer then becomes, what is referred to as, the *disponent* owner and is free to subcharter or re-let the ship as he wishes, as long as the period of such a contract does not overlap the time which he has agreed for returning the ship into the hands of the actual shipowner. The charterer might also be constrained by certain provisions within the bareboat charter with respect to cargoes carried or ports of call etc. Ihre, Gorton & Sandevärn (1984p91) suggest that:

> "The bareboat charter has been a comparatively unusual type of charter but with changing trading and investment patterns it has become more common. Sometimes a second-hand sale has been disguised as a bareboat charter with an option to buy in order that taxation can be avoided."

The bareboat charter is sometimes linked to other practices in the shipping industry which are of questionable morality. Most notable amongst these is the, now infamous, Japanese Shikumisen deal whereby high crew costs can be avoided by bareboat chartering to a brass plate company in a flag of convenience country.

A bareboat charter is akin to a time charter by virtue of the fact that the shipowner derives his revenue in the form of charter hire. His only cost responsibility under such a charter lies with the payment of capital costs. As has been said, all other costs are the responsibility of the charterer.

7.7 Freight Futures

The Baltic International Freight Futures Exchange (BIFFEX) began operating on May 1st 1985 after a prolonged period of investigation and research into how it should work. The aim of the market is to provide shipowners and charterers with a flexible means for hedging their risk exposure to freight rate movements. Commodity futures markets, such as those for potatoes, grain, tin etc., are well established means of hedging against adverse commodity price movements. However, the trading of futures is based on the existence of a product which exhibits comparative homogeneity, since the contract which is actually traded on the futures market must be representative of a market standard. Such was the case with the traditional futures markets. In shipping, however, there are so many market variables, such as the size and type of ship, cargo carried, possible ports of call etc., that it seemed that the development of a futures market for the hedging of freight might be impossible.

The need for a standard commodity to form the basis of a futures market is derived from the fact that there must be a large volume of players in the market who wish to trade the futures contract. Also, in traditional futures markets, it is feasible that a particular futures trade might be allowed to run to maturity and that then there could be a physical delivery of the commodity. Clearly, in such a case, the specification of exactly the form of that commodity must be clear.

Obviously, because of the lack of homogeneity in shipping, a freight futures contract based on traditional commodity futures markets is impossible. With the development of futures markets such as LIFFE (London International Financial Futures Exchange) and the NYCRB (New York Commodity Research Bureau) came the idea of futures markets based on the trading of an index value. This prompted the BIFFEX Committee, when investigating the viability of a freight futures market, into the development of a suitable index that might form the basis of futures trading in shipping.

The resultant index is known as the Baltic Freight Index (BFI) and represents a basket of single-voyage trades from the dry bulk shipping sector. As such, it is deemed to constitute a barometer of the prosperity of the dry bulk sector. In deriving its constitution, BIFFEX research analysts sought to include dry bulk trades which represented the major revenue contributors to the market in general. Additionally, it was important that specific voyage charters that were included in the index were frequently and regularly traded and that some geographic, ship size and tonne-mile balance was present in the index. Initially, 13 trades were selected for inclusion in the BFI, each weighted in accordance with the above factors. These weightings varied from 20% down to just 2.5%.

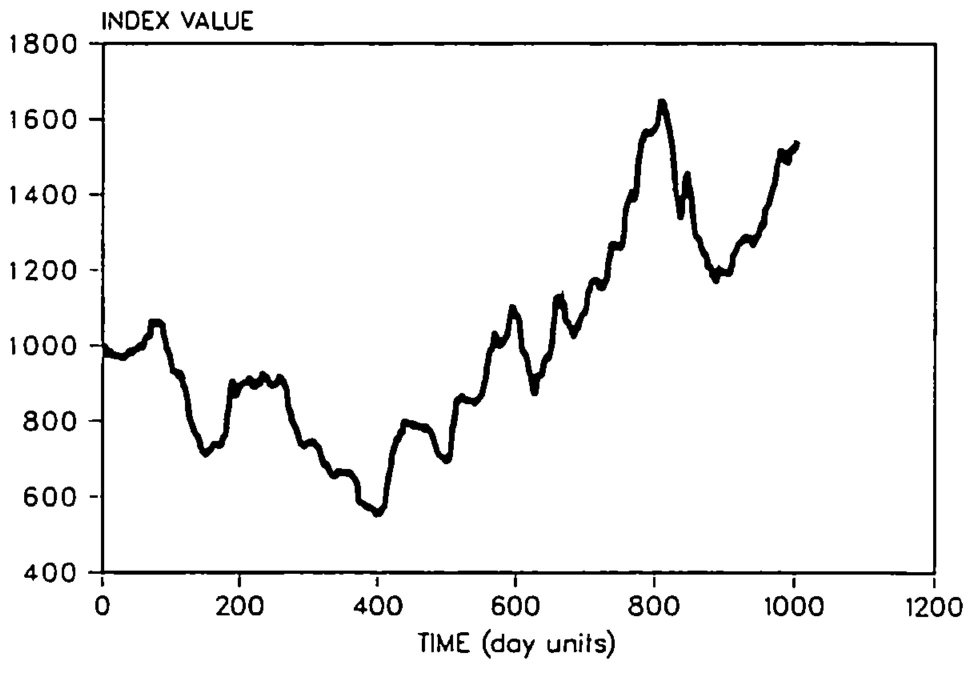
Provision was made in the original development of the BFI that the composition of the index could be altered as time progressed in line with changes that occurred in the physical dry bulk sector *vis a vis* the factors outlined above. In fact, this has proved to be the case since now the BFI is composed of just 12 trades and several of the original constituent routes have been deleted from the index and new ones added.

On each BIFFEX trading day, eight members of the Baltic Exchange, who happen to be the eight leading international shipbroking companies, supply either the current actual freight rates pertaining on each of the index routes or estimates of those rates should there be no actual fixtures that they may refer to. The Baltic Exchange average the quoted rates for each route, after ignoring the highest and lowest quotes, and then compute the weighted average to calculate the day's value of the BFI. Carter (1987) states:

"The BFI has received wide acceptance as fairly reflecting 'the market' and the Baltic Exchange intends to ensure that it will be amended, as may be necessary within its Rules, so as to continue to reflect the current trading patterns in the daily spot market. No other fixture collating service matches the Baltic Exchange in benefiting from receipt of a disciplined, verified daily input reflecting ship charters being negotiated as well as those fixed during each twenty-four hour period. This is the unique contribution of the Baltic Exchange enabling it to produce daily a tamper-proof and audited BFI."

Clearly, since the BFI is composed of averaged freight rates, it represents the movement in gross cost to the charterer or gross revenue to the shipowner, rather than, for example, the net earnings of a shipowner. Figure 7.1 shows the movement of the BFI from its introduction until the end of 1988.

Figure 7.1: The Movement of the BFI (May 1985-Dec 1988)



The BFI forms only the basis of BIFFEX. It represents an economic indicator of the state of the dry bulk voyage charter market, but is *not* traded on the market. Operationally, the BFI's sole purpose is to provide the price at which open contracts are settled at, should those contracts be allowed to run to maturity. In fact, in order to prevent manipulation of this *settlement price*, the value of the BFI for the five days previous to the settlement day are averaged out to provide the settlement price.

Originally, there were eight actual futures contracts that could be traded on BIFFEX. The four "nearby" contracts were for January, April, July and October of the current year, while the four "distant" contracts were for the same months of the following year. Each futures contract matures on the last trading day of the month. In July 1988, a new nearby contract was introduced which was for the nearest end of month should this not coincide with a contract that already existed. Thus, in February 1988, a futures player could trade contracts for April, July, October 1988 and for January, April, July, October 1989 as well as for January 1990. In September 1988, the following contracts would be available: September and October 1988; January, April, July and October 1989; January, April, July 1990. Clearly, this means that the time horizon of the market is anything up to two years ahead.

A trader on BIFFEX can open a position, i.e. invest in freight futures, by going *long* or *short* on a particular freight futures contract as just discussed.

The terms *long* and *short* within the context of a futures market are respectively synonymous with buying and selling. If a trader, for example, sells a September 1989 contract at the beginning of September 1989, he may *close out* his position by buying a similar contract before the end of September 1989 or he may hold on to the contract until it reaches maturity at which time the value of that contract is determined by the level of the BFI as previously outlined.

The price of the respective futures contracts at any given point in time is related to the BFI insofar as those prices are the expected future values of the BFI at the dates of maturity of the individual futures contracts. These expectations are summarized by the price of those contracts by virtue of the fact that the prices are determined by the demand and supply of willing purchasers and willing sellers. Thus, there is continuous market agreement on the future value of the BFI and, therefore, on the current prices of the individual futures contracts.

Each index point of the BFI and of the individual futures contracts is valued at $10. Thus, if a futures trader goes long on one contract valued at 981, he will be buying one particular futures contract for $9,810. He may sell a contract with the same date of maturity before the settlement date in order to close out his position or he may just maintain his open position until the settlement date of the contract. If the latter is the case and the average level of the BFI over the five days previous to the settlement date is 992, then he will be deemed to have sold his existing bought contract at that value and will have made a profit of $9,920 - $9,810 = $110 on that single contract.

When hedging, and indeed speculating, on BIFFEX, traders, unless they are new to the market, invariably do not limit themselves to the trading of just a single contract. The number of contracts which a hedger purchases is related to his degree of risk exposure in the physical dry bulk market. Perhaps the best way to illustrate the mechanics of the market in a hedging context is to reproduce an example from the BIFFEX marketing literature. To that end, the following is a simplified theoretical example of a shipowner's hedge on BIFFEX:

At the end of October 1984, a shipowner knows that his ship will be free of charter in 3 months time, but is unable to find a charterer to fill that slot. At the end of October 1984, the spot single voyage charter rate is $12 per ton of cargo carried. His ship can carry 100,000 tons. Fearing that the spot voyage freight rates will decline before a fixture is concluded, the shipowner intends to sell on BIFFEX to hedge his position.

—If the shipowner could arrange a charter now to carry 100,000 tons of coal at $12 per ton for the free period in three months time, he would be expecting to receive $1.2 million in revenue (less commissions).

—With the spot market at $12 for this voyage, the BFI stands at 1000. The January 1985 futures price also stands at 1000.

—One contract on BIFFEX at $10 per index point with index at 1000 has a value of $10,000. Thus, the shipowner sells contracts forward (the January 1985 contracts) equivalent to the value of the hoped for revenue. That is, 120 contracts each at $10,000 equals $1.2 million.

—During the interval between effecting this hedge and fixing his ship on the freight market, rates drop by 10% so that the shipowner obtains a freight rate of only $10.80. Thus, earning only $1.08 million.

—At the same time, the January 1985 futures, which the shipowner had previously sold at the end of October 1984, will also have fallen by 10% to stand at an index value of 900. With a value of $10 per index point, the current contract value is now $9,000.

—The shipowner now buys back the 120 futures contracts he sold when the index was at 1000. The price he pays is at the new lower level. That is, 120 contracts ×$9,000 = $1.08 million. This closes out his open futures sale. making a futures profit of $120,000. Thus, the profit on the shipowner's futures sell hedge compensates for the drop in earnings on the actual chartering fixture. The position can be seen in full in Table 7.1 below:

Table 7.1: Actuals and Futures Results of Theoretical Investment

Actual		Futures	
Expected income	=$1.2 million	Value of Sold futures contracts	=$1.2 million
Actual income after 10% drop in rates	=$1.08 million	Cost of buying back futures position after 10% drop in rates	=$1.08 million
Actual Loss	=$120,000	Futures Profit	=$120,000

The existence of speculators as investors in BIFFEX is vital in providing the liquidity to ensure that the hedgers can trade. This is particularly the case where the hedgers on the market have similar expectations of the future and would consequently all line up on one side of the market. As a consequence no trades would be completed for the whole of the period of similar expectations amongst hedging shipowners. It is for this reason that speculators are required in order to provide the necessary liquidity. The introduction of the new nearby futures contract in August 1988 was, in fact, an attempt to draw more speculative capital into the market to provide that much needed liquidity for successful hedging. Obviously, the attraction of greater broking commission is another reason.

BIFFEX investment is highly geared in that for each contract traded it is only necessary to make a deposit of $500 irrespective of the value of a contract. However, for the purpose of this analysis, it is deemed that investment in freight futures relates to the total value of the commitment of resources. This circumvents the problems encompassed in perceiving the meaning of investment where only a deposit is paid and where contracts can be sold prior to being bought.

At this point, it might be useful to make some observations concerning the degree of acceptance of BIFFEX amongst shipowners, since it is with their investment decisions that this study concerns itself. Does BIFFEX provide a hedging mechanism that is actually used by shipowners? Sections A and C of the questionnaire, contained in Appendix A and sent to a sample of shipowners, attempt to answer this and other questions.

7.7.1 The Use of BIFFEX by Shipowners: Results from a Survey

The survey concerned was sent to all shipowners in Britain, Greece, Hong Kong and Norway. The methodology, detail of survey design and response rate statistics have already been discussed in Chapter 5 in relation to Utility Analysis which was the primary reason for sending the survey. However, responses to sections A and C provide additional information which allow the analysis of the use of BIFFEX by shipowners. Suffice it to say at this point that 85 usable responses were received which form the basis of the following analysis.

Of the 85 responses received, only 13 had ever traded freight futures contracts. This represents 15.3% of respondents. Initially, this might be deemed to be reasonably respectable. However, of these 13, 11 respondents used the market exclusively for speculative purposes, 2 invested as both speculators and hedgers and only 2 used the market purely as a hedging device. Thus, only 4.7% of respondents had ever used the market for hedging purposes. It is interesting to note that 2 of these 4, were not shipowners primarily involved in the dry bulk market. A contingency table showing the relationship between hedging on BIFFEX and dry bulk operation was derived from the responses and is shown in Table 7.2.

A χ^2 test was run on this contingency table to test the hypothesis that there is no relationship between the two variables. A χ^2 statistic of 0.1005 was

Table 7.2: Contingency Table of Primary Dry Bulk Operation vs. Hedging on BIFFEX

Hedging on BIFFEX	Primary Dry Bulk Operation		
	Yes	*No*	*Total*
Yes	2	2	4
No	47	34	81
Total	49	36	85

derived with 1 degree of freedom. This is totally insignificant and no evidence whatsoever exists to reject the null hypothesis. Thus, the evidence suggests that there is no relationship between hedging on BIFFEX and whether the hedger is involved primarily in the dry bulk market.

This prompts the question as to whether these 2 shipowners are merely hedging their secondary trades or whether they are actually attempting to hedge trades which are not dry bulk. The answer to that question might be imputed from the related contingency tables, illustrated in Tables 7.3 and 7.4, which show the frequency of responses received from dry bulk operators as against their self-avowed knowledge of BIFFEX.

A χ^2 test of the first of these contingency tables yields a χ^2 statistic of 21.326 with 1 degree of freedom. This statistic is very significant and, consequently, provides overwhelming support, not unexpectedly, that familiarity with the term 'BIFFEX' is dependent on whether a shipowner operates primarily in the dry bulk sector or not. An analysis of the components of the χ^2 statistic shows that a shipowner who does not operate primarily in the

Table 7.3: Contingency Table of Primary Dry Bulk Operation vs. Familiarity with the Term 'BIFFEX'

Familiar with term 'BIFFEX'	Primary Dry Bulk Operation		
	Yes	*No*	*Total*
Yes	48	21	69
No	1	15	16
Total	49	36	85

Table 7.4: Contingency Table of Primary Dry Bulk Operation vs. Degree of Understanding BIFFEX

Understand BIFFEX	Primary Dry Bulk Operation		
	Yes	*No*	*Total*
Very well	12	4	16
Fairly Well	20	5	25
Only slightly	17	13	30
Not at all	0	14	14
Total	49	36	85

dry bulk trade is much more likely to be unfamiliar merely with the *term* BIFFEX. It is interesting to note that 18.8% of the sample had never even heard of BIFFEX.

A similar statistical analysis of the second of these contingency tables again provides a very significant χ^2 statistic of 26.16 with 3 degrees of freedom. Thus, the level of a shipowner's understanding of how BIFFEX works is very dependent on whether he is primarily a dry bulk operator or not. Analysis of the components of the χ^2 statistic suggests that a shipowner who understands nothing at all about how BIFFEX works is again likely not to be involved primarily in the dry bulk sector.

These two sets of analysis, taken together, imply that an understanding of at least some aspects of BIFFEX is almost totally dependent on the shipowner being involved primarily in the dry bulk trades. The level of confidence with which this statement can be made makes it very unlikely that the 2 rogue shipowners, previously discussed, are attempting to hedge trades that are not dry bulk. Probability suggests, therefore, that they are likely to be hedging dry bulk trades which are secondary to their mainstream shipping business.

Given the analyses undertaken thus far, it can be seen that familiarity with and knowledge of BIFFEX is very much related to a shipowner's experience in the dry bulk trades. However, perhaps somewhat dichotomously, it has also been shown that hedging is not necessarily dependent upon dry bulk operation. One could draw the conclusion, therefore, that although ***hedging*** does not depend upon what primary trade the shipowner operates, ***speculation*** in the market does. To test this hypothesis, a χ^2 test was implemented on the data contained in Table 7.5.

Table 7.5: Contingency Table of Primary Dry Bulk Operation vs. Speculative Investment on BIFFEX

Speculate on BIFFEX	Primary Dry Bulk Operation		
	Yes	*No*	*Total*
Yes	9	2	11
No	40	34	74
Total	49	36	85

An analysis of this contingency table yielded a χ^2 statistic of 3.0325 with 1 degree of freedom. The associated $p-value$ lies between 0.05 and 0.1. This provides only comparatively weak evidence of the existence of a relationship between speculation on BIFFEX and the shipowner's primary involvement in the dry bulk trades. The components of the χ^2 statistic suggest that shipowners involved primarily in the dry bulk trades are more likely to speculate on BIFFEX than those who are not.

Using the survey data, there are several other interesting relationships that can be analysed in the same way. One of the questions on the survey asked whether respondents had used any futures market other than BIFFEX. Quite a large proportion of the sample (35.3%) replied that they had. In order to investigate whether previous knowledge of futures trading influenced either hedging or speculating on BIFFEX, the following contingency tables were analysed using the χ^2 test.

Table 7.6: Contingency Table of Previous Futures Experience vs. Hedging on BIFFEX

Hedging on BIFFEX	Previous Futures Experience		
	Yes	*No*	*Total*
Yes	2	2	4
No	28	53	81
Total	30	55	85

Table 7.7: Contingency Table of Previous Futures Experience vs. Speculation on BIFFEX

Speculating on BIFFEX	Previous Futures Experience		
	Yes	*No*	*Total*
Yes	7	4	11
No	23	51	74
Total	30	55	85

The χ^2 statistic for the first of these tables is 0.397 with 1 degree of freedom. This is totally insignificant. Consequently, one may conclude that there is no relationship between previous experience of futures trading and hedging on BIFFEX. A shipowner who has traded on other futures markets is no more likely to hedge on BIFFEX than a shipowner with no previous knowledge of futures markets.

The second of these tables, however, yields a χ^2 statistic of 4.444 with 1 degree of freedom. The associated $p - value$ of this statistic lies between 0.05 and 0.025. This suggests that there is some evidence of a relationship between whether a shipowner has previous futures experience and whether or not he speculates on BIFFEX. Analysis of the components of the χ^2 statistic suggests that a shipowner with previous futures experience is more likely to speculate on BIFFEX than one who has not.

Given that futures trading is a difficult concept to grasp and debatably, even more difficult to practice, these results might be deemed to imply that speculation on BIFFEX is a more complex task than hedging and is generally undertaken by the more sophisticated players. Conversely, it might imply that the hedging strategies adopted by shipowners who are trading on BIFFEX are comparatively naive in the sense that they might be virtually semi-automatic. It might be that even 'blind' hedging (to be discussed in Chapter 8) is the norm. However, perhaps the most realistic interpretation of these results lies with the degree of broker supervision. Hedgers are more likely to ask the advice of their futures broker in implementing a suitable hedging strategy, whereas the speculator will inevitably play his own hunches based on past experience and intuition.

The affect of various structural characteristics of shipowners upon their participation in BIFFEX trading is also interesting. For example, the size of a shipowning company might exert some influence over whether they trade freight futures contracts. Question 1 of section C of the questionnaire asked respondents for their total asset size. The particularly sensitive nature of this question (or perhaps ignorance), meant that only 39 responses to this particular question were received. Each of these respondents was classified as being a 'big' or 'small' shipowning company on the basis of whether the value of their assets was greater or smaller than the mean for all the respondents. The mean asset value of the responses received was $33,207,176. Table 7.8 shows the interaction between size of shipping company, as determined by this classification criterion, and whether or not the company concerned trades on BIFFEX.

Table 7.8: Contingency Table of Size of Company vs. BIFFEX Trading

Trades on BIFFEX	Size Classification of Company		
	Big	*Small*	*Total*
Yes	2	5	7
No	9	23	32
Total	11	28	39

The χ^2 statistic of this contingency table is 0.0006 with 1 degree of freedom and is totally insignificant. As a result, one can conclude that the size of a company bears no influence whatsoever on whether or not that company trades on BIFFEX, either as a hedger or speculatively. This is a somewhat surprising result especially when further analysis suggests that neither speculation nor hedging are individually dependent on size of company. Thus, size of company is totally irrelevant to all forms of BIFFEX trading and, assuming that larger companies are more sophisticated than smaller ones, seems to belie the assertion that futures trading requires a degree of sophistication.

Since the survey was sent to the shipowning companies of four nations, an investigation of the relationship between nationality and BIFFEX usage might prove fruitful. The contingency table representing this relationship can be seen in Table 7.9.

Table 7.9: Contingency Table of Nationality vs. BIFFEX Trading

Location of Company	Trades on BIFFEX		
	Yes	*No*	*Total*
Britain	5	32	37
Greece	5	19	24
Hong Kong	0	7	7
Norway	3	14	17
Total	13	72	85

The χ^2 statistic for this contingency table is 1.996 with 3 degrees of freedom and again is totally insignificant. The null hypothesis cannot, therefore, be rejected and one must construe that there is no relationship between the nationality of a shipping company and whether or not it trades on BIFFEX. This suggests that BIFFEX itself is truly an international market at least as far as these traditional maritime nations are concerned.

The final structural relationship that is tested is whether investment in BIFFEX is explained by a particular attitude to risk. Using the classification of responses to the utility questions, seen in Chapter 5, Tables 7.10 and 7.11 relate risk attitude to participation in BIFFEX under conditions of both good and poor liquidity. The first of these contingency tables yielded a χ^2 statistic of 2.239, while the second yielded 4.23. Both statistics have 3 degrees of freedom and are both insignificant. Thus, risk attitude has no bearing on whether a company invests in BIFFEX or not. This conclusion supports the finding that speculation on BIFFEX, where attitude to risk is totally variable, is much more prevalent than hedging, where traders are inevitably motivated by risk aversion.

Table 7.10: Contingency Table of Risk Attitude in Good Liquidity vs. BIFFEX Trading

Attitude to Risk	Trades on BIFFEX		
	Yes	*No*	*Total*
Averse	8	31	39
Prone	1	12	13
Neutral	1	3	4
Others	3	26	29
Total	13	72	85

Table 7.11: Contingency Table of Risk Attitude in Poor Liquidity vs. BIFFEX Trading

Attitude to Risk	Trades on BIFFEX		
	Yes	*No*	*Total*
Averse	11	50	61
Prone	0	3	3
Neutral	1	1	2
Others	1	18	19
Total	13	72	85

45.9% of the total sample, but more importantly 53.1% of respondents involved primarily in the dry bulk trades, regarded BIFFEX as a major innovation in the shipping industry. This must augur well for the future of the market as long as the marketing strategy which promotes it is appropriate. Implications for the future development of BIFFEX are also implicit in certain of the other responses received.

The BIFFEX Committee would like to see the introduction of options contracts in the near future since they are regarded as a more powerful mechanism for hedging risk exposure than pure futures contracts. The nature of options contracts is explained in several texts but notably that of Cox & Rubinstein (1985). Of the survey sample, a surprising 77.7% of the respondents were, at least, *familiar* with the term 'options'. Of those 66 respondents that were familiar with the term, 8 (12.1%) would trade options on BIFFEX if they became available, 16 (24.2%) said that it would depend on the nature of the options market adopted and 5 (7.6%) of the respondents replied that they did not know whether they would trade such contracts. However, 37 (56.1%) of the respondents replied that they definitely would not trade options within BIFFEX. Perhaps more interestingly, the split of the 13 companies within the sample that do currently trade on BIFFEX is as follows: would trade options on BIFFEX; 5, would not trade options on BIFFEX; 4, depends; 3 and 1 current BIFFEX trader who had never heard of the term 'options'.

With regard to whether shipowners perceived freight futures contracts as providing possible security on a loan, in the same way as time charters are sometimes used, 18.9% of respondents felt that this was indeed possible, while 40% felt that it was not.

7.8 An Overall View of Market Investment in Dry Bulk Shipping

In order to implement a Modern Portfolio Theory methodology, it is necessary to identify the individual market investments for further consideration. These individual investments are combined into portfolios which can be analysed by applying the principles of the theory. It is imperative to recognize, however, that Modern Portfolio Theory and specifically the required inputs to the theory, *vis a vis* the individual market investments, are financially oriented. Thus, it is the financial differences between potential market investments that form the justification for their inclusion in the universal set.

The inclusion of freight futures investment can clearly be justified on the basis of its financial uniqueness within the shipping world. The basis of revenue earning and cost of investment are so completely incomparable with the alternative market investments that it would provide an interesting analysis even when considered on its own merits. When considering the interaction of freight futures investments with the more traditional physical market investments, it is clear that the results could constitute an original and valuable insight into the holding of shipping portfolios.

When considering which of the individual physical market investments should be included in the universal set for further analysis, it has been decided that the financial returns from consecutive voyage charters and contracts of affreightment would be the same as those from voyage charters given the assumptions of a standard time unit for comparison and full employment. The basis of this decision can be imputed from Table 7.12 which shows the cost responsibilities of a shipowner. It is apparent that the costs to the shipowner do not differ between these three forms of charter. Similarly, since revenue earning is derived from the same basis of $/ton of cargo, there is clearly no differential effect on the returns to the shipowner. Because of the comparative rarity in the dry bulk trades of the alternatives, voyage charters are assumed to be on FIO terms.

Table 7.12: Cost Responsibilities of the Shipowner Under Different Forms of Charter-Party

Cost Items	Bareboat Charter	Period Time Charter	Trip Time Charter	Single-Voyage Charter	Consecutive Voyage Charter	Contract of Affreightment
Capital Costs						
Repayment of Capital	√	√	√	√	√	√
Interest	√	√	√	√	√	√
Operating Costs						
Crew costs, wages etc.		√	√	√	√	√
Provisions		√	√	√	√	√
Spare parts		√	√	√	√	√
Lube oils		√	√	√	√	√
R & M		√	√	√	√	√
Insurance		√	√	√	√	√
Admin.		√	√	√	√	√
Others		√	√	√	√	√
Voyage Costs						
Bunkers				√	√	√
Port dues				√	√	√
Canal tolls				√	√	√
Others				√	√	√
Cargo Costs						
loading						
Discharging						

This table also suggests that there is no financial difference between a period time charter and a trip time charter. As a result of this, and also the fact that trip time charters are nearly always associated with the liner trades rather than the dry bulk sector, it has been decided to include only period charters in the set of possible individual investments for further analysis. This set is now solely composed of just four possible market investments; period time charters, single-voyage charters (FIO terms), bareboat charters and freight futures. It is this set which will be carried forward as the basis for the ensuing analysis under the principles and methodology of Modern Portfolio Theory.

As has already been mentioned, this method of analysis is based purely on the financial characteristics of the individual investments. Before completely dispensing with the more nebulous qualitative features of the different physical market investments, it might prove beneficial to illustrate the advantages and disadvantages of each (from the shipowner's point of view), in order to place the ensuing quantitative analysis into some form of perspective. To this end, Yolland (1978) summarizes them as shown in Table 7.13.

Table 7.13: Advantages and Disadvantages of the Different Forms of Charter-Party

Type of Charter	Advantages	Disadvantages
Bareboat	No operational problems. Long-term income guarantee.	Loss of control of asset Total loss of flexibility. No high market benefits
Period Time	Guaranteed period income. Protected against low markets. Reduced operational problems.	Partial loss of control. No high market benefits. Limited flexibility. May suffer from cost escalation.
Voyage & Trip Time	Maximum flexibility. Benefits on high markets. Maximum control of asset.	No income guarantee except short-term. Suffer on low markets. Maximum forecasting problem.
Contract of Affreightment	Considerable flexibility. Guaranteed period income. Considerable low market protection. Maximum control of asset.	May not fully benefit on high market. May suffer cost escalation.

Chapter 8

A Building Block Approach to Modelling the Returns in Dry Bulk Shipping

8.1 Definition of Returns and Framework for Data Collection

From the exposition of Modern Portfolio Theory outlined in Chapter 6, it is clear that, along with utility and risk measures, the returns accrued from different investments constitute one of the three major inputs to the modelling process. It has been implied that most of the applications of Modern Portfolio Theory have been to the determination of subjectively optimal portfolios in the stock market. The standard definition of 'return' reflects this. McLaney (1986) suggests that return is calculated as follows:

$$r_t = \frac{P_t - P_{t-1} + d_t}{P_{t-1}}$$

Where:

r_t = The return from the security or portfolio at time t.

P_t = The price of the security or portfolio at time t.

P_{t-1} = The price of the security or portfolio at time $t-1$.

d_t = The dividend arising, if any, from holding the security or portfolio for the standard unit time period.

Obviously, such a definition relates directly, and very specifically, to the stock market and the nature of the returns that are made within that environment. Capital gains and dividends which accrue over the holding period are expressed as a percentage of the original value of the asset. This suggests that the term 'return' implicitly relates to the 'return on investment' as defined by:

$$\frac{Profit}{Cost\ of\ Investment}$$

In the case of the stock market, the capital gains plus the dividend received represent the profit. However, $Profit = Revenue - Cost$. This representation is implicit in the stock market definition of return outlined above, but is more directly apparent in the definition of return on investment provided by Bromwich (1976):

$$r_i = \frac{R_i - I_i}{I_i}$$

Where:

r_i = The rate of return from the i^{th} security.

R_i = The revenue accrued by the i^{th} security during a given time period.

I_i = The original cost of the i^{th} security.

This formula leads directly to the definition of return on investment which will be used in this work as the basis for calculating the returns to dry bulk shipping services. Precisely, that definition is given by the expression:

$$ROI_{it} = \frac{Revenue_{it} - Cost_{it}}{Cost_{it}}$$

Where:

ROI_{it} = The return on investment of the i^{th} security or portfolio during a standard time period.

$Revenue_{it}$ = The revenue earned by the i^{th} security or portfolio during the standard time period t.

$Cost_{it}$ = The costs incurred or investment made in holding the i^{th} security or portfolio for the standard time period t.

As mentioned in the earlier parts of this work, any cost incurred by a shipowner entering into and fulfilling a particular market transaction can be considered as an investment. The two phrases are directly interchangeable.

The previous chapter highlighted the fact that as far as financial aspects are concerned, as differentiated from legal and operational considerations, there are basically just four market investments which a shipowner can make. As has already been emphasized, these investments materialize in terms of a commitment of resources and can generally be categorized as follows:

1. Voyage charters.

2. Time charters.

3. Bareboat charters.

4. Freight futures contracts.

Of these four categories of market investment, the importance of the bareboat charter is comparatively minute. Although they do represent a theoretical alternative market investment, their occurrence in practice is so rare they are hardly worthy of consideration. Because of their rarity, the collection of cost and revenue information, necessary to undertake an analysis of returns, becomes extremely difficult if not impossible. Their scarcity of occurrence also implies that a shipowner may not be able to invest in such a transaction even if he should choose to do so. Modern Portfolio Theory concerns the optimization of a certain decision making process. Since the decision as to whether or not to invest in a bareboat charter is effectively removed from the shipowner, the inclusion of such transactions seems incongruous. It is for these reasons that the bareboat charter has been expunged from the universal set of individual market investments considered within this analysis for inclusion in a subjectively optimal market portfolio.

The constraint of considering only three market investments within the confines of Modern Portfolio Theory greatly simplifies the analysis which needs to be undertaken in applying the methodology. This is most apparently relevant to the calculation of covariances necessary to the application when variance or standard deviation is the measure of risk employed. As will be seen in Chapter 9, covariance measures shorten the process of portfolio risk calculation where variance or standard deviation are used as the proxy for risk. For other measures of portfolio risk, no such short-cuts exist. Consequently, each possible portfolio mix needs to be considered individually. Limiting the number of individual investments that compose those portfolios to just three, obviously, greatly facilitates ease of analysis. This is especially important in that this work seeks to determine an adjusted Modern Portfolio Theory methodology which can be practically applied by shipowners in their regular market decision making.

At first sight, it would seem that as far as returns are concerned, the analysis now progresses by determining the return on investment accruing to shipowners in the voyage charter, time charter and freight futures markets. However, Chapter 3 pointed to the fact that there is no such thing as a voyage charter market or a time charter market. These are merely generic terms which, in effect, represent an amalgam of specific submarkets which can be delineated in terms of;

- ship size.
- cargo carried.
- traded route.

As such, an analysis of the returns in the general voyage and time charter markets will mean nothing since the shipowner does not actually receive such returns. Such returns are inevitably merely averages of the actual achievable returns. Their analysis within the framework of Modern Portfolio Theory, therefore, would contribute nothing to the required objective of ameliorating the decision making processes of shipowners. Clearly, the analysis needs to be undertaken at the level of specific submarkets so that the estimated returns constitute, at least approximately, realistic and, therefore, achievable returns.

To analyse the returns of each dry bulk submarket over however short a period would be a mammoth task. In order to simplify the analysis still further it is necessary to concentrate the analysis solely on a sample of the available submarkets. To this end, the following three trades have been selected for in-depth analysis.

1. 30,000 Dwt. US Gulf Coast (USGC) to Japan (JAP) carrying grain.

2. 55,000 Dwt. Hampton Roads (HR) to Japan (JAP) carrying coal.

3. 120,000 Dwt. Brazil (BRZ) to North-West Europe (NWE) carrying iron ore.

These trades will be analysed under both voyage and time charters. Similarly, returns from freight futures will be derived for shipowners involved in these trades. The reasons why these three have been chosen are several.

1. They represent a good cross-section, in terms of size of ship and cargo carried, of the overall dry bulk market.

2. These trades are very important to the overall dry bulk shipping market. This can be seen very clearly in Table 8.1.

Table 8.1: The Importance of the Three 'Sample' Trades to the Overall Dry Bulk Market in 1985

Cargo	Total World Tonnes Carried	Sample Route	Total Tonnes on Sample Routes
Grain	181.5m	USGC-JAP	21.0m
Coal	271.6m	HR-JAP	32.3m
Iron Ore	320.6m	BRZ-NWE	35.2m

Source: Fearnleys, World Bulk Trades

In 1985, 21.0m tonnes of grain, representing 11.6% of the total world grain cargoes, was shipped from USGC to JAP, 32.3m tonnes of coal, representing 11.9% of the total world coal cargoes, was shipped from HR to JAP and 35.2m tonnes of iron ore, representing 11.0% of the total world iron ore cargoes, was shipped from BRZ to NWE. The ranking of the respective international trades within their commodity grouping is as shown in Table 8.2.

Table 8.2: Ranking of 'Sample' Trade Movement Within Cargo Grouping

Route & Cargo	Rank within cargo group
USGC-JAP Grain:	4
HR-JAP Coal:	5
BRZ-NWE Iron Ore:	2

Source: Fearnleys, World Bulk Trades

The proportions of the specific cargo trades that are carried in the size of ship with which this study concerns itself are shown in Table 8.3.

Table 8.3: Proportions of Trades Carried in 'Sample' Ship Sizes

Specific trade	'Sample' ship size	Proportion of Trade carried in 'Sample' ship size
USGC-JAP Grain:	30,000	29.0%
HR-JAP Coal:	55,000	24.0%
BRZ-NWE Iron Ore:	120,000	65.5%

Source: Fearnleys, World Bulk Trades

3. The routes are regularly traded. It is for this reason that the freight

rate data pertaining to each of these trades is readily available. In fact, Lloyd's Shipping Economist publishes the prevailing freight rate for each of these trades every month. From a practical viewpoint, it was this ready availability of the data which formed the major consideration when selecting which trades to base the analysis on. Apart from the fact that these trades can be justified on other grounds (as seen in the points above), freight rate data is just not so consistently or easily accessible for alternative trades.

The availability of monthly freight rate data for the three trades considered prompted the analysis of returns on the basis of monthly observations. Most applications of Modern Portfolio Theory, such as that by Vandell, Harrington & Levkoff (1978), Jensen (1975) and Blume & Friend (1975), base their analyses on monthly observations of the data. When analysing the returns in shipping, a major advantage of using monthly data arises from the relative simplicity of converting time charter rates to monthly voyage equivalents.

Before actually collecting and analysing the data, the final operational aspect which needs to be dealt with is the period of analysis. Since the objective of this part of the analysis lies in the determination of the returns of portfolios composed of voyage charters, time charters and freight futures contracts, a constraint is placed on the period of interest by virtue of the fact that freight futures were unavailable before May 1985. As a consequence, it was decided that the data should be collected for the period: May 1985 to December 1988 inclusive. This means that 44 observations of each individual investment is possible for the period.

8.2 The Methodology of Returns Analysis

As has already been mentioned, return on investment is dependent on revenue and costs. The revenue side of the equation depends upon the supply of shipping services and the price at which they are supplied. Prices, in the form of freight rates, are readily available for the three trades considered in this study since they are published on a monthly basis in Lloyd's Shipping Economist. For the purposes of this analysis, the supply of shipping services is deemed to be constant. More precisely, ships are assumed to be fully employed within each trade and on that trade alone. This is a very unrealistic assumption to make since it is based on the prerequisite that suitable repeat charters are constantly available and that unproductive ballast voyages do not, therefore, exist. This assumption implies that fully laden ships trade to and fro between the same two ports of call all the time.

In order to calculate revenue, it is necessary to make some assumptions *vis a vis* employment of the ships. Any such assumptions made can be criticized as being unrealistic. However, as long as the assumptions are applied across the board to all three trades considered and to all types of investment, the errors in estimating returns will be of the same order for each of the trades and for each of the market investments. The level of relative error is, therefore, minimal. Since Modern Portfolio Theory considers mixes of different investments, the resultant subjectively optimal portfolio should be the same whatever the assumptions governing employment. The absolute level of return on portfolio investment may be erroneous, but different portfolios will remain directly comparable. In fact, because of the assumption of full employment for the ships on each of the trades, the expected returns for the different portfolios will inevitably be overestimated because of the fact that non-revenue earning ballast legs are ignored. Nevertheless, this feature in itself does not negate the methodology employed nor the results achieved.

Having made the required assumptions regarding a ship's employment pattern, the revenue calculations, necessary as input into the calculation of return on investment, are relatively straightforward. Revenue calculations become primarily based on the price charged for the provision of shipping services. This price is known as the freight rate and, as will be seen in the sections which actually deal with revenue estimation, may be quoted in a number of different ways which usually depend on the form of the specific market transaction.

The issue of cost calculation is another matter. Companies in all industries are extremely sensitive where costs are concerned. A widely-held view exists that the secrecy over costs which pervades the shipping industry is even more extreme. Because of this inherent dearth of publicly available information with regard to accurate shipping costs, most research which requires such knowledge, for example Glen (1987), invariably bases its cost estimates on the output from some modelling exercise.

Within the field of cost estimation in the shipping industry, there are basically two approaches which may be adopted. The first is known as the elasticities approach and has gained a much greater following amongst the academic community involved in shipping research than among industrial practitioners. The leading contemporary proponents of this method of cost estimation are undoubtedly Jansson & Shneerson (1987), especially insofar as it relates to the liner shipping industry. Glen (1988) discusses the applicability of this methodology to the determination of costs in the tanker market. When describing the model upon which the elasticities approach is founded, he writes:

> "The model contains a set of estimated size elasticities for capital, operating and fuel and port costs, which are combined with daily operating expenditures to provide an estimate of the total voyage costs of transporting a given volume of cargo on a given trip."

The attempted general applicability of the elasticities approach is implicit in this statement. The motivation in adopting the elasticities approach often lies in an attempt to optimize ship size to attain the most efficient carriage of goods. This was the explicit aim in the work of Heaver (1969), Goss & Jones (1971) and Jansson & Shneerson (1982). Apart from the optimization of ship size, other possible motivations for the employment of the elasticities approach to costing arise from attempts to explain and/or predict cost movements in the industry. Such motivation lies at the heart of the work by Shimojo (1978) who adopted another form of theoretical mathematical costing model as the basis of his analysis of freight rate determination in the shipping markets.

It is apparent that the aim of the elasticities approach, and other theoretical modelling exercises, is not just the determination of costs but rather the determination of underlying factors which influence costs. Such approaches are, therefore, defined as being 'fundamental' in nature. They are undoubtedly important in their own right since they provide insight into shipping costs over and beyond the mere specification of values and amounts. The results produced by such models permit the explanation, prediction and control of costs. However, for the purposes of this work such models exhibit elements of overkill. This analysis is only concerned with the costs incurred by shipowners under different forms of contract for a limited period of only 44 months. Why or how such costs arise is irrelevant. It is for this reason that the alternative building block approach to costing is used within this study. Such an approach is expounded in several basic standard shipping textbooks such as Packard (1978), Casas (1981) and Downard (1981) and is widely used in industry.

The building block approach to the estimation of shipping costs is basically an accounting procedure whereby detailed estimates of the various categorized cost components are added together to arrive at a total cost. This is undertaken separately for each ship size. The categorized cost estimates used within this work were derived from approximated data published monthly in various shipping trade journals such as Lloyd's Shipping Economist and Drewry Shipping Statistics and Economics. Again, criticism could be levelled at the use of such approximated data. However, given the lack of a feasible alternative, particularly access to real company cost data, the use of such approximate data seems the only way forward. Also, the errors in estimation will again be of the same order as they affect each of the potential market investments. Consequently, the existence of such errors or inaccuracies should not introduce any bias into the portfolio analysis and the resultant theoretically suggested subjectively optimal market portfolio. Heaver (1985p35) supports this pragmatic stance by suggesting that:

> "Costing is often discussed as though there were a 'true cost' of providing a service. There is no such single cost. The relevant cost is always dependent on the purpose for which the costing is to be performed."

Such a view points to the impossibility of assessing the magnitude of errors made in any *estimation* of costs. It also suggests that errors may even exist in costs supplied direct from a company, especially when the objective for which they are required differs from that of pure management or financial accounting. Goss (1985p3) provides further support for this view:

> "...we cannot expect to get the right answer unless we know the right question and we are unlikely to get that without defining our terms and purposes very carefully."

In view of this advice, suffice it to say that in summary the purpose of this costing exercise is to provide an input into the calculation of returns in shipping which, in turn, will provide input to a Modern Portfolio Theory model of market portfolio selection for shipowners. A building block approach has been adopted as the basis of cost determination since it is only required to determine cost values for a certain prespecified period. As long as the same rules of cost estimation are applied across the board, there will be no differential error effect and, therefore, the results from the final portfolio selection model will be unbiassed and free from error at least as far as the cost estimation methodology is concerned.

The following sections describe in detail the revenue and building block cost calculations undertaken to arrive at a time series of returns on investment. As one can imagine, the level of intricate detail necessary to undertake this analysis is such as to mitigate against the in-text inclusion of the precise calculations. For this reason, only appropriate summaries are presented at this stage. However, an exhaustive presentation of the modelling process and results is provided in Appendices B-D. For the purpose of clarity, in the ensuing sections, the various cost estimations and associated assumptions are discussed within the context of the standard cost component classification recommended by Stopford (1988).

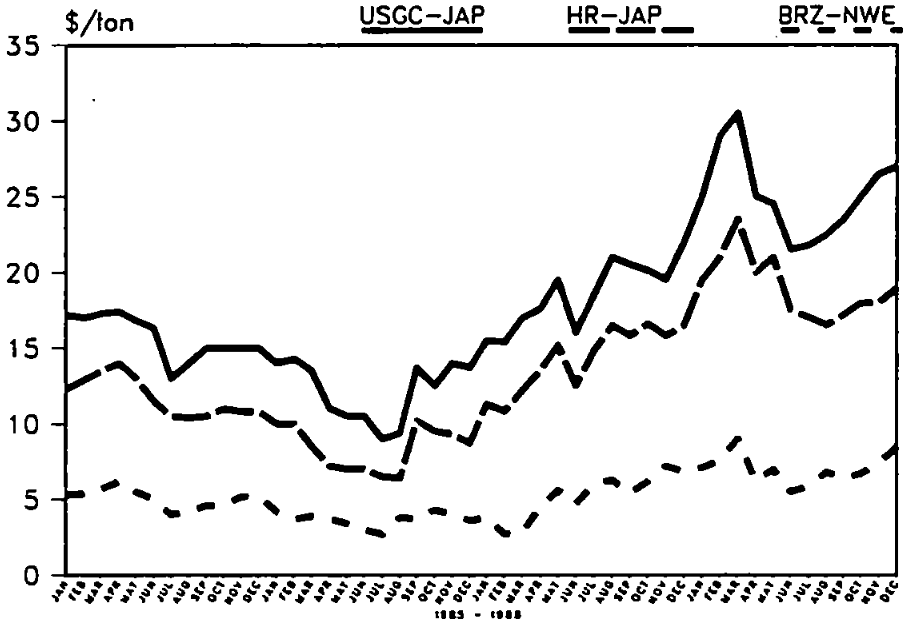
8.3 The Returns on Investment of Voyage Charters

8.3.1 Revenue Considerations

Voyage charters are most normally quoted in terms of $/ton of cargo. A summary of the freight rates under voyage charter for the three trades with which this study concerns itself are shown in Appendix E for the 44-month period of interest. A plot of the data is presented in Figure 8.1.

Gross freight revenue for a voyage charter is derived from the above time series of freight rates by multiplying the individual monthly freight rates, expressed in $/ton of cargo terms, by the amount of cargo carried on the voyage. For the purposes of simplicity of calculation, this has been assumed to be equal to the deadweight tonnage of the ship which carries it.

Figure 8.1: Average Monthly Voyage Freight Rates of the Three 'Sample' Trades (1985-1988)



Source: Lloyd's Shipping Economist

8.3.2 Cost Considerations

In order to undertake some of the cost calculations made within this section it was necessary to obtain very specific route, charter and ship information on which to base certain of the assumptions made. Having decided on the three trades that would be analysed in detail, Mardata fixture reports were scrutinized for actual fixtures which corresponded to the three trades which are analysed herein. The details of the reported fixtures were then looked up in the appropriate editions of Lloyd's List. The fixtures which were randomly selected and deemed as being representative of the three sample trades were as follows:

- USGC-JAP, *Oriental King*, 31,000t HSS, $18.80, FIO, 3 days/5 days, Apr. 1987.
- HR-JAP, 55,000t, *Pacer*, Coal, $24, FIO, 5 days Shinc, March 1988 (NYK).
- Tubarao-Rtm, *Dimitrios*, owner's option *Irene*, 125,000t, Iron Ore, $4.90, FIO, 6 days Shinc, Aug. 1-10 1988 (Dillingen).

Performance and structural characteristics of each of the ships involved in these charters were then derived from their respective entries in Lloyd's Register. These characteristics were compared to other similar sized ships in Lloyd's Register in order to deduce their representativeness. It soon became obvious that the *Oriental King* burned an excessive amount of fuel and could not, therefore, be regarded as representative of a handy-sized ship. Nevertheless, after some deliberation, it was decided that the characteristics of this ship should remain the basis upon which certain modelled cost estimates would be made. Clearly, one would expect such a ship to operate very uneconomically. However, this should be reflected in the results provided by the application of Modern Portfolio Theory. Consequently, should the results of applying the model serve to emphasize the uneconomic nature of this ship then this, in itself, validates the application of Modern Portfolio Theory. The necessary route, charter and ship characteristics which were determined in this way are summarized in Table 8.4 and are used in some of the later cost calculations.

Voyage Costs

Commissions This is the amount due to brokers and agents involved in negotiating the voyage charter. By contacting various people in the shipping industry, it was established that 2.5% of gross freight revenue would be a realistic figure to use.

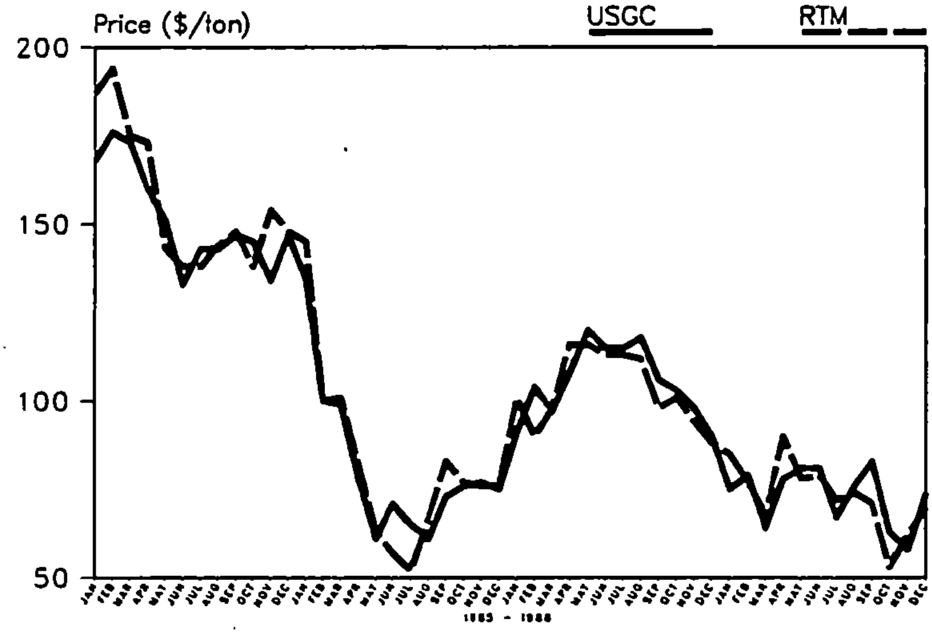
Fuel The total bunker or fuel cost is composed of the cost of heavy fuel oil plus the cost of diesel oil. These costs are dependent upon the respective prices of the different oils and on their consumption. Monthly prices of heavy

Table 8.4: Route, Charter and Ship Characteristics of the Three Sample Trades

Route:	USGC-JAP	HR-JAP	BRZ-NWE
Ship size:	30,000Dwt	55,000Dwt	120,000Dwt
Cargo:	Grain	Coal	Iron ore
Proxy ship:	*Oriental King*	*Pacer*	*Dimitrios*
Actual Dwt:	36,138	61,737	129,882
Single leg distance (nm):	9115	9504	5256
Via Panama Canal:	Yes	Yes	No
Laden speed (knots):	14.5	15.0	15.5
Laden Fuel Oil cons. (t/day):	74.5	52.0	87.5
Laden Diesel Oil cons. (t/day):	4.5	3.0	5.25
Loading time (days):	3	2	3
Discharging time (days):	5	3	3

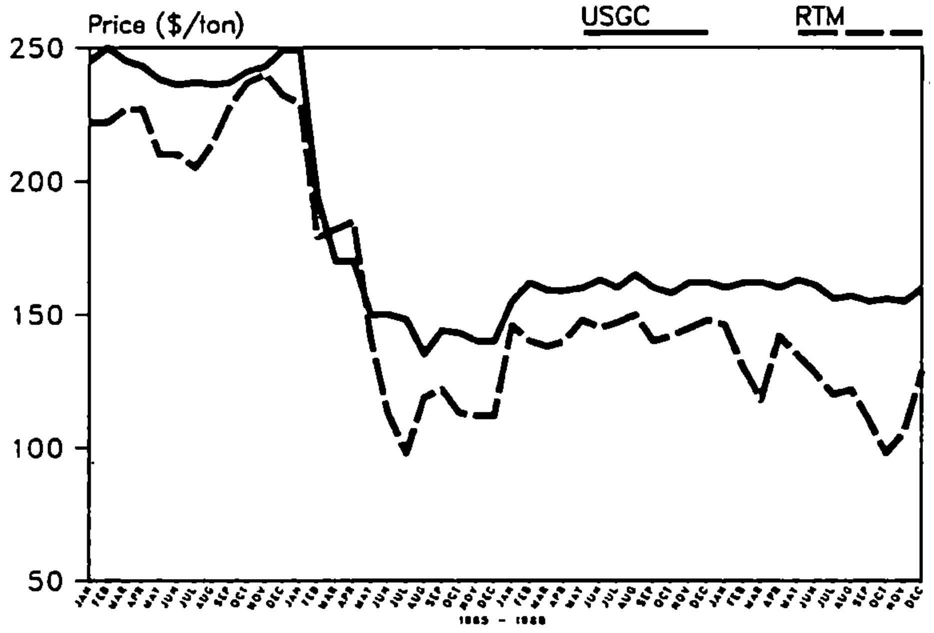
fuel oil and diesel oil (for USGC and Rotterdam) are itemized in Appendices H and I, but a plot of the price movements can be seen in the Figures 8.2 and 8.3. For the purposes of this analysis it is assumed that fuel for the USGC-JAP and HR-JAP voyages is purchased at USGC prices and fuel for the BRZ-NWE voyage is purchased at Rotterdam prices.

Figure 8.2: Average Monthly Prices of Heavy Fuel Oil in USGC and Rotterdam (1985-1988)



The total heavy fuel oil consumption is obtained by multiplying the daily consumption rate by the total number of days at sea. The total number of days at sea is deduced by dividing the total voyage distance by the speed in

Figure 8.3: Average Monthly Prices of Diesel Oil in USGC and Rotterdam (1985-1988)



knots multiplied by 24 hours steaming in a day. Thus:

$$TC_{HFO} = \frac{d}{(s \times 24)} \times C_{HFO} \times P_{HFO}$$

Where:

TC_{HFO} = The total cost of heavy fuel oil.

d = The single leg voyage distance in nautical miles.

s = The laden speed of the ship in knots.

C_{HFO} = The consumption rate of heavy fuel oil at sea in tonnes per day.

P_{HFO} = The price per tonne of Heavy Fuel Oil.

The total consumption of diesel oil is obtained by multiplying the at sea consumption rate by the number of days at sea and adding the in port consumption rate multiplied by the number of days in port. Thus:

$$TC_{DO} = [\frac{d}{(s \times 24)} \times C_{DO_s} + T_p \times C_{DO_p}] \times P_{DO}$$

Where:

TC_{DO} = The total cost of diesel oil.

d = The single leg voyage distance in nautical miles.

s = The laden speed of the ship in knots.

C_{DO_s} = The consumption rate of diesel oil at sea in tonnes per day.

C_{DO_p} = The consumption rate of diesel oil in port in tonnes per day.

T_p = The number of days in port.

P_{DO} = The price per tonne of diesel oil.

Total bunker cost is simply the addition of the total cost of heavy fuel oil and the total cost of diesel oil. Thus:

$$TC_{Fuel} = TC_{HFO} + TC_{DO}$$

Port Charges Estimates of port costs were derived from the Lloyd's Shipping Economist database. A summary of the port costs used can be seen in Table 8.5.

Table 8.5: Port Costs for the Three 'Sample Trades

	USGC-JAP 30,000Dwt Grain	HR-JAP 55,000Dwt Coal	BRZ-NWE 120,000Dwt Iron ore
Jan 85-Jan 87:	$35,750	$47,625	$105,658
Feb 87-Jan 88:	$36,750	$48,625	$135,342
Feb 88-Dec 88:	$36,750	$48,625	$147,711

As can be seen, port charges depend upon the size of the ship. However, they also vary depending upon the sort of ship and actual ports of call. Since precise data for the ports involved in the three 'sample' trades was unavailable, the charges of the ports shown in Table 8.6 were used as proxies.

Table 8.6: Proxies used for Loading and Discharging Ports in evaluating Port Charges

	USGC-JAP 30,000Dwt Grain	HR-JAP 55,000Dwt Coal	BRZ-NWE 120,000Dwt Iron ore
Loading Port:	New Orleans	New Orleans	New orleans
Discharging Port:	Yokohama	Yokohama	Rotterdam

Canal dues The USGC-JAP and HR-JAP trades involve passage through the Panama canal. Consequently, canal dues are payable. The magnitude of this cost depends upon the size of the ship and whether it is laden or in ballast. Lloyd's Shipping Economist provides quotes for laden 20,000 Dwt. and 60,000 Dwt. ships. The amounts to be paid as canal dues within this analysis are derived by simple arithmetic interpolation. They are $28,200 for USGC-JAP and $45,700 for HR-JAP.

General Comments Gross voyage surplus is derived by subtracting all the above voyage costs from the gross freight revenue. In Appendices B and C, an additional item called net freight revenue refers to the amount after subtracting just commissions from the gross freight revenue. However, after arriving at a figure for gross voyage surplus it is then converted into a daily figure by dividing it by the number of days taken to undertake the voyage. Thus:

$$GVS/day = \frac{GVS}{T_p + \frac{d}{s \times 24}}$$

Where:

$GVS =$ The gross voyage surplus.

$T_p =$ The number of days in port.

$d =$ The single-leg voyage distance in nautical miles.

$s =$ The speed of the ship in knots.

The actual number of days taken to complete the one-way voyages used within this analysis are USGC-JAP: 35 days, HR-JAP: 32 days and BRZ-NWE: 21 days.

Operating Costs

Operating costs refer to the costs that are incurred whatever trade the ship is employed in. They are not specific to the voyage. They constitute the amalgamation of the following individual costs:

Crew Cost which includes victuals, relieving and repatriation costs and, of course, the wages of the seafarers.

Technical Cost which includes the costs of stores, supplies, luboil and running repairs and maintenance.

Management & Miscellaneous Cost which includes a management fee and the costs incurred in obtaining insurance and communications.

The values which are used as estimations for the monthly operating costs of the three sample trades of this analysis are shown in Table 8.7.

A daily operating cost is derived by dividing the monthly operating cost by 30.4375. Lloyd's Shipping Economist assumes that these costs are relevant to ships registered under an open flag and operating with Indian officers and Korean ratings. In modern times the practice of flagging-out has become

Table 8.7: Operating Cost Estimates for the Three 'Sample' Trades

	USGC-JAP 30,000Dwt Grain	HR-JAP 55,000Dwt Coal	BRZ-NWE 120,000Dwt Iron ore
1985	$71,000	$79,600	$100,700
1986	$72,100	$79,000	$100,700
1987	$73,200	$78,400	$100,700
1988	$74,300	$77,800	$100,700

extremely common as a cost cutting exercise. Consequently, such assumptions cannot be regarded as unrealistic. Since the ships considered within this analysis are assumed to be constantly employed, it would seem illogical to make provision for drydocking. This omission can also be justified on the basis that such provision does not constitute an actual cash flow and, as such, should make no negative contribution to return on investment until the cost actually materializes. As long as the study maintains consistency, there should be no differential affects on the results.

Cargo Handling Costs

Since all three trades considered within this analysis are operating under FIO (free in and out) charters, there are obviously no cargo handling costs to consider.

Capital Costs

The value of capital costs depends upon factors such as:

- The purchase price of the ship.
- The sale price of the ship.
- When the ship was purchased and when sold.
- The arrangements made with regard to the financing of the purchase.

Obviously, in order to determine some modelled values for capital costs, it is necessary to make certain assumptions concerning these factors. To this end, it is assumed, in order to maintain comparability, that all three ships were purchased in December 1983 and then sold in December 1988. The purchase and sale prices were deemed as being the average market price at the time of purchase and sale for the type and size of ship concerned. These values are summarized in Table 8.8.

Table 8.8: Purchase and Sale Prices of the Three 'Sample' Ships ($million)

	30,000Dwt	55,000Dwt	120,000Dwt
Purchase Price (Dec. 1983):	15.0	18.1	28.0
Sale Price (Dec. 1988):	12.4	15.0	27.5

In order to simplify the calculations necessary for determining capital cost, it was decided that, rather than use the complicated 'LIBOR+' financing system as the basis of analysis, it would be more advantageous to use standard OECD financing terms. This system provides finance for 80% of the purchase price at 8% interest to be repaid in 17 equal semi-annual instalments over $8\frac{1}{2}$ years. Such an assumption is reasonably realistic since many ship purchases do actually meet the requirements necessary to obtain this financially advantageous package. Tables 8.9-8.11 show calculations of the total interest payable under OECD financial arrangements for each of the three ships over the five year holding period.

Table 8.9: Interest Payable on 30,000 Dwt. Ship ($million)

Month	Period	Capital Outstanding	Capital Repaid	Interest Payable
Dec 1983	0	12.00	0.00	0.00
Jun 1984	1	11.29	0.71	0.48
Dec 1984	2	10.59	0.71	0.45
Jun 1985	3	9.88	0.71	0.42
Dec 1985	4	9.18	0.71	0.40
Jun 1986	5	8.47	0.71	0.37
Dec 1986	6	7.76	0.71	0.34
Jun 1987	7	7.06	0.71	0.31
Dec 1987	8	6.35	0.71	0.28
Jun 1988	9	5.65	0.71	0.25
Dec 1988	10	0.00	5.65	0.23
			Total Interest:	3.53

Table 8.10: Interest Payable on 55,000 Dwt. Ship ($million)

Month	Period	Capital Outstanding	Capital Repaid	Interest Payable
Dec 1983	0	14.48	0.00	0.00
Jun 1984	1	13.63	0.85	0.58
Dec 1984	2	12.78	0.85	0.55
Jun 1985	3	11.92	0.85	0.51
Dec 1985	4	11.07	0.85	0.48
Jun 1986	5	10.22	0.85	0.44
Dec 1986	6	9.37	0.85	0.41
Jun 1987	7	8.52	0.85	0.37
Dec 1987	8	7.67	0.85	0.34
Jun 1988	9	6.81	0.85	0.31
Dec 1988	10	0.00	6.81	0.27
			Total Interest:	4.26

Table 8.11: Interest Payable on 120,000 Dwt. Ship ($million)

Month	Period	Capital Outstanding	Capital Repaid	Interest Payable
Dec 1983	0	22.40	0.00	0.00
Jun 1984	1	21.08	1.32	0.90
Dec 1984	2	19.76	1.32	0.84
Jun 1985	3	18.45	1.32	0.79
Dec 1985	4	17.13	1.32	0.74
Jun 1986	5	15.81	1.32	0.69
Dec 1986	6	14.49	1.32	0.63
Jun 1987	7	13.18	1.32	0.58
Dec 1987	8	11.86	1.32	0.53
Jun 1988	9	10.54	1.32	0.47
Dec 1988	10	0.00	10.52	0.42
			Total Interest:	6.59

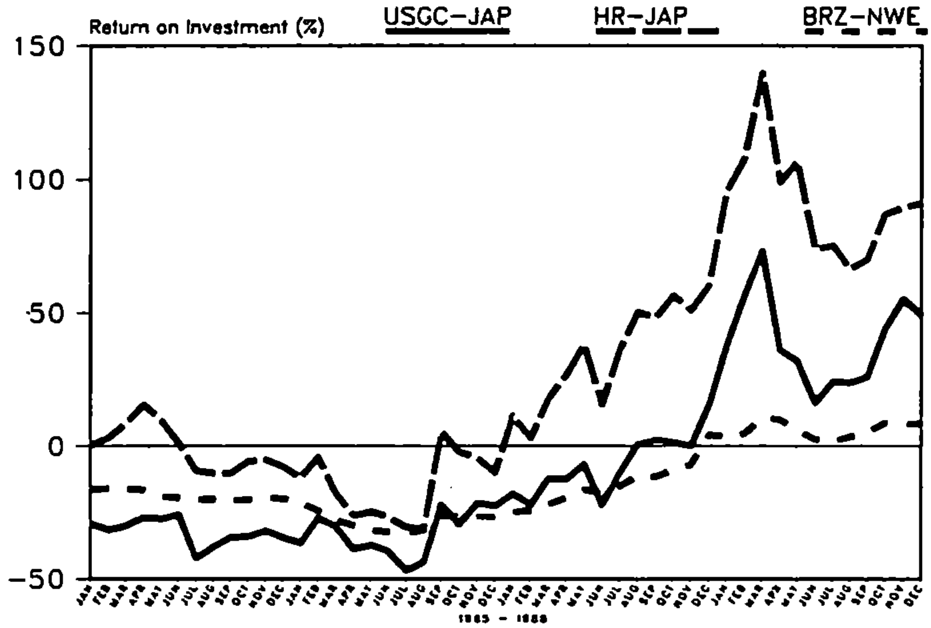
The total capital cost for the whole five year holding period for each ship is calculated by summing the interest payable, the amount of capital outstanding at the end of the period and the book loss/profit on sale. The resultant capital cost figures are shown in Table 8.12.

Table 8.12: Capital Cost Summary

Capital cost	30,000 Dwt.	55,000 Dwt.	120,000 Dwt.
Total:	$11.07m	$13.32m	$16.31
Monthly:	$184,500	$222,000	$271,833
Daily:	$6,061.6	$7,293.63	$8,930.86

The daily capital cost figures have been calculated by dividing the monthly capital cost by 30.4375. A net daily profit figure can now be obtained by subtracting the daily operating cost and the daily capital cost from the daily gross voyage surplus. For the purpose of calculating return on investment, it is this figure that constitutes return. Summing the total daily costs provides the denominator for calculating return on investment. The subsequent value is then expressed as a percentage to give the daily return on investment. The monthly return on investment will obviously be the same percentage figure. A complete summary of the whole 44-month period calculations for voyage charters is shown in Appendix B. However, a plot of the resulting time series of returns on investment for each ship can be seen in Figure 8.4.

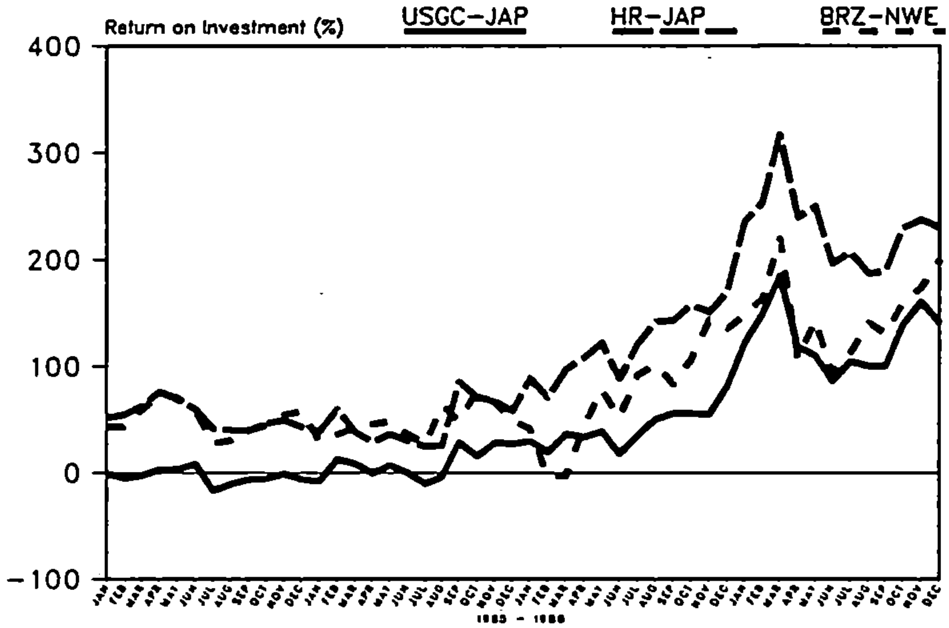
Figure 8.4: Estimated Average Monthly Returns on Investment from Voyage Charters (1985-1988)



It is interesting to note the generally poor levels of return which result from this analysis and also the fact that they have been improving over recent years. It is also interesting to look at the levels of return on investment when capital costs are excluded. These can be seen in Figure 8.5.

By comparing Figure 8.4 with Figure 8.5, it is clear that shipping, at least as far as the trades analysed herein are concerned, would be a reasonably profitable business if it were not for the astronomically high value of capital required to partake in that business. Consequently, the widely-held view in the industry that it is capital charges and debt provision which are crippling shipping would seem to be borne out by the results of this part of the analysis.

Figure 8.5: Estimated Average Monthly Returns on Investment from Voyage Charters Excluding Capital Costs (1985-1988)



8.4 The Returns on Investment of Time Charters

8.4.1 Revenue Considerations

The price or freight rate which pertains under a time charter is usually quoted in terms of $/day. The total revenue is thus derived by multiplying this figure by the length of time of the time charter. The monthly revenue which is implied from a time charter rate is usually at a discount to the equivalent voyage charter rate. One reason for this is that a time charter has an in-built premium in terms of security of prolonged employment. Time charters may theoretically be of any length but by far the most usual durations are six months and a year. As has been seen in Chapter 7, another reason why time charter revenue cannot be directly compared to that derived from voyage charters is that under a time charter the shipowner is not responsible for voyage costs. Naturally, this is reflected in the freight rate that he obtains. The corollary of this is that the returns on investment from a time charter cannot be directly compared to those of a voyage charter where time charter revenue is based on a \$/day freight rate. Instead, the prevailing time charter rate needs to be converted to a \$/ton of cargo basis so that direct comparisons with voyage charters is possible.

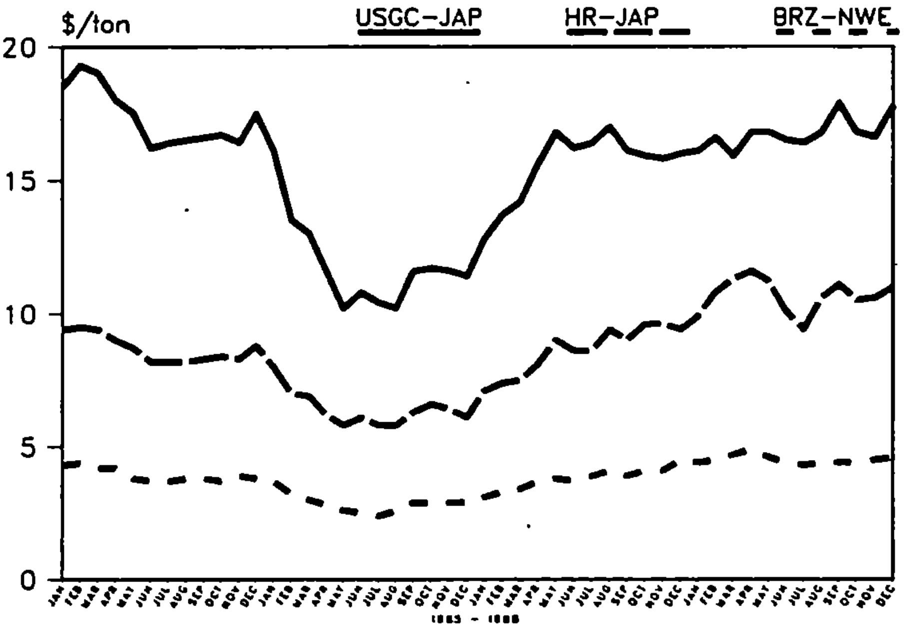
The formula which permits this conversion is given by:

$$\frac{T/C\ rate\ per\ day \times round\ voyage\ time + total\ voyage\ expenses}{cargo\ quantity\ in\ tons}$$

The original \$/day time charter rates and the converted voyage equivalent rates can be seen in Appendices F and G respectively. A plot of the converted voyage equivalent rates in terms of \$/ton of cargo can be seen in Figure 8.6.

The revenue calculations now become directly comparable to those undertaken in the analysis of voyage charters.

Figure 8.6: Average Mothly Voyage Equivalent Time Charter Freight Rates for the Three 'Sample' Trades (1985-1988)



8.4.2 Cost Considerations

It is not necessary to go into too great a depth at this point with regard to the cost estimates necessary under a time charter. Suffice it to say that now the basis of the revenue calculations is $/ton of cargo, the costs remain broadly calculated on the same basis as under voyage charter. Voyage costs need to be included because of the conversion previously undertaken and will take exactly the same values as under a voyage charter. Commission is again calculated at 2.5% of gross freight revenue which, of course, will now differ because of the different freight rate base being used. All the other cost assumptions and, indeed, values remain the same. Consequently, the process of calculating return on investment of a time charter is identical to that of a voyage charter once the conversion to a similar revenue base has been performed. A complete set of figures used in the analysis together with the results can be seen in Appendix C. However, a plot of the time series of returns on investment from the three trades (including and excluding capital costs) can be seen in Figures 8.7 and 8.8.

Figure 8.7: Estimated Average Monthly Returns on Investment from Time Charters (1985-1988)

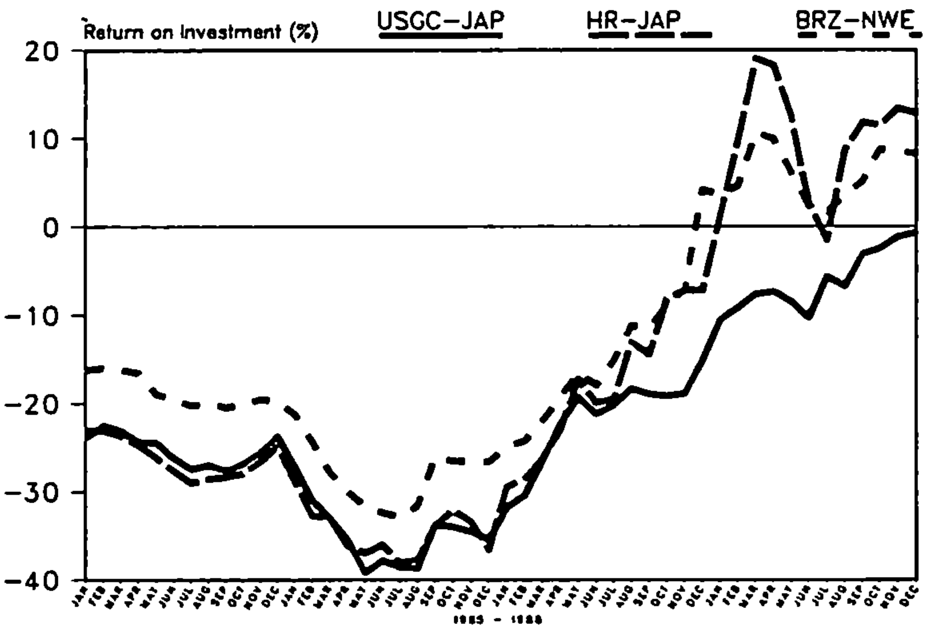
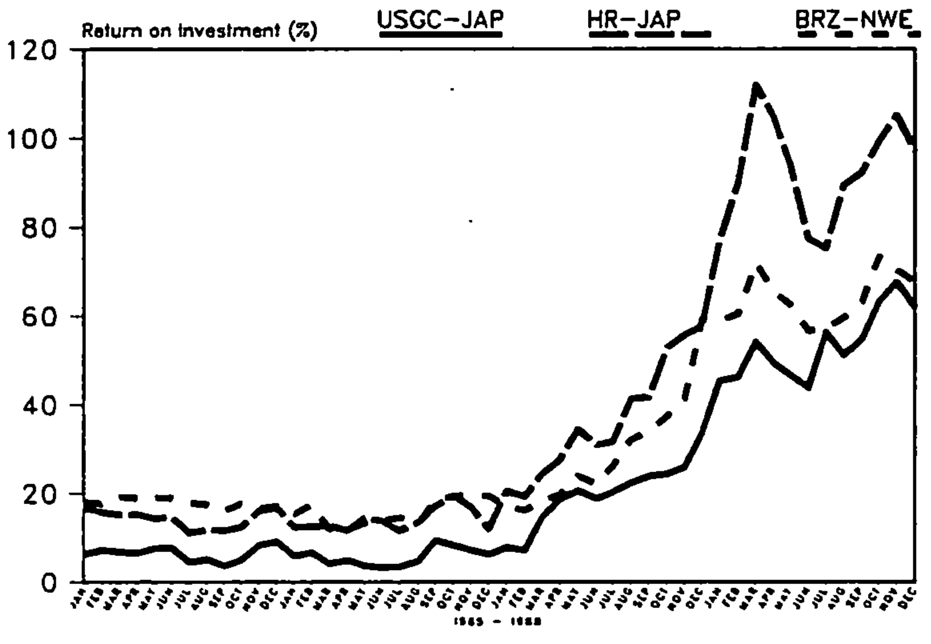


Figure 8.8: Estimated Average Monthly Returns on Investment from Time Charters Excluding Capital Costs (1985-1988)



8.5 The Return on Investment of Freight Futures

The calculation of returns on investment from freight futures contracts is extremely difficult. The method adopted in order to derive a pattern of returns on investment through time is basically one of simulation. The first thing to consider is the motivation for the shipowner in playing the futures market. Since this work is concerned with hedging in a portfolio context, it would seem inappropriate for the simulated shipowner to be motivated by speculative desires. The science or art of speculation lies beyond the bounds of an analysis based on optimizing portfolio holdings since a speculator's attitude tends to be one of 'all or nothing'. Consequently, the first assumption that was made when developing the simulation was that the shipowner player was motivated by the desire to hedge his physical contracts.

This assumption obviously implies some form of interrelationship between actions on the futures market and circumstances in the physical market. As was seen in Chapter 7, the nature of this interrelationship may take several forms. The simulation was begun by placing a theoretical hedging shipowner back in time to May 1985 when BIFFEX was initiated. The underlying philosophy of the simulation was that the shipowner should make decisions, *vis a vis* the purchase or sale of freight futures contracts, which were logically consistent with his circumstances in the physical market as time progressed.

Some of the physical market factors which may affect the freight futures decisions of a hedger include:

- Whether the trade which the shipowner is seeking to hedge is under voyage or time charter.
- Whether the shipowner has any forward commitments or not.
- the prevailing freight rate of the physical trade in which the ship is involved.

8.5.1 Revenue Considerations

Mathematically, the determination of the revenue from freight futures contracts is comparatively simple. It is given by the equation:

$$| R_{FF} | = (P_o - P_c) \times N$$

Where:

$| R_{FF} | =$ The absolute value of revenue from freight futures contracts.

$P_o =$ The price of the freight futures contracts at the time of opening the position.

$P_c =$ The price of the freight futures at the time of closing out the position.

$N =$ The number of contracts held and closed out.

This equation constitutes a drastic oversimplification of the revenue calculations that are typically necessary when dealing with freight futures in the real world. It results from the fact that the simulation undertaken within this work is based on an assumption of what is referred to as 'blind' hedging. A shipowner decides on his risk exposure and then attempts to hedge the full amount on BIFFEX. He then lets the hedge run the whole course of its life as determined by the length of the physical contract he is involved in. The only time a shipowner will re-hedge his physical position is where a futures contract expires before the expiration of the physical risk. A true hedging strategy on BIFFEX is usually much more dynamic in nature in that the shipowner will constantly revise his hedged position in line with what is happening both in the physical market and in the futures market. Such a policy requires a degree of skill and the adoption of expectations of the future which would be very difficult to simulate within the context of this work. As a consequence, the 'blind' hedging strategy adopted in this work will provide a pattern of returns on freight futures investments which constitute a minimum level of return. The implications of this assumption will be discussed in a later chapter once the results from the portfolio analysis have been discussed.

For the purposes of calculating the returns from a 'blind' hedging strategy, it is assumed that the shipowner maintains total flexibility in choosing between operating the specific physical trade under a time charter or a voyage charter. It is further assumed that this decision should be based on whichever contract provides the highest freight rate in terms of the comparable \$/ton of cargo measure. Thus, a shipowner operating a 30,000 Dwt. ship on USGC-JAP will run under a voyage charter where the \$/ton of cargo freight rate for a voyage charter is greater than the equivalent freight rate of a time charter. Under voyage charter, the shipowner is committed to the contract only for the length of time taken to make the voyage which in this example is 35 days. This shipowner is then free to again choose between a time and a voyage charter for the next 35 day period. If a shipowner chooses to operate under time charter, he is assumed to be committed to that contract for a period of 6 months, or approximately 5 voyages in this case, despite any improvement in voyage rates.

A further assumption made in the running of the BIFFEX hedging simulation is that the hedger transacts only the nearest futures contract however short the length of time left to run on that contract. Thus, a shipowner involved in the USGC-JAP trade will open a position on BIFFEX by transacting the nearest futures contract. If this contract expires before the completion of a 35 day voyage, he will then re-hedge his position on the new nearest futures contract.

Remembering that a player on BIFFEX need not have bought previous to selling contracts, the price at the time of opening a position may be the price at which contracts are bought or the price at which contracts are sold. The situation is analogous with respect to the closing price. Thus, the calculation of the absolute value of revenue is simple (as shown in the equation above), but the calculation of revenue in its true form depends upon the sign of the right hand side of the equation above and on whether the opening position was a buy or sell. Where the closing price is higher than the opening price, then the sign of the right hand side of the equation above will be positive. However, where the original opening position was a sell then the true revenue will be negative. Where the opening position was a buy then the true revenue will be positive. The converse is true for a situation where the closing price is lower than the opening price.

It is clear that whether a shipowner buys or sells in opening a position on BIFFEX is of vital importance to the determination of revenue, at least insofar as it effects the flow of funds either positively or negatively. Thus, the motivation behind the choice of either buying or selling is of overwhelming import. It has been assumed for the purposes of the simulation that this motivation is based on whether or not he holds any forward physical contracts which are deemed to start when his current contract is completed. The freight rate at which the forward contract will be performed is assumed to be that prevailing at the time of his wishing to open a position on BIFFEX. If the shipowner concerned is trading on BRZ-NWE at a rate of $5.3 per ton of cargo, then he is deemed to have locked in that rate for a subsequent forward contract due to begin in 21 days time after the completion of his current voyage contract. He hopes that the market rate at that time will not be higher than $5.3 since he will then have lost out by being committed to the forward contract. In an attempt to hedge against this possibility, he will *buy* on BIFFEX. Conversely, if a shipowner does not hold any forward contracts, he hopes that the market *will* rise in the interim period while he completes his current contract but is afraid that it will fall. To hedge against this potential risk he will sell futures contracts on BIFFEX.

The buy/sell decision is thus completely prescribed by the existence or otherwise of forward contracts. The fact that the simulation assumes 'blind' hedging means that individual perceptions or expectations of the future can be ignored. In the simulation a random number generator, programmed to provide integer values on a uniform interval between 0 and 1, was used in the determination of whether or not forward contracts were held.

It has already been stated that revenue is arithmetically dependent on the prices pertaining at the time of the opening and closing positions and on whether the futures contracts were opening sale/closing purchase or opening purchase/closing sale. However, the final factor in the determination of freight futures revenue is the number (N) of contracts that are transacted. This is entirely dependent on the level of risk exposure and is logically calculated as follows:

The price of the nearest futures contract at the time of opening a position implies some future freight rate. Where this price is less than the current value of the BFI, then a decline in the general level of dry bulk freight rates is expected. The converse is true when the price of this futures contract is higher than the current level of the BFI. A precise expected future freight rate can be implied from this price by relating the level of the BFI to the actual current physical freight rate and then relating the current level of the BFI to the futures price. If a shipowner is currently engaged in a contract which yields $17.5 per ton of cargo, the current value of the BFI is 1062 and the current price of the nearest futures contract is 981 then an implied future freight rate of $16.17 can be imputed from the figures as follows:

$$\frac{981}{1062} \times \$17.5 = \$16.17$$

The level of expected future freight revenue can be deduced by multiplying the implied future freight rate by the cargo carrying capacity of the ship concerned. Thus, this shipowner seeking to hedge a 30,000 Dwt. ship would expect to receive $484,958 on a future forward contract. The level of risk which he faces in the interim period is dependent upon how far the freight rate varies from this implicit predicted level. Since the predicted freight rate is derived purely from the price of a freight futures contract, it is necessary to determine the precise relationship between the movement in the physical freight rates of a particular trade and the price movements on BIFFEX. This relationship is termed the 'Basis' risk and is calculated by comparing the volatility of a particular trade freight rate with that of the BFI. Mathematically, this is achieved as follows:

$$Basis\ Risk = \frac{\Sigma_{pfr}/\overline{x}_{pfr}}{\sigma_{bfi}/\overline{x}_{bfi}}$$

Where:

σ_{pfr} = The standard deviation of a sample time series of physical freight rates for the trade considered. This measures the volatility of those freight rates.

$\overline{x}_{pfr}$ = The mean of a time series of physical freight rates. This divisor serves to standardize the units of volatility.

σ_{bfi} = The standard deviation of a sample time series of BFI values. This measures the volatility of the BFI.

$\overline{x}_{bfi}$ = The mean of a time series of BFI values. This divisor serves to standardize the units of volatility.

In statistical terms, this measure relates the coefficient of variation of specific trade freight rates to the coefficient of variation of the BFI. The 'Basis' risk, therefore, measures relative volatility and is, therefore, aligned to measures of correlation. Where the basis risk is equal to unity, the freight rates of the trade considered have the same degree of volatility as the BFI. Where the basis risk is greater than unity, the physical market exhibits greater volatility than the futures market and vice versa where the basis risk is less than unity. Total risk exposure is arrived at by multiplying the implicitly expected future revenue by the basis risk of the trade considered. Basis risk estimates have, therefore, been calculated for the three trades considered in this study, under both voyage and time charter, so that risk exposure may be determined for all possible physical market circumstances. The results of those calculations are given in Table 8.13 and are obviously derived from the database of physical market freight rates shown in Appendices E and G.

Table 8.13: Basis Risk Estimates

Type of Charter	USGC-JAP 30,000 Dwt. Grain	HR-JAP 55,000 Dwt. Coal	BRZ-NWE 120,000 Dwt. Iron Ore
Voyage Charter:	1.08	1.19	1.08
Time Charter:	0.60	0.71	0.65

Thus, in the example being considered, expected revenue is \$484,958 for a 30,000 Dwt. ship currently on time charter, so the risk exposure is $\$484,958 \times 0.6 = \$290,975$. It is this amount that the shipowner will seek to cover or hedge on BIFFEX. The current price of the nearest futures contract is 981 which is valued at \$10 per index point. Thus, one contract will cost \$9,810. Consequently, the total number of futures contracts necessary to hedge the current physical time charter contract is given by:

$$N = \frac{\$290,975}{\$9810} = 29.66 = 30\ Contracts$$

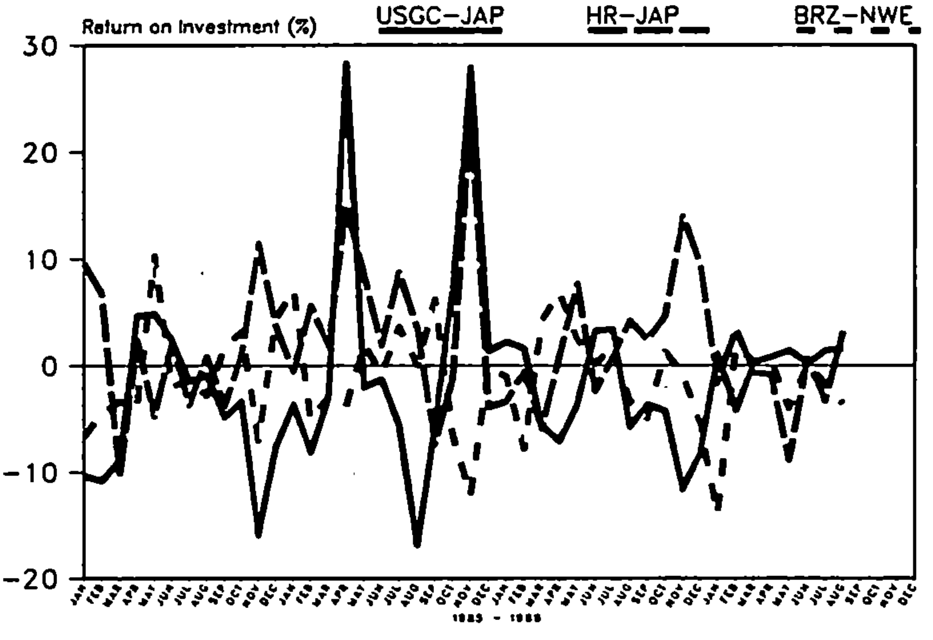
Because of the necessity for rounding, the shipowner will in effect be hedging a risk exposure of $30 \times \$9,810 = \$294,300$. As has been stated already, whether he buys or sells 30 contracts depends on whether or not he holds any future forward contracts.

8.5.2 Cost Considerations

Whether a hedger buys or sells freight futures contracts in opening a position, he is still deemed to have made an investment in terms of the commitment of resources, which in this case is money. The total cost of the hedge is simply the level of this investment. That is, the number of contracts purchased or sold multiplied by the price at the time of opening a position. The calculation of cost is, therefore, very much related to the calculation of revenue, since revenue actually directly depends upon the cost. In fact, the cost of investment in the theoretical example previously quoted is $294,300. However, to this must be added a sum for broker's commission which is calculated as $30 per contract transacted. This total is then used as the denominator for calculating the return on investment.

The full results of the simulation used to generate returns on investment from freight futures contracts can be seen in Appendix D. It is important to note that the time intervals used to calculate the profits and losses from freight futures contracts were dependent on the length of the voyage considered. Thus, all resulting profits/losses and investments had to be apportioned on a monthly basis so as to finally arrive at a 44-period time series of returns on investment from freight futures. A plot of this time series relevant to the hedging of each of the three sample trades can be seen in Figure 8.9.

Figure 8.9: Estimated Average Monthly Returns on Investment from Freight Futures Contracts (May 1985-Dec 1988)



8.6 Some General Observations on the Time Series of Returns on Investment

The returns on investment for each possible individual investment have now been determined. These individual investments can be combined to form portfolios. As has already been seen, the expected return from a portfolio is derived from a simple calculation. Since this study concerns itself with three possible individual investments that may be included in the portfolio, then that calculation takes the form:

$$E[x_p] = \sum_{i=1}^{3} p_i E[x_i] \qquad i = 1, 2, 3$$

or

$$E[x_p] = p_1 E[x_1] + p_2 E[x_2] + p_3 E[x_3]$$

Where:

$E[x_p]$ = The expected return from a portfolio of the three individual investments.

$E[x_1]$ = The expected return on investment from voyage charters.

$E[x_2]$ = The expected return on investment from time charters.

$E[x_3]$ = The expected return on investment from freight futures contracts.

p_1 = The proportion of the portfolio which is in the form of voyage charters.

p_2 = The proportion of the portfolio which is in the form of time charters.

p_3 = The proportion of the portfolio which is in the form of freight futures contracts.

As Harrington (1983) points out, the statistical means of an historic time series of returns on investment are usually used as proxies for the expected returns on investment. The means of the individual returns on investment as calculated herein are shown in Table 8.14.

These mean returns on investment, acting as proxies for expected return, can be combined to determine portfolio expected returns. For example, a

Table 8.14: The Individual Mean Returns on Investment

Individual Investment	*Mean Return on Investment*		
	USGC-JAP 30,000 Dwt. Grain	HR-JAP 55,000 Dwt. Coal	BRZ-NWE 120,000 Dwt. Iron Ore
Voyage Charter	-8.18	27.55	18.33
Time Charter	-22.02	-17.15	-13.81
Freight Futures	-0.02	0.02	-0.01

portfolio for a 30,000 Dwt. ship trading USGC-JAP (grain) composed of 10% time charters, 10% freight futures and 80% voyage charters will yield an expected return on investment as follows:

$$(0.8 \times -8.18) + (0.1 \times -22.02) + (0.1 \times -0.02) = -8.67\%$$

Obviously, the expected returns of any portfolio mix can be simply calculated in the same fashion.

Several other conclusions can be drawn from the analysis of returns on investment which has just been undertaken. Some are very interesting in their own right, but by virtue of the fact that they coincide with the market sentiment as expressed in trade journals, they also serve to justify the results of the returns modelling process in that they are logical.

1. The fact that most of the returns on investment were negative, illus-

trates the depression inherent in the dry bulk shipping sector. However, analysis of the actual time series from which these means were drawn shows that results have been improving over recent times.

2. The previous point suggests that returns on investment move in parallel to freight rates given that freight rates too have been improving in recent times. The proof of this conclusion lies with the correlation of returns on investment with the related freight rates. The results of such an exercise are provided in Table 8.15.

Table 8.15: Correlations of Freight Rates with Returns on Investment

Type of Charter	USGC-JAP 30,000 Dwt. Grain	HR-JAP 55,000 Dwt. Coal	BRZ-NWE 120,000 Dwt. Iron Ore
Voyage Charter	0.96	0.98	0.98
Time Charter	0.70	0.92	0.90

The implication of these high levels of correlation is that changes in the profitability of dry bulk shipping companies are almost entirely due to changes in the freight rates.

3. Despite the previous point, the absolute levels of profitability are most drastically effected by the level of capital cost which is paid. Taking both these points together, it is clear that there must exist a reasonably high freight rate which provides enough revenue to cover capital

charges. Thus, a break-even freight rate exists which is usually fairly high.

4. Over the period of analysis (May 1985-Dec 1988) voyage charters have consistently outperformed time charters. This is probably due to the fact that the market has been consistently rising during this period and shipowner expectations are, therefore, reasonably high. Charterers, on the other hand have been attempting to peg back the prices that they pay for transportation so have not responded to this optimistic view of the future by offering higher time charter rates.

5. As far as the profitability of ship size is concerned, the Panamax bulk carrier clearly outperforms the alternatives, at least under voyage charter. The handy-sized market is extremely weak, while the Cape-sized market provides an unhappy medium. Undoubtedly, the explanation of such results lies in the flexibility of the Panamax bulk carrier. This size ship is large enough to achieve economies of scale in cargo carrying so reducing the capital cost per ton of cargo carried, while at the same time is not that limited with respect to what trades it may ply.

6. The simulation of a BIFFEX hedging strategy yields returns on investment for all three sample trades which are not significantly different from zero. This points to the accuracy of those estimates. Since the methodology adopted was based on the premise of 'blind' hedging, one

should not expect returns that *are* different from zero. Each profit made on the BIFFEX simulation should match a loss in the physical market. The converse is true of losses made on BIFFEX. This supports the contention that BIFFEX does constitute a viable hedging medium and that freight futures returns can only improve if an alternative, more informed and more logical approach were adopted. Thus, zero returns constitute the minimum level that would be achieved by an intelligent hedger. This is especially attractive given the comparative level of returns from the physical market.

7. Certain authorities, notably Gemmill (1985), suggest that time charters cannot be effectively hedged on BIFFEX. The point above seems to mitigate against this view insofar as time charters were seemingly very successfully hedged using a 'blind' hedging policy. The benefits to be derived from using BIFFEX as a hedging medium are, as Gray (1986) points out, dependent upon the level of correlation between the freight rates of the trade for which a hedge is sought and the BFI. The apparent success achieved in hedging time charters within the simulation prompted an investigation of the correlations between the freight rates, both time and voyage, of the three sample trades and the BFI. The results are shown in Table 8.16.

   It seems clear that a BIFFEX hedging policy is indeed possible for the

Table 8.16: Correlations of Voyage and Time Charter Freight Rates with the BFI

Type of Charter	USGC-JAP 30,000 Dwt. Grain	HR-JAP 55,000 Dwt. Coal	BRZ-NWE 120,000 Dwt. Iron Ore
Voyage Charter	0.98	0.97	0.91
Time Charter	0.63	0.93	0.89

time charters of at least two of the three trades considered.

As has been seen, having deduced the time series of returns on investment for the three sample trades, it is now easily possible to combine them in portfolios to assess the returns on investment from the portfolio. However, they are also a prerequisite to the assessment of risk and it is to this problem that the next chapter will address itself.

Chapter 9

The Mensuration of Risk in Dry Bulk Shipping

One of the major explicit assumptions of Modern Portfolio Theory is that risk can be summarized by a measure of the variation of returns. In fact, as Ryan (1978p58) points out:

> "The theory of portfolio selection under conditions of risk can only be made operational by using a measurable concept of risk."

It has already been shown that, for computational reasons, Modern Portfolio Theory assumes this measure to be the variance or standard deviation of returns. The computational benefits of using either of these measures arise from the fact that the risk of a portfolio (in terms of variance or standard deviation) can be deduced directly from the risk of the individual investments that compose that portfolio. Thus, in relation to this study, knowledge of the variance and standard deviation of the three individual investments will enable the generation of risk measures for any linear combination of those three investments as represented by a portfolio.

Because of the mathematical properties of the alternative risk measures which are examined in this chapter, such benefits are not always present. Knowledge of a particular risk measure for the three individual investments may not necessarily allow the deduction of a similar risk estimate for a portfolio composed of the three individual investments. The corollary of this is that, for some measures of risk, it is necessary to assess its quantitative value for each and every possible portfolio on an individual basis. This is done by deducing the time series of expected returns that would occur given a particular portfolio combination and then observing the value of the particular risk measure. To illustrate how much work is involved in implementing this process, Table 9.1 below shows the total number of possible portfolios (composed of just three individual investments) which would occur if the holdings of each individual investment within those portfolios were constrained to 10%, 5% and 1% 'chunks' of investment.

Table 9.1: Total Number of Portfolios Under Different Holding Constraints

Percentage 'chunk' holding	Total Number of Portfolios
10%	66
5%	231
1%	5151

Obviously, where the amount of an individual investment contained in a portfolio is totally unconstrained, then the possible number of portfolios approaches infinity. Because assessments of risk measures other than variance and standard deviation have to be undertaken on the basis of individual portfolios, it is necessary to place a constraint on the 'chunk-size' of investment holdings. For the sake of simplicity, it was decided initially that holdings of individual investments within portfolios should be in blocks of 10%. The resulting 66 possible portfolios can be seen in Table 9.2.

Table 9.2: Specification of the Possible Portfolios Under a 10% Chunk-size Constraint

Portfolio Identifier	Percentage of Voyage Charters	Percentage of Time Charters	Percentage of Freight Futures
1	0	0	100
2	0	10	90
3	0	20	80
⋮	⋮	⋮	⋮
65	90	10	0
66	100	0	0

Clearly, the assessment of risk measures other than variance and standard deviation is not possible without having detailed knowledge of the time series of returns for each individual investment that may compose the portfolio. By linearly combining the three time series of returns on individual investments, a time series of returns on investment for a particular portfolio may be deduced. As a consequence, the analysis undertaken in the previous chapter is always a prerequisite to risk analysis. With these time series of returns on individual investments to hand, it is now possible to evaluate the associated risk, whatever measure may be used. As has already been stated, this is attempted initially for portfolios where the three individual investments are represented in 10% chunks.

9.1 Variance and Standard Deviation as Measures of Risk

It has been emphasized that the variance from a portfolio of investments may be deduced automatically from the variances of the individual investments that compose that portfolio. The mathematical means by which this is achieved is given by the formula:

$$\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} p_i p_j Cov_{ij}$$

In this formula:

$$Cov_{ij} = \sigma_i \sigma_j \rho_{ij}$$

Where:

Cov_{ij} = The covariance between the time series of returns on individual investment i and those of individual investment j.

σ_i = The standard deviation of the time series of returns on investment i.

σ_j = The standard deviation of the time series of returns on investment j.

ρ_{ij} = The correlation between the time series of returns on investment i and those of investment j.

Bearing in mind that *standard deviation* = $\sqrt{variance}$, the process of evaluating the risk, as measured by variance, of a particular portfolio (σ_p^2) becomes obvious. The inputs necessary in order to undertake such calculations are merely the variance of each individual investment that may be included in the portfolio, all the pairwise correlations between the time series of the different individual investments and the proportions of each individual investment included in the portfolio. This information for the three individual investments considered herein is shown in Tables 9.3 and 9.4.

Table 9.3: Variance Data of the Individual Investments

Trade	Type of Individual Investment		
	Voyage Charter	Time Charter	Freight Futures
USGC-JAP 30,000 Dwt. Grain	1047.17	133.35	71.70
HR-JAP 55,000 Dwt. Coal	2118.77	338.93	43.65
BRZ-NWE 120,000 Dwt. Iron Ore	1249.69	198.01	23.57

Table 9.4: Correlations Between the Returns from the Individual Investments

Trade	Pairs of Individual Investments		
	Voyage Charter /Time Charter	Voyage Charter /Freight Futures	Time Charter /Freight Futures
USGC-JAP 30,000 Dwt. Grain	0.905	-0.058	0.004
HR-JAP 55,000 Dwt. Coal	0.964	-0.004	-0.072
BRZ-NWE 120,000 Dwt. Iron Ore	0.896	-0.012	-0.15

The more variation there is in a time series of returns on investment, then the greater is the range of possible results. Hence, the risk is greater since there is equal potential for returns which are a long way below average as there is for returns well above average. Consequently, larger values of variance are associated with greater levels of risk. On this basis, voyage charters are the most risky of the possible individual investments and freight futures are the least risky. This is true of all three sample bulk market trades where variance is used as the measure of risk. It has been shown in the previous chapter that the expected returns from each of the three individual investments for each sample trade is as given in Table 9.5.

When looking at the expected returns together with the risk estimates of the different individual investments, it can be seen that, for the handy-

Table 9.5: The Expected Returns of the Individual Investments

Individual Investment	*Mean Return on Investment*		
	USGC-JAP 30,000 Dwt. Grain	HR-JAP 55,000 Dwt. Coal	BRZ-NWE 120,000 Dwt. Iron Ore
Voyage Charter	-8.18	27.55	18.33
Time Charter	-22.02	-17.15	-13.81
Freight Futures	-0.02	0.02	-0.01

sized market, freight futures provide the investment with the least risk and the greatest return. Logically, therefore, with variance as the measure of risk, one would expect the risk averse investor to prefer to have his money in freight futures rather than in the physical market itself. This is a sad reflection on the general state of that particular market over the last few years. In the other two sample trades, freight futures provide the median level of return for least risk while voyage charters yield the biggest expected return for the greatest risk. This fits in with the typical risk/return trade-off phenomenon expounded by authors such as Weston & Brigham (1979) and so provides support for the adoption of an approach to investment selection, such as that of Modern Portfolio Theory, where risk attitude is incorporated.

By way of illustrating the calculation of portfolio risk, the portfolio variance formula will be used to calculate the variance of a portfolio for USGC-

JAP composed totally of voyage charters. Thus;

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} p_i p_j Cov_{ij}$$

and

$$Cov_{ij} = \sigma_i \sigma_j \rho_{ij}$$

Let the subscripts 1,2,3 refer respectively to voyage charters, time charters and freight futures. Thus:

$$\begin{aligned}
Cov_{11} &= \sqrt{1047.17} \times \sqrt{1047.17} \times 1.000 &= 1047.17 \\
Cov_{12} &= \sqrt{1047.17} \times \sqrt{133.35} \times 0.905 &= 338.185 \\
Cov_{13} &= \sqrt{1047.17} \times \sqrt{71.70} \times -0.058 &= -15.893 \\
Cov_{21} &= Cov_{12} &= 338.185 \\
Cov_{22} &= \sqrt{133.35} \times \sqrt{133.35} \times 1.000 &= 133.35 \\
Cov_{23} &= \sqrt{133.35} \times \sqrt{71.70} \times 0.004 &= 0.391 \\
Cov_{31} &= Cov_{13} &= -15.893 \\
Cov_{32} &= Cov_{23} &= 0.391 \\
Cov_{33} &= \sqrt{71.70} \times \sqrt{71.70} \times 1.000 &= 71.70
\end{aligned}$$

Now:

$$
\begin{aligned}
\sigma_p^2 &= \sum_{i=1}^{3}\sum_{j=1}^{3} p_i p_j Cov_{ij} \\
\sigma_p^2 &= \sum_{i=1}^{3} p_i p_1 Cov_{i1} + p_i p_2 Cov_{i2} + p_i p_3 Cov_{i3} \\
\sigma_p^2 &= p_1 p_1 Cov_{11} + p_1 p_2 Cov_{12} + p_1 p_3 Cov_{13} + \\
&\quad p_2 p_1 Cov_{21} + p_2 p_2 Cov_{22} + p_2 p_3 Cov_{23} + \\
&\quad p_3 p_3 Cov_{31} + p_3 p_2 Cov_{32} + p_3 p_3 Cov_{33} \\
&= (1)(1)(1047.17) + (1)(0)(338.185) + (1)(0)(-15.893) + \\
&\quad (0)(1)(338.185) + (0)(0)(133.35) + (0)(0)(0.391) + \\
&\quad (0)(1)(-15.893) + (0)(0)(0.391) + (0)(0)(71.70) \\
&= 1047.17
\end{aligned}
$$

This truism, whereby the variance of a portfolio composed solely of voyage charters is equal to the variance of voyage charter returns, proves the mathematics involved in assessing portfolio variance. The mathematics is identical for any portfolio in that it is only the proportions of each individual investment that will vary while the covariances will always stay the same.

By virtue of the fact that *standard deviation* $= \sqrt{variance}$, the calculation of the standard deviation of a portfolio's returns is directly analogous to that outlined above for variance, except that the functional interrelationship between the two terms needs to be taken into account. The ordinality of the results achieved under each measure will be exactly the same. A computer program for evaluating the expected return, variance and standard deviation of a portfolio was written in **FORTRAN 77** in order to ease the burden of calculation. The only inputs required for the running of the program are the expected return, standard deviation and pairwise correlations of the three individual investments that may be included in any portfolio combination. The program also requires a further input with respect to the 'chunk-size' constraint that is required of the portfolio. Remembering that it has been assumed initially that the individual investments must be held in blocks of 10%, the program will generate portfolio expected return, variance and standard deviation for 66 possible combinations. A listing of the program can be seen in Appendix J and the results from the run based on this initial assumption can be seen in Appendix K.

It has been emphasized in Chapter 6 that Modern Portfolio Theory utilizes variance and/or standard deviation as the measure of risk because of the mathematical properties that have just been discussed. It has also been mentioned that an implicit assumption behind their use as such a measure is the fact that the returns from the possible portfolios are normally distributed. Plots of the distribution of returns for each of the individual investments for each trade can be seen in Figures 9.1-9.9.

Figure 9.1: Distribution of Returns for USGC-JAP Voyage Charter

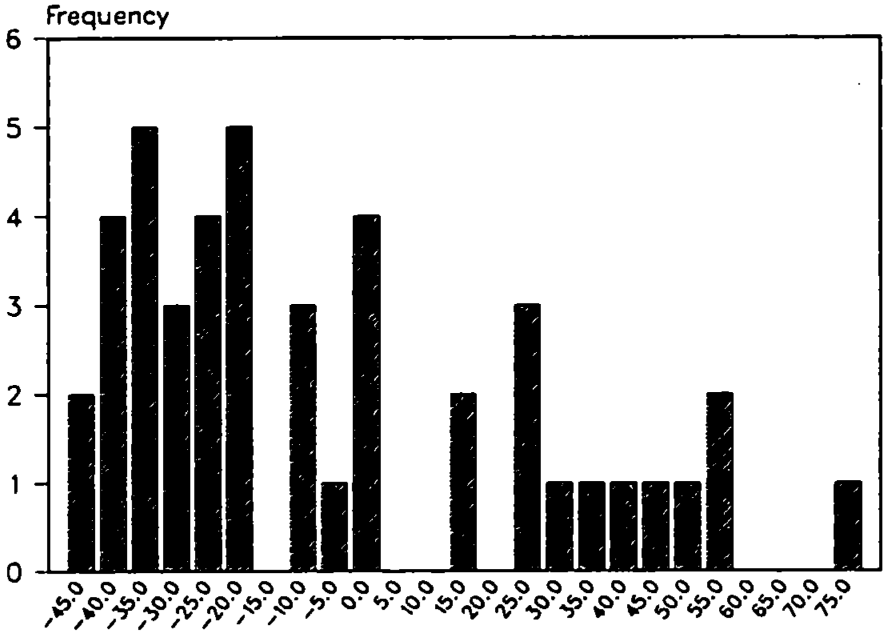


Figure 9.2: Distribution of Returns for USGC-JAP Time Charter

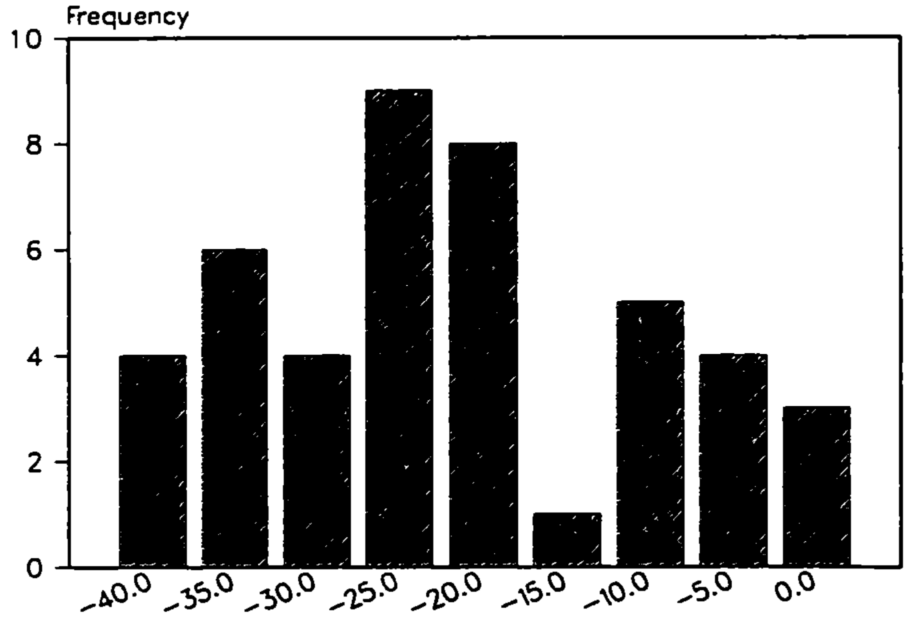


Figure 9.3: Distribution of Returns for USGC-JAP Freight Futures

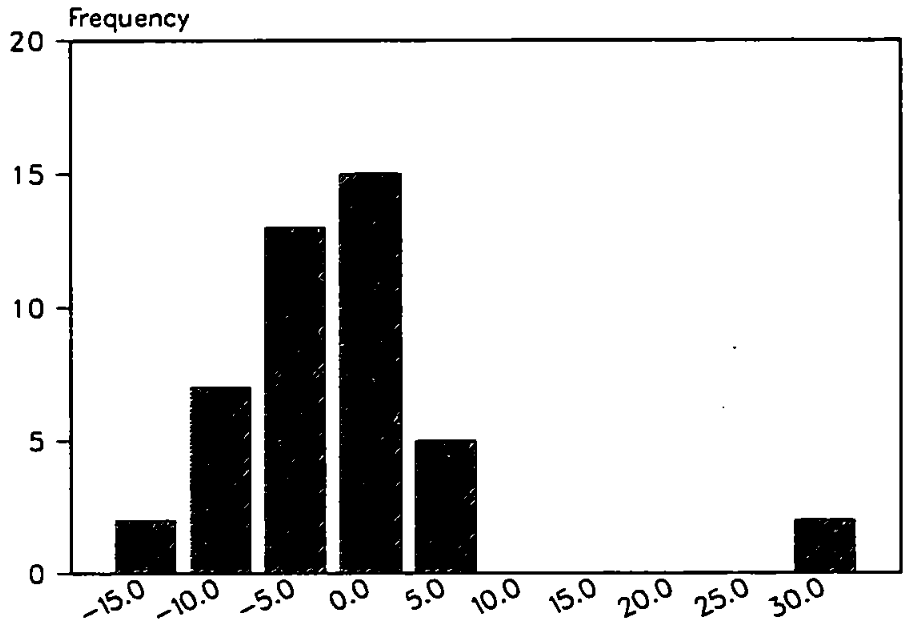


Figure 9.4: Distribution of Returns for HR-JAP Voyage Charter

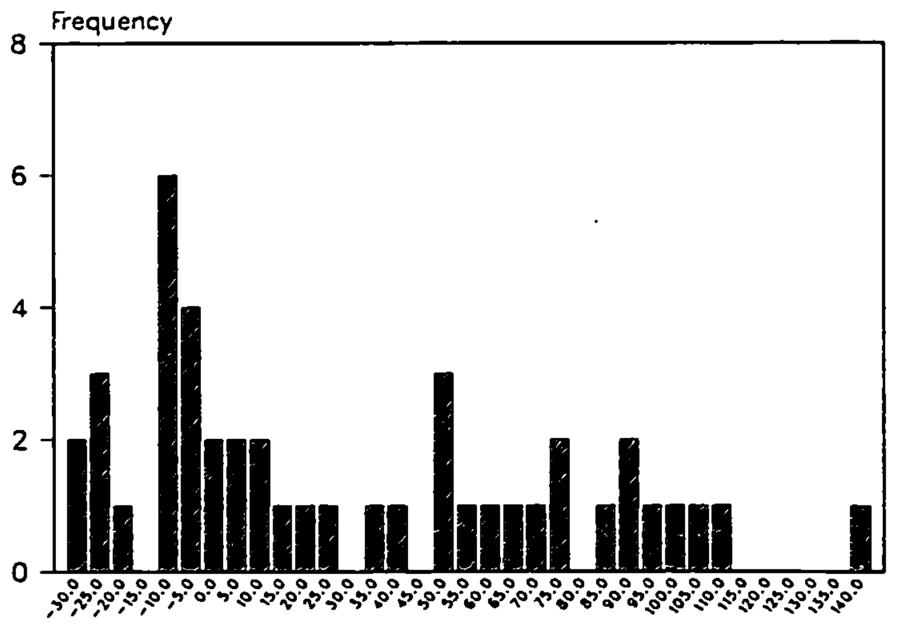


Figure 9.5: Distribution of Returns for HR-JAP Time Charter

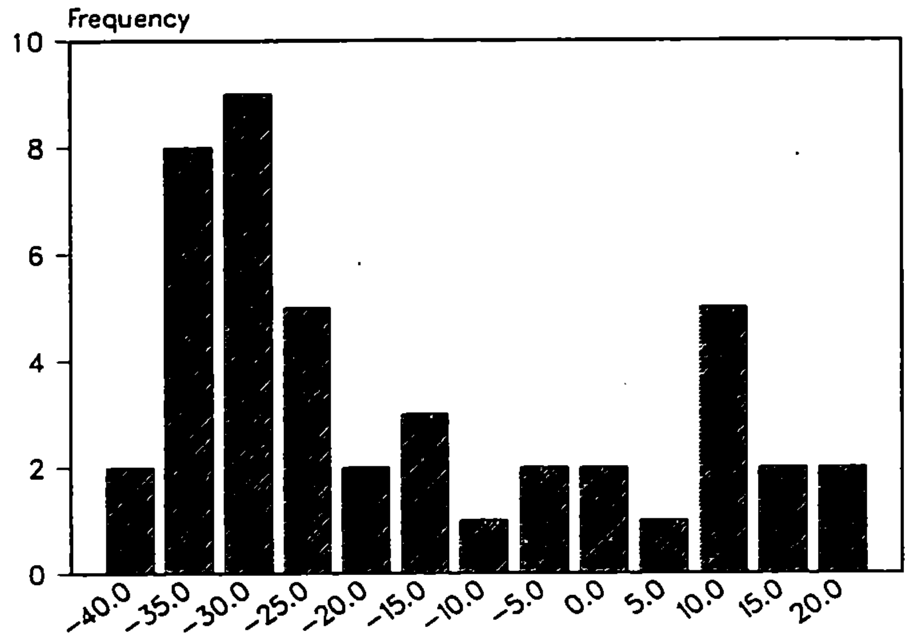


Figure 9.6: Distribution of Returns for HR-JAP Freight Futures

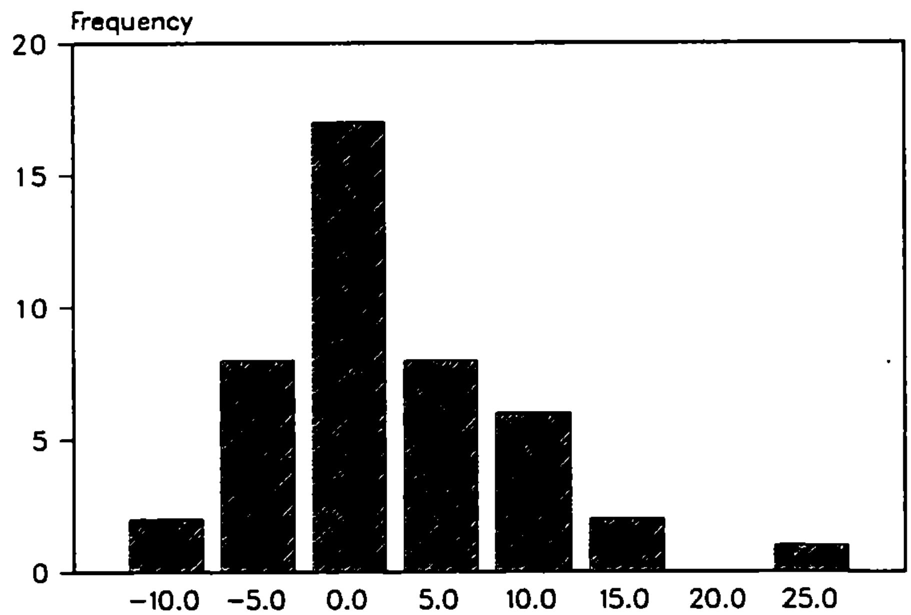


Figure 9.7: Distribution of Returns for BRZ-NWE Voyage Charter

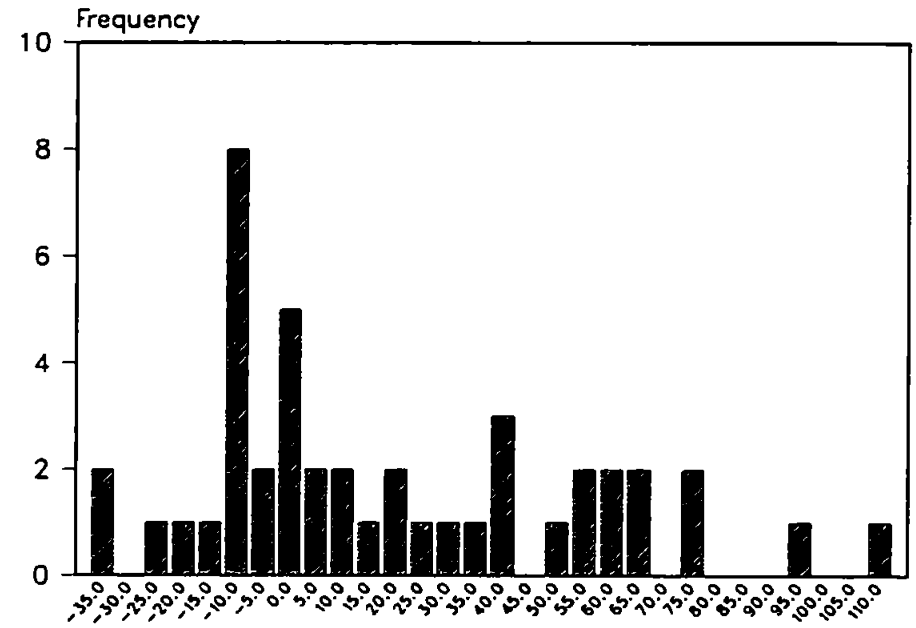


Figure 9.8: Distribution of Returns for BRZ-NWE Time Charter

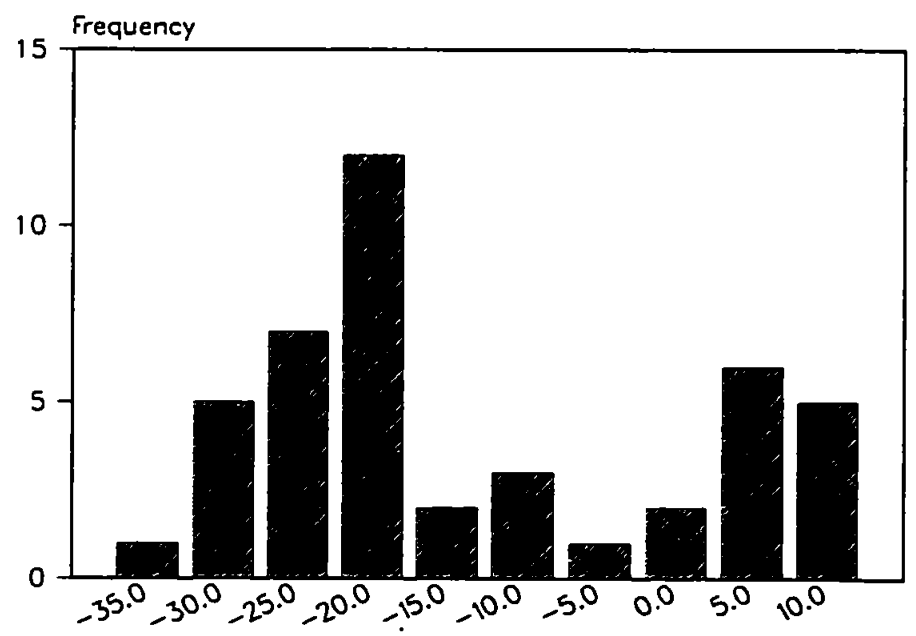
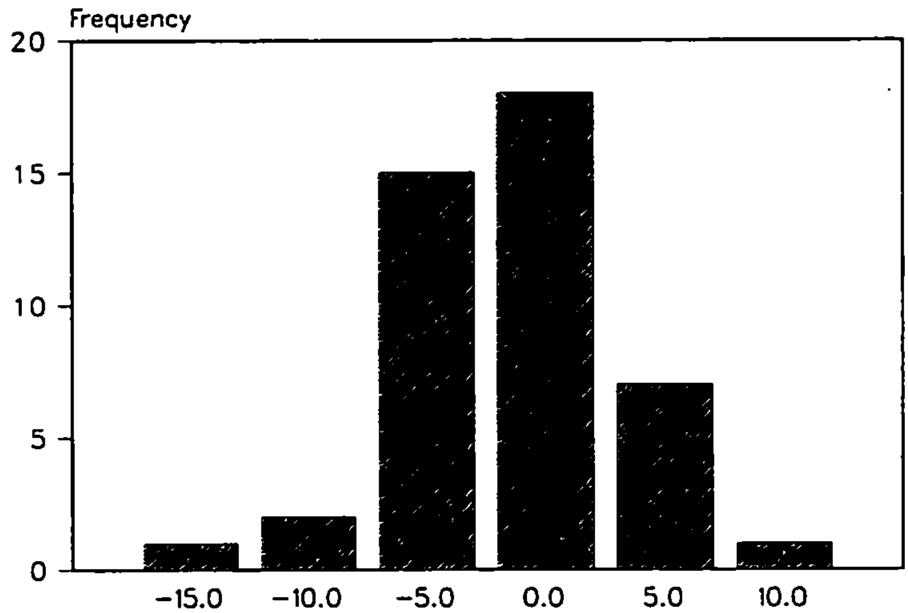


Figure 9.9: Distribution of Returns for BRZ-NWE Freight Futures



It is clear that in almost all cases, the returns from the individual investments are roughly negatively skewed. When considering portfolio combinations of these investments, therefore, it is extremely unlikely that they will be normally distributed. This brings into question the validity of using variance or standard deviation as the measure of risk. This is due to the fact that these measures do not reflect the greater probability of poor performance implied by the existence of negatively skewed distributions of returns. In effect, variance and standard deviation as measures of risk attach no differential importance whatsoever to levels of return which are below the average.

Because of the functional relationship between variance and standard deviation, Markowitz (1952) points out that it does not matter which measure is used since the final subjectively optimal portfolio as prescribed by Modern Portfolio Theory will be the same in either case. This is true only where the returns on investment being considered are normally distributed. Where they are not, as is apparently the situation in this study, the results will differ. Consequently, variance and standard deviation have been treated as two separate measures of risk for the purposes of this application of Modern Portfolio Theory. Should each measure result in differing subjectively optimal portfolios, then one may be justified in assuming that the returns on investment in dry bulk shipping are not, in fact, normally distributed. Should this prove to be the case, then the suitability of variance and standard deviation as measures of risk can only be judged in comparison to the underlying nature of the alternatives and the results that such alternatives produce.

9.2 The Interquartile Range as a Measure of Risk

The use of the interquartile range as a measure of risk constitutes an attempt to overcome the problems associated with those occasions when skewed returns are apparent. The calculation of interquartile range is undertaken as follows:

1. The time series of returns on investment is ordered from its lowest value (R_L) up to its highest value (R_H).

2. If the new ordered series has n values of return, then the first quartile (Q_1) is given by the $(n/4)^{th}$ observation in the series starting from R_L. The third quartile (Q_3) is given by the $(3n/4)^{th}$ observation.

3. The interquartile range is defined by $Q_3 - Q_1$.

The advantage of this measure of risk as compared to variance and standard deviation is that it is not mean dependent. The interquartile range gives the spread between the upper and lower limits of the middle 50% of observations irrespective of whether this range includes the mean or not. Variance and standard deviation are derived from the calculation of distances away from the mean. For this reason, in cases where the distribution of returns is non-normal, the interquartile range may be a more appropriate measure of the variation in those returns, since proportionately more weight is attached to that part of the distribution where observations are most dense.

Other measures of risk have been suggested which essentially achieve the same objective. That is, they do not rely on the assumption of the normality of the distribution of returns. Such alternatives include the semi-interquartile range which is merely half of the interquartile range and more controversially, the semi-variance which can be mathematically defined as:

$$SV = \sum_{i=1}^{n}([x_i < \bar{x}] - \bar{x})^2$$

Thus, this measure is similar to the calculation of variance except that only those observations which are below the mean for the series are taken into account. Undoubtedly, this measure of risk will lead to the choice of different subjectively optimal portfolios than would be the case if the interquartile range is used. Nevertheless, it does represent a measure of risk which is of the same family as the interquartile range. By virtue of the fact that the automating of its calculation is extremely difficult and since this study is aimed at deducing the most appropriate *type* of risk measure for inclusion in a Modern Portfolio Theory approach to the dry bulk shipping industry, it has been decided to ignore its possible use in this analysis. Should the interquartile range prove to be the most viable method of risk assessment, this would suggest that, in general, measures of dispersion for non-normal distributions are the best *type* of risk estimate and that, therefore, the actual form that such an estimate takes should be further investigated.

A major shortcoming in the use of the interquartile range as a proxy for risk lies with the practical consideration of its calculation for all possible portfolios. Unlike variance and standard deviation, the interquartile range of a portfolio cannot be calculated directly from the summary statistics of the individual investments that compose that portfolio. Consequently, for each possible portfolio, a time series of returns has to be derived in accordance with the laws governing the linear combination of the individual investments. Subsequent to this, the interquartile range has to be measured for each specific time series. For the purposes of this analysis, this was achieved by the incorporation of a 'do-loop' into a pre-programmed set of commands within MINITAB.

The results of this analysis of the interquartile range of the 66 10% 'chunk-size' portfolios for each of the three trades considered can be seen in full in Appendix L. However, a summary of the interquartile range risk estimates for the three individual investments can be seen in Table 9.6.

These results can be compared to those achieved by using variance or standard deviation as the measure of risk. Obviously, the larger the interquartile

Table 9.6: The Interquartile Ranges of the Individual Investments

Trade	Type of Individual Investment		
	Voyage Charter	Time Charter	Freight Futures
USGC-JAP 30,000 Dwt. Grain	55.47	21.22	7.280
HR-JAP 55,000 Dwt. Coal	78.28	32.01	7.565
BRZ-NWE 120,000 Dwt. Iron Ore	55.00	28.00	5.703

range, then the greater is the dispersion of returns and, therefore, the risk. Again, in all cases, voyage charters are assessed as being the most risky of the three individual investments, while freight futures are judged the least risky. One difference between the results provided by these alternative measures of risk is that under the variance and standard deviation measures, cape-size voyage charters are deemed more risky, in an absolute sense, than handy-sized voyage charters. Similarly, freight futures transactions which attempt to hedge the handy-sized market incur more risk than futures transactions hedging the Panamax market. Where the interquartile range provides the measure of risk, these results are reversed.

Because the application of Modern Portfolio Theory contained within this work bases itself on the determination of the subjectively optimal portfolio for each of the three sample trades individually, this disparity does not adversely affect the analysis. As long as the ordinality of the results are consistent with respect to the individual investment, there is no necessity to explain such phenomena. However, the result is interesting when considered in isolation. Intuitively, one might expect the investments pertaining to larger ships and, therefore, to a greater commitment of resources, to exhibit more risk. Such a supposition might lead to the conclusion that the interquartile range is a better measure of risk than either variance or standard deviation. However, the logical basis of this notion does not extrapolate exactly to the other results achieved.

9.3 Minimum Return as a Measure of Risk

All the measures of risk considered thus far have been concerned with the dispersion of returns, albeit where those returns exhibit normal or skewed distributions. It may be, however, that what most worries investors is the worst possible result that could occur irrespective of how small its probability. It is for this reason that certain authorities have advocated the minimum level of possible return as an appropriate proxy for risk.

Again, it is not possible to calculate the minimum level of return for each possible portfolio on the basis of the summary statistics of the individual investments. Consequently, a similar process to that undertaken in the calculation of the interquartile range was instigated for the determination of the minimum level of portfolio return. In the terminology used to illustrate the calculation of the interquartile range, the minimum level of return from any portfolio is given by R_L. The results of these calculations for all the 10% 'chunk-size' portfolios under each of the sample trades are shown in Appendix L, but a summary of the results for the three individual investments is shown in Table 9.7.

Table 9.7: The Minimum Return of the Individual Investments

Trade	Type of Individual Investment		
	Voyage Charter	Time Charter	Freight Futures
USGC-JAP 30,000 Dwt. Grain	-46.91	-39.19	-16.86
HR-JAP 55,000 Dwt. Coal	-30.86	-38.07	-10.51
BRZ-NWE 120,000 Dwt. Iron Ore	-37.19	-32.94	-14.02

This measure of risk assesses the absolute lowest possible level of return that might be earned from a particular investment irrespective of the probability attached to that potential outcome. Obviously, the lower the minimum rate of return, the greater the risk. This measure provides results that are consistent with those of the alternative measures insofar as freight futures again provide the investment with the lowest level of risk across all trades. The major inconsistency when comparing the results derived from this measure with those from the alternatives is that time charters for Panamax trades are assessed as being more risky than voyage charters. An analysis of cross-trade results suggest that the handy-sized market is the most risky irrespective of contractual arrangements, while the Panamax market is the least risky except when comparing time charter investments. The slight inconsistency in risk ranking across the individual investments when using this measure of risk is almost certainly attributable to the fact that certain of the minimum levels of return might have associated probabilities of occurrence which are minute. These very small probabilities of achieving very low returns could well result in the distortion of the risk assessment process by virtue of the fact that investment decision makers might regard the attainability of such returns as being virtually impossible.

9.4 A Capital Asset Pricing Model Estimate as a Measure of Risk

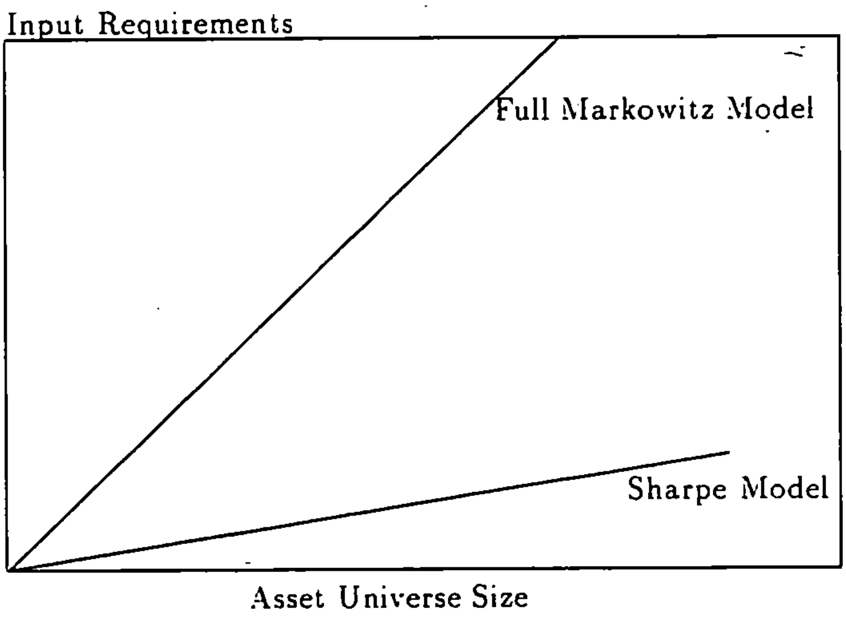
When introducing Modern Portfolio Theory in Chapter 6, it was pointed out that the vast number of calculations necessary to operationalize the theory has deterred many potential practical applications. Since the advent of improved computer technology over the last decade this is no longer the case. The methodology has grown in popularity since the hardware has been available for its successful implementation. The initial exposition of the theory, therefore, was ahead of its time. In an attempt to simplify the original Markowitz Portfolio Theory, Sharpe (1963) devised what has become known as the Capital Asset Pricing Model. This model constitutes an important adjunct to the original Modern Portfolio Theory.

Sharpe suggested that, rather than having to calculate the covariances between all pairs of individual investments/assets that comprise the universal set, the application of the fundamental tenets of Modern Portfolio Theory could be greatly facilitated if the returns from all individual investments could be compared with a single market index. For this reason, the Capital Asset Pricing Model is often referred to as a single-index model. As Rudd & Rosenberg (1979p22) point out:

> "The central theme of the development of portfolio optimization algorithms has been selective simplification of the problem and even approximations to the problem. This has been done chiefly for three reasons: ease of exposition, reduction of computational cost and simplification of use through a reduction in the complexity of inputs. A history of algorithms is thus a record of simplifications and their explanation. These simplifications have occurred in three forms. First, the problem has been simplified by deleting some of its salient features; as a leading instance of this, transaction costs have been assumed away. Second, the utility function has been simplified. Third, the realistic model of variances and covariances of security returns, allowing a 'full covariance' matrix, has been simplified to the 'diagonal' or 'single-index' model."

Because Sharpe was primarily concerned with optimizing the portfolio holdings of stocks and shares, he suggested that the S & P 500 would be a suitable market index. Basically, this is the American equivalent of the FT Index. He advocated that the covariance between each possible individual investment from the universal set and the market index be measured and used instead of the pairwise covariance necessary in the more general Modern Portfolio Theory. In effect, this means that the number of covariance calculations for n individual investments is reduced from $(n^2 - n)/2$ for the Markowitz Portfolio Theory down to just n for the Capital Asset Pricing Model. The potential savings on computational time and effort can be imputed from Figure 9.10.

Figure 9.10: The Input Requirements of the Markowitz and Sharpe Models



Source: Ryan (1978)

The Capital Asset Pricing Model can be applied to numerous areas of interest in financial economics. As Elton & Gruber (1979p3) suggest:

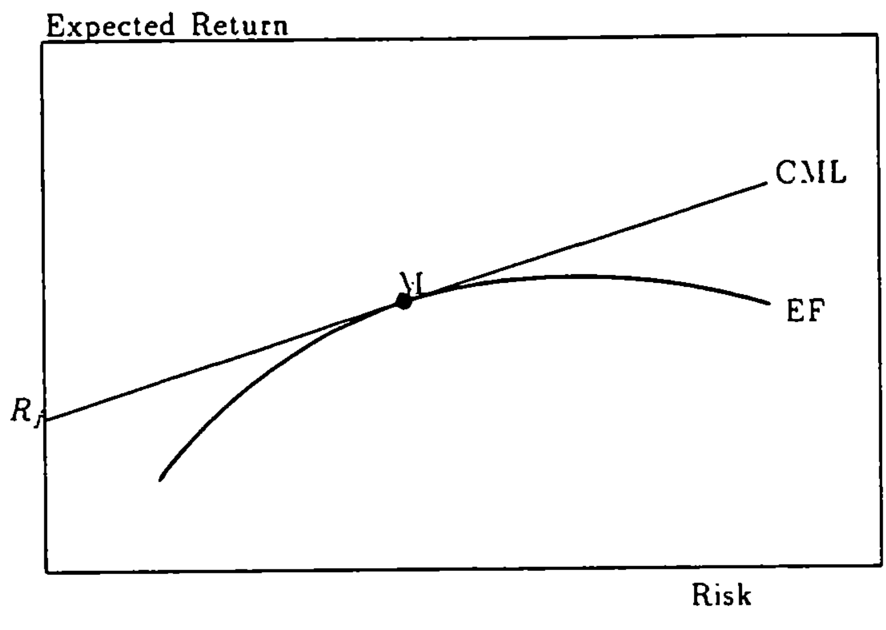
> "Capital asset pricing models are prominently discussed in most new texts, are being used by business firms in investment decisions, and are frequently discussed in regulatory proceedings."

This work concentrates on the potential application of the Capital Asset Pricing Model to risk measurement. Before proceeding to the analysis necessary to undertake such an application, it is advantageous to provide some insight into the nature of this model.

The fundamental logic upon which Sharpe based the substitution of investment/market covariance for pairwise individual investment covariance is as follows: Given that an investor is seeking to optimize his portfolio holdings, the very existence of that 'portfolio', and the decision maker's desire to find it, mitigates against the existence of specific risk within the portfolio. The only risk influence over the portfolio has to take the form of systematic risk since the specific risk is, by definition, diversified away. Systematic risk is industry and economy wide. Thus, any index which reflects the state of the economy or industry concerned will also reflect the prevalence of systematic risk. Systematic risk need not influence portfolios to the same extent as the general market, but a measurement of the covariance between the two will show the relative impact of systematic risk.

The Capital Asset Pricing Model has another feature which differentiates it from Markowitz Portfolio Theory, that being the inclusion of a new hypothetical individual investment which is risk free. That is, the covariance between it and the market index is equal to zero as is the variance of its returns. The inclusion of this new asset has the affect of introducing a new efficient frontier in the form of a straight line known as the Capital Market Line (CML). A graphical representation of the Capital Asset Pricing Model can be seen in Figure 9.11.

Figure 9.11: The Capital Asset Pricing Model



Source: McLaney (1986)

The CML represents the new risk/return trade-offs for efficient portfolios. However, the Capital Asset Pricing Model can be derived mathematically to yield a relationship between the risk and return of *individual securities* that compose the portfolios. This relationship is given by:

$$E[r_i] = r_f + (E[r_m] - r_f)\frac{Cov_{im}}{\sigma_m^2}$$

Where:

$E[r_i]$ = The expected return from an individual security or investment i.

r_f = The risk free rate.

$E[r_m]$ = The expected return from a portfolio containing every investment available in the market in proportion to their respective presence in that market.

Cov_{im} = The covariance of the returns from individual investment i with those of the market portfolio m.

σ_m^2 = The variance of the market returns.

The term $\frac{Cov_{im}}{\sigma_m^2}$ in the above equation is often referred to as β. Thus, the Capital Asset Pricing Model is often specified as:

$$E[r_i] = r_f + (E[r_m] - r_f)\beta$$

Since systematic risk, as has already been implied, embodies the way in which the expected returns from an asset or portfolio vary relative to the returns from the market portfolio, it is clear that β represents an estimate of that systematic risk. Since it is assumed that there is no specific risk inherent in a portfolio holding, then β represents the total risk of a particular portfolio. Portfolio risk, as measured by its β value can be determined, in the same way as the expected return from a portfolio, by linearly combining the β's of the individual investments that compose the portfolio in proportion to their respective holdings. Thus:

$$\beta_p = \sum_{i=1}^{n} p_i \beta_i$$

Where:

β_p = The β risk estimate of the portfolio.

β_i = The β risk estimate of an individual investment i.

p_i = The proportion of the portfolio which contains the individual investment i.

It is important to recognize that β may only provide a sensible measure of portfolio risk when the Capital Asset Pricing Model is adjudged to be appropriate for the application under consideration. Thus, the full model needs to be tested for accuracy and then, if the model is proved well-founded, exact β estimations can be made for each of the 66 10% 'chunk-size' portfolios that are currently being considered within this analysis. Should the model not be appropriate to the dry bulk market, then it cannot be assumed that the β estimate is a good proxy for risk.

In order to test the appropriateness of the Capital Asset Pricing Model, previous research has concentrated on converting the conceptual Capital Asset Pricing Model to what is known as a *market model* form. In general, these market models can take any one of three forms:

The general market model

$$R_{it} = \alpha_i + \beta_i(R_{mt}) + e_{it}$$

The risk-premium market model

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + e_{it}$$

The less-compact risk-premium market model

$$R_{it} = \alpha_i + \beta_{i1}(R_{ft}) + \beta_{i2}(R_{mt}) + e_{it}$$

Where:

R_{it} = The return from individual investment i at time t.

R_{mt} = The return implied the value of some market proxy at time t.

R_{ft} = The return from some investment that is used as a proxy for a risk free investment at time t.

e_{it} = The error or residual of the model at time t.

α_i = An estimated intercept term.

β_i = An estimated slope term.

$\beta_{i1} =$ An estimated slope term.

$\beta_{i2} =$ An estimated slope term.

The purpose of converting the theoretical Capital Asset Pricing Model to these market model forms is to permit the testing of the models using least squares linear regression techniques on historical sets of data. Whatever market model is tested, the results achieved should be directly comparable. The intercepts should be the same as should the β estimates. This means that the following should all be equal: α_i in the general market model, $\alpha_i + \overline{R_{ft}}$ in the risk-premium market model and $\alpha_i + \beta_{i1}(\overline{R_{ft}})$ in the less-compact risk-premium model.

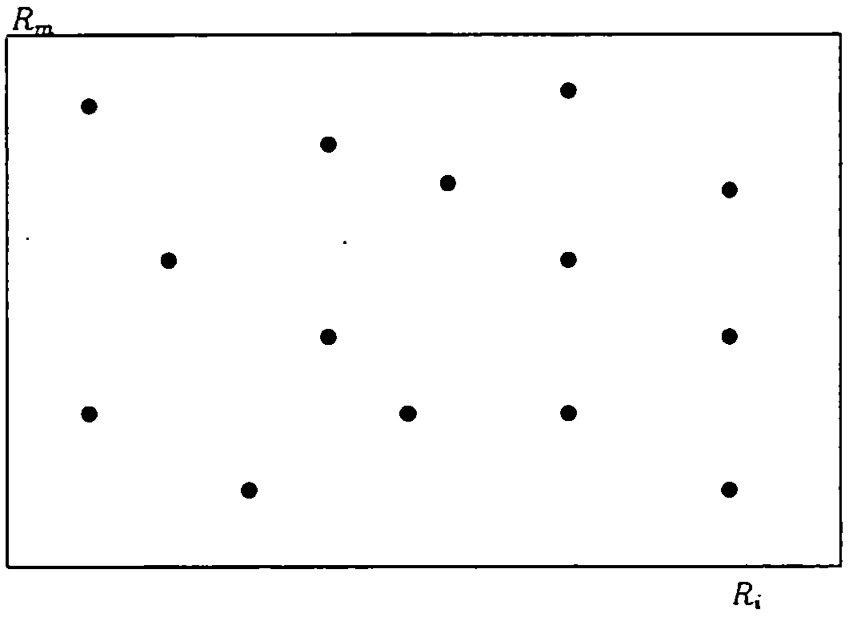
The regression analyses that have been undertaken on this basis have invariably used the U.S. 3-month treasury bill rate as a proxy for the risk free rate and the implied rate of return from a relevant market index as a proxy for the market return. Since the portfolio analysis undertaken within this work concerns only investments made under the auspices of dry bulk shipping, it was decided that the most appropriate proxy for market return would be the rate of return implied by values of the BFI. From a time series of BFI values, the implied rates of return were derived from the following formula:

$$R_{mt} = \frac{BFI_t - BFI_{t-1}}{BFI_{t-1}}$$

The justification for using BFI values as the basis of a market return proxy is derived from the fact that there is no suitable alternative shipping index which reflects solely the prosperity of the dry bulk sector. Also, as Moreby (1987) points out, this index is increasingly being used as the basis for setting prices for forward contractual commitments. This suggests that the shipping industry itself accepts the BFI as an economic indicator of the dry bulk trades. In common with other similar analyses, this study uses the U.S. 3-month treasury bill rate as the proxy for the risk free rate of return.

The underlying principle of the market model forms, and indeed, the Capital Asset Pricing Model itself, is that there is very nearly a clear linear relationship between the returns of an individual investment and the returns from the market. As a consequence, an exploratory data analysis can be undertaken, prior to testing the regression equations that are implied by the market model forms, by plotting the appropriate historical time series representing the rate of return on individual investments against an historical time series of market returns. To this end, daily BFI values were averaged over a calendar month for the 44-month period May 1985 to December 1988. These monthly averages were then converted to implied rates of return and plotted against the following time series: R_{it}, $R_{it} - R_{ft}$ and $R_{it} - \overline{R_{ft}}$. The resulting plots were nearly all random in nature as can be seen in the example given in Figure 9.12.

Figure 9.12: Example of Test Plot for Applying the Capital Asset Pricing Model



The random nature of these plots suggests that no real linear relationship exists between the market return and the returns from individual investments. This would suggest, in turn, that the Capital Asset Pricing Model can be considered inappropriate to the estimation of risk in dry bulk shipping. In order to confirm this suspicion, each of the three forms of the market model were, in fact, tested using regression analysis. The derived estimated models had very low r^2 values with the maximum being 41.2%. For each type of investment in each trade, hypothesis tests were instigated to deduce whether the estimated intercepts and β values were significantly different from the mean value of the estimates of the intercept and β produced by the three market model forms. For example, USGC-JAP voyage charter rates of return were used in three regression models dictated by the three market models. This yielded estimates of I_1,I_2,I_3,β_1, β_2 and β_3 where the subscripts relate to the three market models, the I's relate to estimated intercepts and the β's to estimated values of β. They were then subjected to the following hypothesis tests:

$$H_o: \quad I_i = \frac{I_1+I_2+I_3}{3} \qquad i = 1,2,3$$

$$H_o: \quad \beta_i = \frac{\beta_1+\beta_2+\beta_3}{3} \qquad i = 1,2,3$$

At a 95% significance level, in each of the resulting 18 sets of such hypothesis tests at least one (and on 10 occasions two) of the estimated values were significantly different from the mean value for all model forms.

This constitutes overwhelming evidence that the three market model forms do not yield consistent results. It is possible to conclude from this feature that the Capital Asset Pricing Model, at least in these straightforward market model forms, does not provide an appropriate mechanism for the determination of risk, as measured by β, for the dry bulk shipping industry. This conclusion conforms with the view of Harrington (1983p53) with respect to its more general application:

> "Substantial evidence exists that something is basically wrong with the simple form of the Capital Asset Pricing Model. No one piece of research is sufficiently strong to allow us to reject the model outright, but we should at least be skeptical of the model at this point."

It may be that some more complicated version of the market model, perhaps after a log-linear transformation, might provide useful risk estimates. However, this constitutes a potentially massive area of research in its own right, which although interesting and possibly profitable, is beyond the scope of this work.

Having deduced that there is no useful application of the Capital Asset Pricing Model to the determination of risk estimates in the dry bulk shipping market, it now remains to speculate on the possible reasons why this should be the case. There exist several potential justifications:

1. Regression analysis assumes that the variables within the regression are normally distributed. Bawa & Chakrin (1979p47) make the following point with respect to the Capital Asset Pricing Model:

> "It has been well known for some time that the approach is of limited generality since it is the optimal selection rule only if investors have quadratic utility functions or investment returns are normally distributed. Arrow (1971) and Hicks (1962) have pointed out that the assumption of quadratic utility is highly implausible in that it implies increasing absolute risk aversion. Also, the assumption of normally distributed investment returns carries with it the unrealistic implication of unlimited liability and rules out asymmetry or skewness in the probability distribution of returns."

It has already been shown that normal distributions do not accrue from the time series of the rates of return on the individual investments used in this study. This factor suggests that some transformation of the data may lead to a more appropriate market model which might facilitate the application of the Capital Asset Pricing Model to dry bulk shipping. The vital importance of the shape of the distribution of returns is supported by the evidence of Cooley, Roenfeldt & Modani (1977) who, using Cluster Analysis, compared the similarity of information provided by different measures of risk. They found that measures of kurtosis and skewness provided information that was distinct from that of all other measures tested. This points to the fact that non-normal returns may have an overwhelming influence on risk and its perception. Arditti (1967) and Kraus & Litzenberger (1976), working independently, have drawn the same conclusions from their analyses based on different methodologies.

2. A further assumption of regression analysis is that observations on a particular variable should be independent in a statistical sense. King (1966) found that this was very rarely true when dealing with real data. One may conclude from this that the Capital Asset Pricing Model may well be inappropriate to the explanation of the relationship between risk and return since it is implicitly dependent on estimations based on regression analysis. Cullinane (1989), by applying the Box & Jenkins (1970) approach to time series analysis, has found evidence that the BFI, used within this study as a proxy for the market portfolio, does not exhibit independent observations. In fact, the nature of the interrelationship between successive values of the BFI was determined to be:

$$BFI_t = 1.556BFI_{t-1} - 0.556BFI_{t-2} + 0.189(BFI_{t-3} - BFI_{t-4})$$

3. The BFI might not be a very realistic proxy for market return. Since the BFI includes only voyage charters in its composition, it might not reflect the true state of dry bulk shipping which must be effected by

the returns derived from time charters.

4. The final and perhaps, most convincing, reason why the Capital Asset Pricing Model has proved inappropriate in explaining the relationship between risk and return as it exists within this study, is due to the fact that one of the individual investments that may be included in a portfolio relates to futures contracts. There is a large body of evidence, for example Williams (1986) and Stein (1986), which suggests that the underlying assumptions of the Capital Asset Pricing Model are inappropriate to portfolios which include futures markets.

   The major criticism which arises with respect to this area, is the fact that estimates of market return are invariably based on the preconception that a declining market index results in negative returns and vice versa. In futures markets, however, positive returns can accrue from negative index or price movements. This implies that futures market *returns* are not present in the market portfolio as represented by the BFI, even though this index underpins the actual freight futures market. Obviously, this is due to the fact that in futures markets, unlike ordinary share markets, contracts can be sold previous to being purchased. Although this aspect does not nullify the validity of the Capital Asset Pricing Model itself, it does serve to invalidate the simplified tests of the model that are undertaken.

Dusak (1973) has found that the correlation between the U.S. futures markets and U.S. share prices is very close to zero. In itself, this finding suggests that returns from futures should be included in the market portfolio. However, Black (1976) points out that this is not possible since the aggregate position in futures is always zero. Additionally, Bodie & Rosansky (1980) have found that by including futures contracts in portfolios, it is possible to reduce the standard deviation of the returns from those portfolios by between 13% and 19% without any reduction in the expected return. Here lies a major incongruity of the Capital Asset Pricing Model since as Taylor (1986p202) points out:

> "Risk measurement is now difficult as zero covariance and a positive risk premium are contradictory in the usual asset pricing framework."

In other words, this breaches a rigid assumption of the Capital Asset Pricing Model in that it is only the risk free rate which has zero covariance, but has an associated zero risk premium.

Having now assessed and quantified various risk measures for the possible investment portfolios analysed within this work, the ensuing chapter attempts to integrate both risk and return measures to derive 'efficient' portfolios from which the optimum will be chosen. The following chapter, therefore, serves to knit together the various aspects of the analysis and to arrive at a point where some conclusions may be drawn.

Chapter 10

Selecting the Optimum Portfolio

Thus far, this study has concerned itself with the collection, modelling and analysis of the data required as inputs to the Modern Portfolio Theory methodology. This chapter seeks to apply the model inherent in that theory as first developed by Markowitz (1952). The first stage in operationalizing the model involves the determination of the efficient frontiers for each type of risk attitude. It should be reiterated at this stage that the definition of 'efficient' as used within this study is much more wide-ranging than that originally used by Markowitz (1952). That original study assumed that an 'efficient' frontier existed only for the risk averse investor. This analysis redefines the term to include the possibility of an 'efficient' frontier for a risk prone investor. Consequently, whether or not a frontier is deemed efficient depends upon the risk attitude that is being applied to it. It should be borne in mind that the three possible risk attitudes are:

Risk Aversion where the investor is willing to sacrifice some expected return in order to reduce his risk.

Risk Proneness where the investor is willing to sacrifice some expected return in order to increase his risk.

Risk Neutrality where the investor does not care about the risk influence and so will merely select the option which provides the highest expected return.

As was seen in Chapter 6 and in the analysis that followed, it is necessary that each portfolio considered can be totally and uniquely described by its expected return and its risk. This has now been achieved for all possible portfolios which are governed by the constraint that each holding of individual investments within the portfolio should be in multiples of 10%. As a consequence, at this stage, the analysis is based on the consideration for investment selection of 66 possible portfolios within each trade.

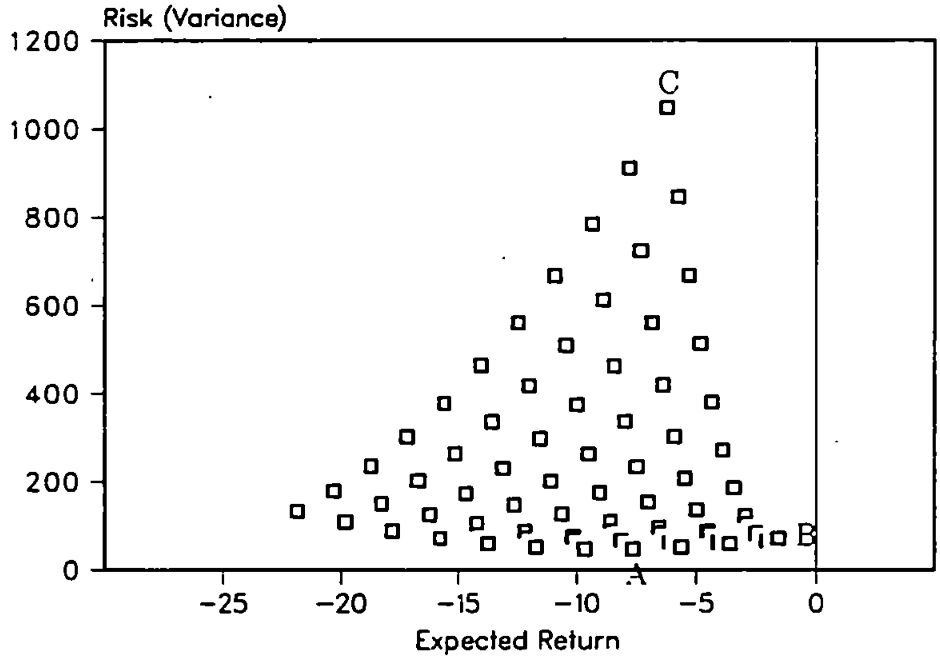
10.1 The Determination of the Efficient Frontiers

Because each possible portfolio within each trade can be uniquely described by its level of expected return and level of risk, it is now possible to plot these portfolios in two-dimensional risk/return space. These plots will form the basis of a graphical determination of the portfolios that lie on efficient frontiers. Remembering that four measures of risk have been employed in the analysis, then for each of the three trades there exist four plots of expected return against risk (as measured by; variance, standard deviation, interquartile range and minimum level of return).

10.1.1 USGC-JAP, 30,000 Dwt., Grain

Variance as the Measure of Risk

Figure 10.1: USGC-JAP: Scattergram of Variance Against Expected Return



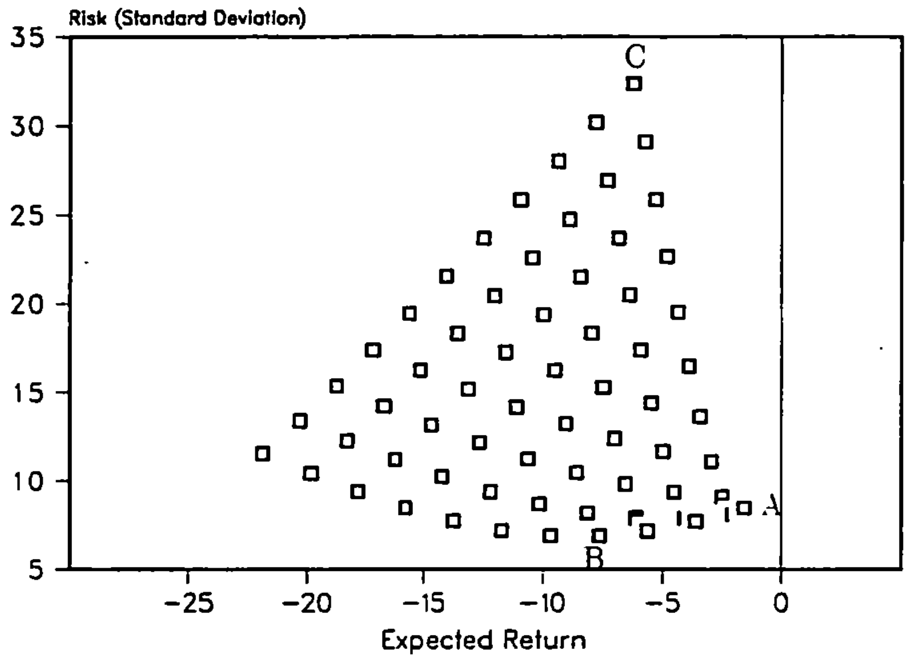
It can be seen in Figure 10.1 that the efficient portfolios for a risk averse investor lie on the edge of the scattergram between portfolio A and portfolio B. In this case, they lie between the portfolio yielding minimum risk and the portfolio yielding maximum expected return. To the risk averse investor, all portfolios along this edge are more efficient than all other alternatives since none of the others yield less risk for the same level of expected return or more expected return for the same level of risk.

The efficient portfolios for a risk prone investor lie on the edge of the scattergram between portfolio A and portfolio C. That is, between the portfolio yielding maximum expected return and the portfolio yielding maximum risk. No other portfolios provide more risk for the same level of expected return. Such an investor is "*logical*" to the extent that he prefers a greater expected return to less given the same level of risk and it can be seen that no portfolios provide greater expected return for the same level of risk than those on the efficient frontier.

The risk neutral investor will obviously select portfolio A since this is the portfolio which provides maximum expected return. Implicitly, therefore, it is preferable to ignore the decisions made by risk neutral investors when an assumption of this analysis is that investment holdings are in multiples of 10%. At a later stage, the analysis will look at portfolios composed of individual investments which are held in multiples of 1%. This will provide much more accurate and, therefore, realistic investment decisions. The risk neutral investor will not change his decision criteria and will still select the portfolio yielding maximum expected return. Consequently, this analysis reserves its conclusion as to the portfolio chosen by a risk neutral investor until that later stage has been reached.

Standard Deviation as the Measure of Risk

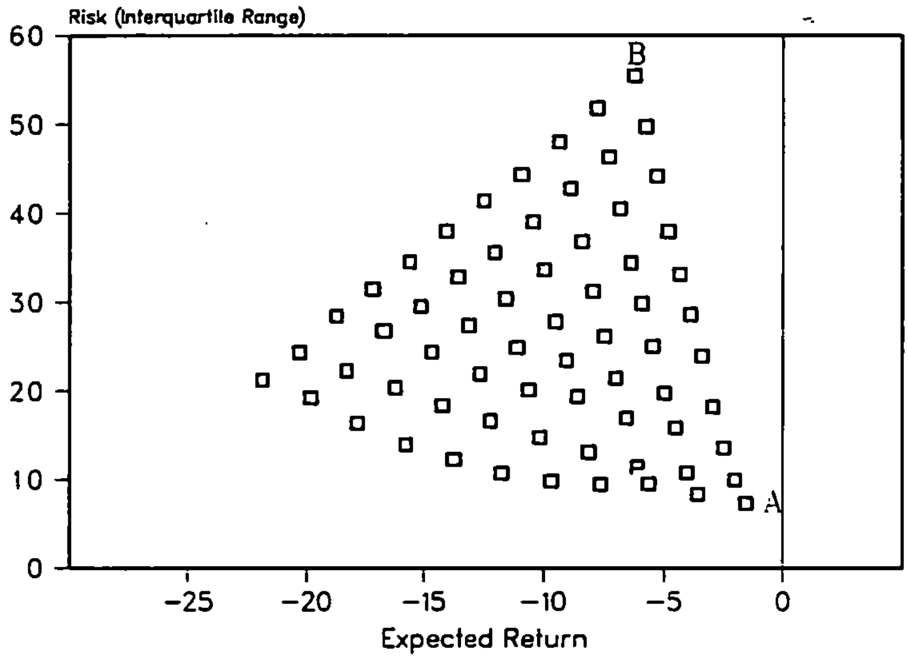
Figure 10.2: USGC-JAP: Scattergram of Standard Deviation Against Expected Return



As expected, by virtue of the fact that *standard deviation* $= \sqrt{variance}$, this risk/return scattergram is very similar to that derived when variance is the measure of risk. Consequently, the portfolios lying on the efficient edge are analogous. A risk averse investor, for the same reasons outlined above, will select a portfolio between portfolio A and portfolio B. Similarly, a risk prone investor will invest on the edge of the scattergram lying between portfolio A and portfolio C.

Interquartile Range as the Measure of Risk

Figure 10.3: USGC-JAP: Scattergram of Interquartile Range Against Expected Return

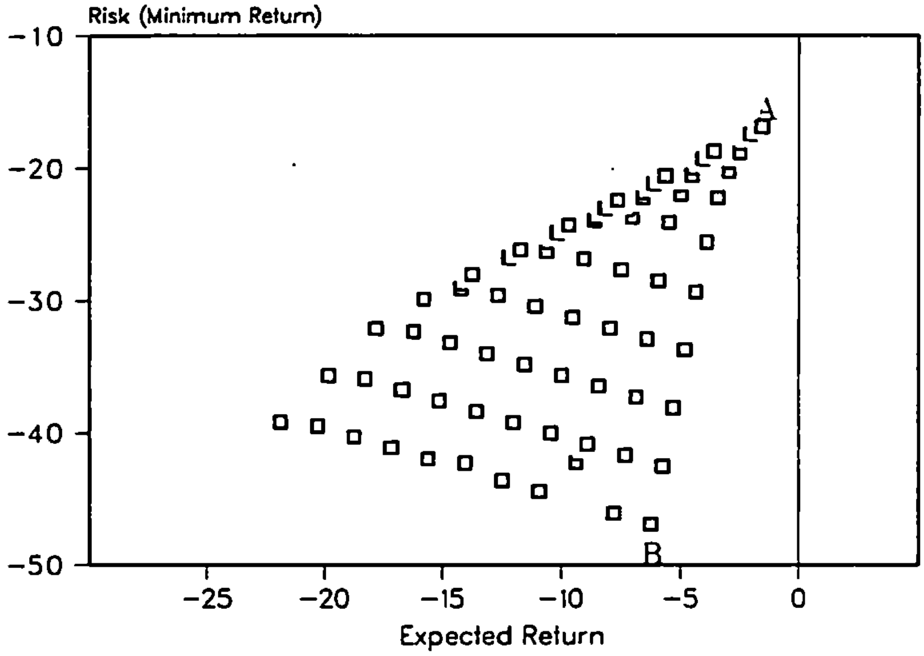


From Figure 10.3, it is clear that the use of the interquartile range as the measure of risk results in a different pattern of plots than the two previous measures discussed. In this case, there is no efficient frontier for the risk averse investor. This is due to the fact that portfolio A provides the portfolio with the greatest expected return *and* the least risk. There is no need for a risk averse investor to select between portfolios since portfolio A uniquely satisfies all his criteria for investment. There are no other portfolios which yield a higher expected return for the same level of risk *or* less risk for the same level of expected return. Where holdings of individual investments within portfolios are constrained to 10% multiples, portfolio A constitutes the optimum for a risk averse investor.

Efficient portfolios for a risk prone investor lie on the edge of the scattergram falling between portfolio A and portfolio B. That is, between the portfolio yielding maximum expected return and the portfolio yielding maximum risk.

Minimum Return as the Measure of Risk

Figure 10.4: USGC-JAP: Scattergram of Minimum Return Against Expected Return



Yet another pattern of plots in risk/return space is achieved by using the minimum level of return as a proxy for risk. The minimum level of return is different from the other measures of risk with respect to the fact that the smaller this minimum level of return, then the greater the risk. Since all the minimum levels of return measured for the purposes of this study are less than zero, then the greater the absolute value of the negative minimum level of return, the greater the risk. This aspect must be borne in mind when inspecting plots of minimum level of return against expected return. It implies that there needs to be a slight shift in perspective when interpreting the plots. This new perspective becomes intuitively obvious when analysing Figure 10.4.

A risk averse investor will automatically choose to invest in portfolio A. This constitutes the only efficient portfolio in that there are no other portfolios that provide greater expected return for the same level of risk or less risk for the same level of expected return. Consequently, there exists no frontier as such, from which the risk averse investor must select a particular portfolio.

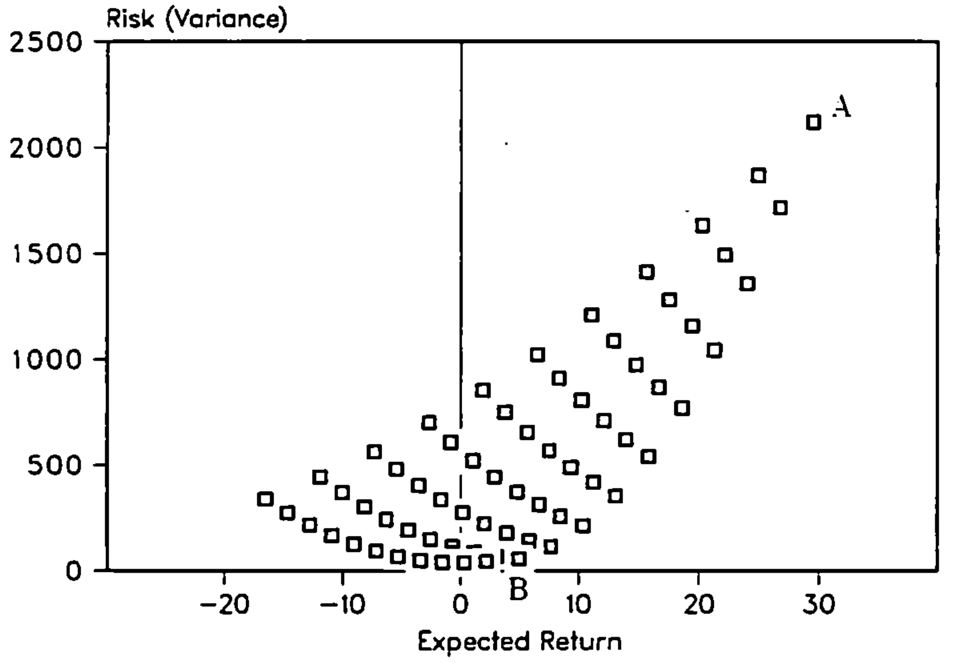
A risk prone investor has an efficient frontier which lies between portfolio A and portfolio B. Again, these are the portfolios which yield maximum expected return and maximum risk. There are no portfolios which yield a higher expected return for the same level of risk or more risk for the same level of expected return than those that lie on the edge of the scattergram between these two points.

10.1.2 HR-JAP, 55,000 Dwt., Coal

The analysis of the risk/return plots for the other two trades is analogous to that undertaken for the USGC-JAP trade. In an effort to avoid repetition of the explanations and arguments presented above, comments made with respect to the nature of the plots will be more succinct from this point on.

Variance as the Measure of Risk

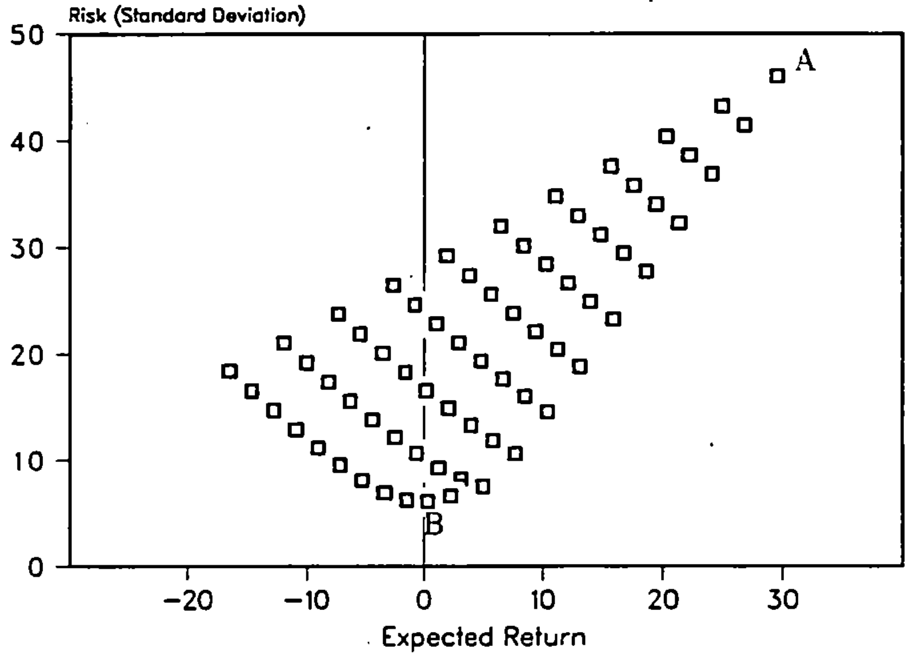
Figure 10.5: HR-JAP: Scattergram of Variance Against Expected Return



Risk averse investors will select portfolios which lie between portfolio A and portfolio B. Portfolios lying on this edge are deemed efficient. Risk prone investors will automatically select portfolio A since it provides maximum expected return and maximum risk.

Standard Deviation as the Measure of Risk

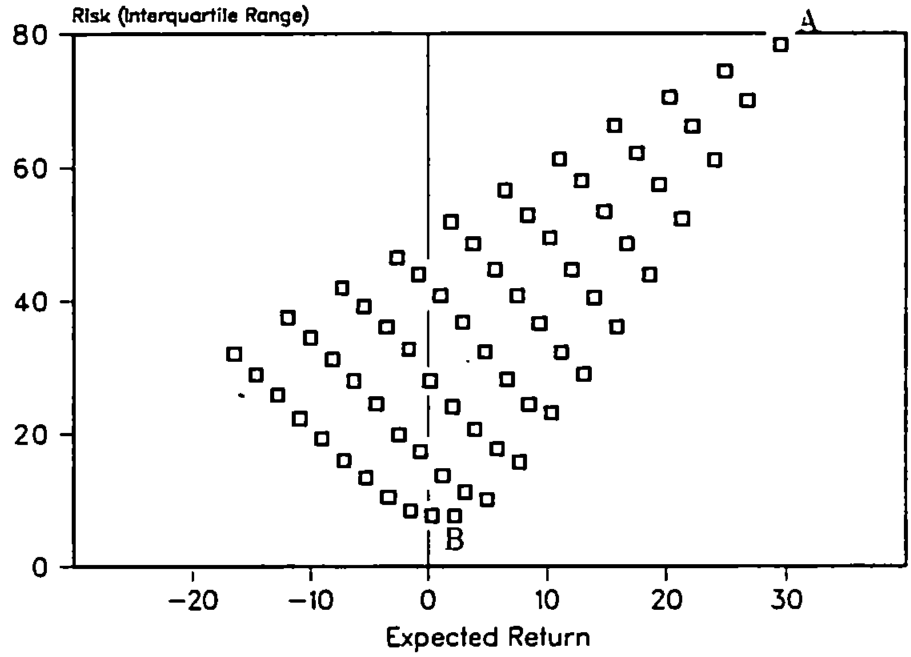
Figure 10.6: HR-JAP: Scattergram of Standard Deviation Against Expected Return



Again, this plot in risk/return space is similar to that where variance is the measure of risk. A risk averse investor has an efficient frontier which lies between portfolio A and portfolio B. Risk prone investors will automatically select portfolio A since it yields maximum expected return and maximum risk.

Interquartile Range as the Measure of Risk

Figure 10.7: HR-JAP: Scattergram of Interquartile Range Against Expected Return

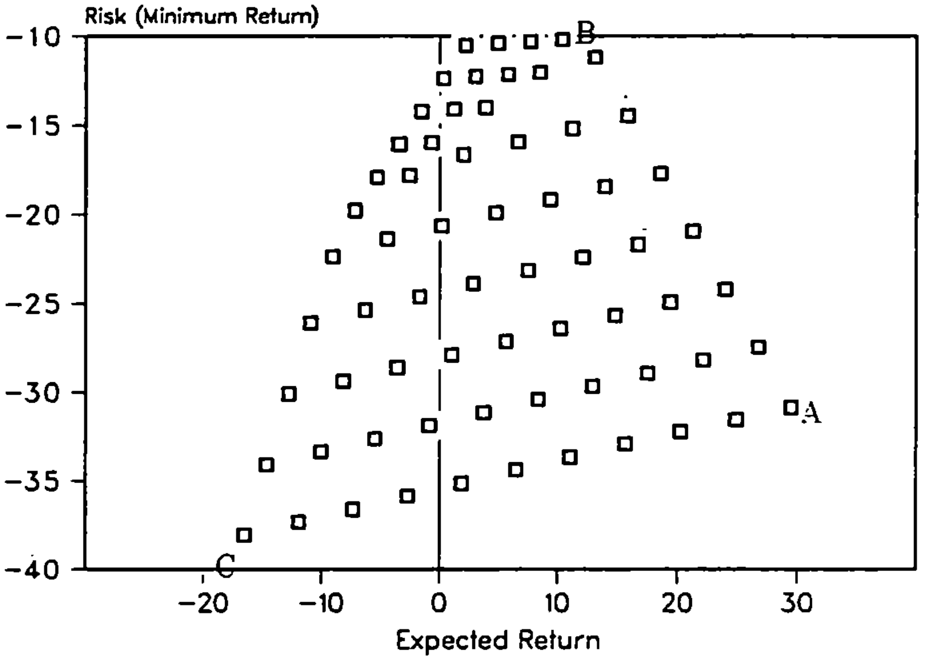


The efficient frontier for a risk averse investor lies along the edge between portfolio A and portfolio B. A risk prone investor has no efficient frontier since portfolio A fulfils all his portfolio selection criteria. That is, this is the single portfolio which provides maximum expected return for maximum risk.

Minimum Return as the Measure of Risk

Adopting a slightly different perspective on Figure 10.8 than that adopted for the three previous plots, a risk averse investor will select a portfolio which lies on the edge of the scattergram between portfolio A and portfolio B. The efficient frontier for a risk prone investor is defined as the edge of the scatter

Figure 10.8: HR-JAP: Scattergram of Minimum Return Against Expected Return



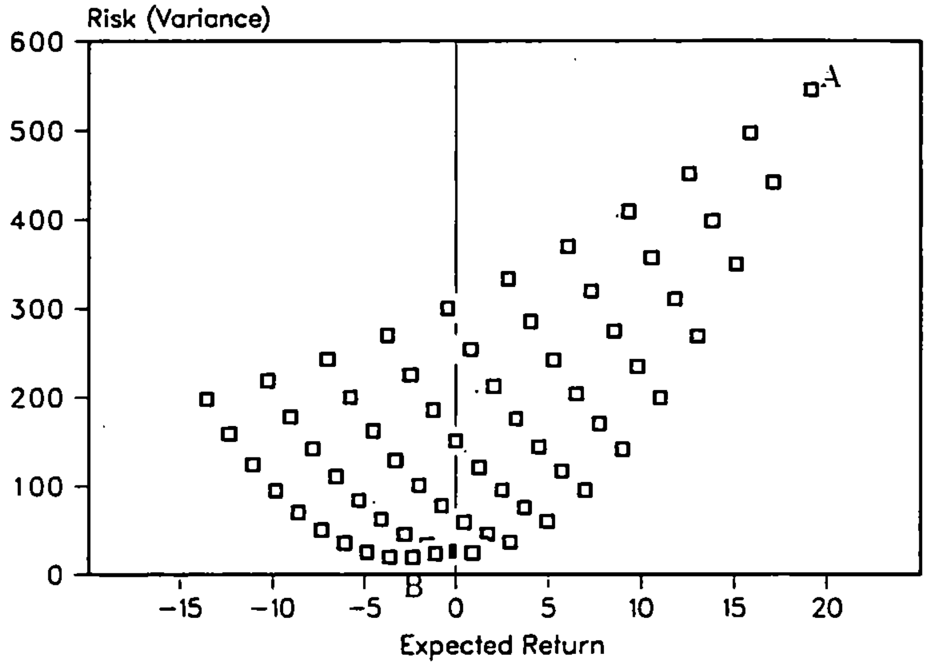
lying between portfolio A and portfolio C.

10.1.3 BRZ-NWE, 120,000 Dwt., Iron Ore

Variance as the Measure of Risk

The efficient frontier for a risk averse investor lies between the portfolio yielding minimum risk and the portfolio yielding maximum expected return. That is, between portfolio A and portfolio B. The risk prone investor chooses portfolio A because it has the greatest expected return for the greatest risk.

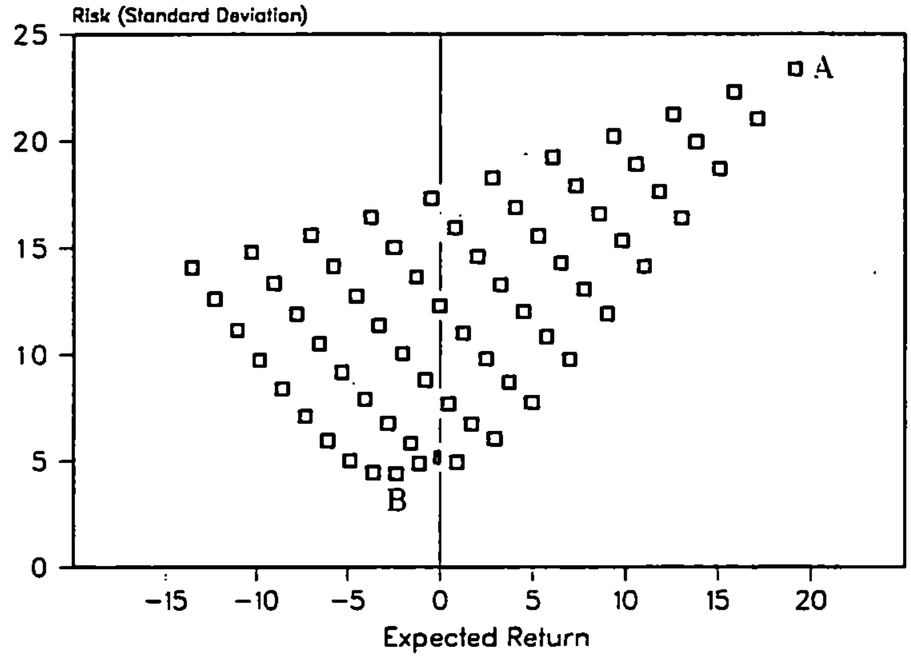
Figure 10.9: BRZ-NWE: Scattergram of Variance Against Expected Return



Standard Deviation as the Measure of Risk

Figure 10.10 is again similar to that achieved when variance is the measure of risk. Consequently, the conclusions drawn *vis a vis* efficient frontiers are similar. The risk averse investor will choose a portfolio which lies on the edge of the scatter between portfolio A and portfolio B, while the risk prone investor automatically selects portfolio A because it provides both maximum risk and maximum expected return.

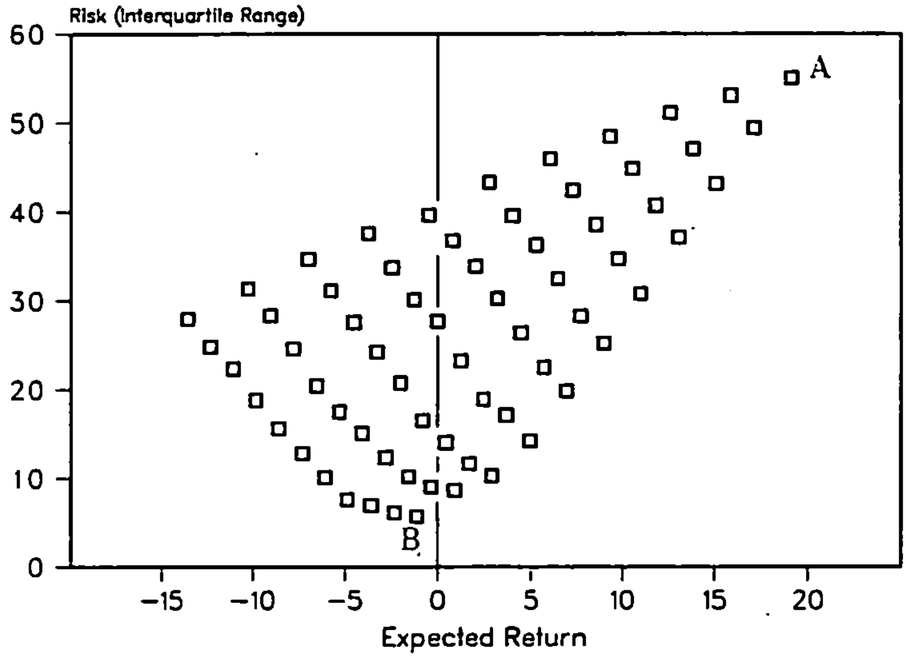
Figure 10.10: BRZ-NWE: Scattergram of Standard Deviation Against Expected Return



Interquartile Range as the Measure of Risk

The efficient frontier for a risk averse investor lies between portfolio A and portfolio B. For a risk prone investor, the set of efficient portfolios contains only the single portfolio A since this portfolio contemporaneously provides maximum risk and maximum expected return.

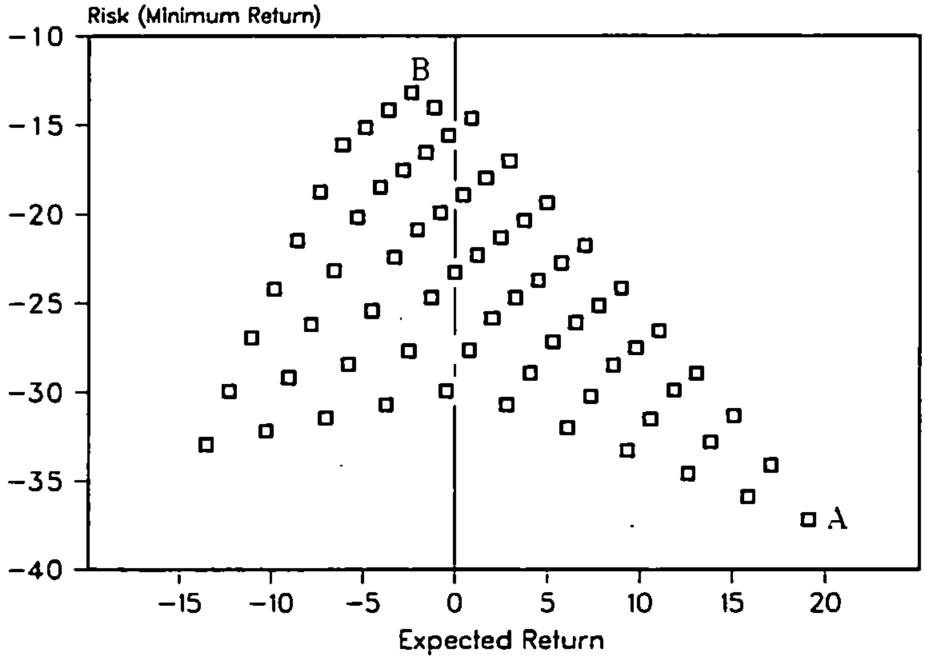
Figure 10.11: BRZ-NWE: Scattergram of Interquartile Range Against Expected Return



Minimum Return as the Measure of Risk

As is seen from Figure 10.12, an unusual plot is achieved for minimum return as the level of risk. However, it is just as simple to interpret if one bears in mind the standard rules which govern the risk preferences of investors. Risk averse investors prefer a greater expected return for the same level of risk and less risk for the same level of expected return. Remembering also that the lower the level of minimum return, then the greater the risk, one can deduce that the efficient set of portfolios for a risk averse investor lies between portfolio A and portfolio B. The risk prone investor prefers greater expected return for the same level of risk and greater risk for the same level of expected return. Consequently, such an investor merely selects portfolio

Figure 10.12: BRZ-NWE: Scattergram of Minimum Return Against Expected Return



A since this provides maximum return and maximum risk. This portfolio constitutes a risk prone investor's sole efficient portfolio.

10.1.4 Comment on the Graphical Analysis of the Efficient Frontiers

The circumstances where it is necessary to deduce an efficient set of portfolios (i.e. those containing more than one portfolio) is clear from the analysis that has just been undertaken. Where there is no necessity for deducing an efficient set, it is a relatively simple task to identify the single optimum portfolio that a particular investor will automatically select.

Under conditions where automatic portfolio selection has been the case, the risk neutral investor will always select the portfolio that yields maximum expected return, the risk prone investor will always select the portfolio which yields maximum expected return because it is the portfolio with the maximum risk, and the risk averse investor will also always select the portfolio with maximum expected return since this will be the portfolio with minimum risk. As a consequence of these characteristics, it becomes a relatively simple task, for *all* types of investors, to select, from the database of all possible portfolios, the portfolio which yields the maximum expected return.

Tables 10.1-10.3 summarize, on a per trade basis, the results of the previous graphical analysis. The tables highlight those circumstances where it is necessary to determine an efficient set of portfolios before the analysis progresses any further.

Table 10.1: USGC-JAP: Summary of Results Achieved from Graphical Analysis of Portfolios in Two-Dimensional Risk/Return Space

Measure of risk	Risk Attitude	Need to Find Efficient Set
Variance	Averse	Yes
	Neutral	No
	Prone	Yes
Standard Deviation	Averse	Yes
	Neutral	No
	Prone	Yes
Interquartile Range	Averse	No
	Neutral	No
	Prone	Yes
Minimum Return	Averse	No
	Neutral	No
	Prone	Yes

Table 10.2: HR-JAP: Summary of Results Achieved from Graphical Analysis of Portfolios in Two-Dimensional Risk/Return Space

Measure of risk	Risk Attitude	Need to Find Efficient Set
Variance	Averse	Yes
	Neutral	No
	Prone	No
Standard Deviation	Averse	Yes
	Neutral	No
	Prone	No
Interquartile Range	Averse	Yes
	Neutral	No
	Prone	No
Minimum Return	Averse	Yes
	Neutral	No
	Prone	No

Table 10.3: BRZ-NWE: Summary of Results Achieved from Graphical Analysis of Portfolios in Two-Dimensional Risk/Return Space

Measure of risk	Risk Attitude	Need to Find Efficient Set
Variance	Averse	Yes
	Neutral	No
	Prone	No
Standard Deviation	Averse	Yes
	Neutral	No
	Prone	No
Interquartile Range	Averse	Yes
	Neutral	No
	Prone	No
Minimum Return	Averse	Yes
	Neutral	No
	Prone	No

10.1.5 The Derivation of Approximations to the Efficient Frontiers

Given that a particular investor can select a portfolio from an efficient set of possible portfolios, the actual choice is made on the basis of his risk attitude. This is encapsulated in his utility function as derived in Chapter 5 for risk averse and risk prone investors. In order that utility functions, in their mathematical form, can be applied to sets of efficient portfolios, it is necessary to derive a mathematical definition of the portfolios that are included in an efficient set. Consequently, the curve that delineates an efficient frontier needs to be mathematically modelled.

Because at this stage of the analysis only 66 portfolios are being considered, it is a relatively simple task to deduce, via the scrutinization of the risk/return graphs, which of the 66 portfolios lie on an efficient frontier. These then comprise what has been referred to as the efficient set. Each portfolio within this efficient set is uniquely characterized by its level of expected return and level of risk (whatever measure is used for this purpose). Similarly, each portfolio within the efficient set can be uniquely identified by its percentage mix (in multiples of 10% at this stage) of the different individual investments.

The process of mathematically modelling each efficient frontier is based on finding a relationship between the risk of the portfolios included in the efficient set and their expected return. Since utility is expressed as a function of expected return, it is necessary to mathematically define risk also as a function of expected return. This is achieved by the application of linear regression analysis. This procedure is data driven and is based on a least squares methodology. The input data for the regression analysis will be the $(return, risk)$ coordinates of the portfolios that are included in the efficient set. The output from the analysis will take the general form:

$$y = f(x)$$

Where:

$x =$ return.

$y =$ risk.

Given that an efficient set of portfolios contains n portfolios that lie on the efficient edge of a risk/return scattergram, then each of them will be defined by unique $(return, risk)$ coordinates. There are thus n distinct values of *return* or x and n distinct values of *risk* or y which constitute the inputs to the regression analysis. The fact that the values are distinct arises directly from the fact that the portfolios are efficient.

For each set of efficient portfolios, regression analysis produces an equation which explains risk in terms of expected return. This equation will be linear in its coefficients. The aim of the analysis is to produce analytically tractable functions which have high explanatory power and yet remain in as simple a form as possible. The degree of explanatory power is dependent on how well the resultant regression equation fits the data. This is assessed by summing the squares of the errors in prediction. Hence, the term 'least squares', since the smaller this value, the smaller the errors produced and the more accurate the fitted equation. The explanatory power of a regression equation is summarized by the r^2 statistic. Thus, the dual aim of the analysis is the maximization of r^2 and the minimization of the number of terms in the equation.

Stepwise regression analysis is a particular process for instigating this dual objective of achieving high explanatory power and parsimony. Given the original input data in (x, y) form, new inputs are provided by taking mathematical transforms of the x and y values. Stepwise regression, which is only usually viable within a computerized environment, analyses the input data to produce regression equations which fulfil these requirements. Taking a dependent variable; either y or a transform of y, stepwise regression first of all includes in the regression equation the independent variable, x or one of its transforms, which has the highest correlation with the dependent variable being used. It then continues by progressively adding into the equation other independent variables on the basis of their correlation, after adjustment for the variables already included in the equation, with the dependent variable. The process ceases when the additional explanatory power achieved does not justify the consequential loss in parsimony. This is assessed on the basis of the t-statistics of each independent variable. This statistic summarizes the significance of each variable in adding to the explanatory power of the overall regression equation. Stepwise regression and the statistics that it employs are explained in most basic statistics texts such as that by Chatterjee & Price (1977).

For each set of efficient portfolios, therefore, the data shown in Table 10.4 was entered into **MINITAB**:

Table 10.4: Input Data for Efficient Frontier Stepwise Regression

Variable Identifier	Variable Name	Variable Transforms						
x	*Return*	x^2	x^3	x^4	x^5	$\ln x$	$\frac{1}{x}$	$\sqrt{x}$
y	*Risk*	-	-	-	-	$\ln y$	$\frac{1}{y}$	$\sqrt{y}$

Since the data is cross-sectional, summary statistics relating to autocorrelation are irrelevant. However, since regression analysis is based on the assumption of the observations being normally distributed, it is important that the residuals of each possible regression equation be analysed for normality. As a consequence, the regression equations selected as the 'best' approximations to the efficient frontiers for each situation, are not necessarily those with the *highest* associated r^2 statistic. Explanatory power, as measured by r^2, has on occasion, been sacrificed in order to achieve more theoretically viable results. The final set of chosen equations, which are deemed to be representative approximations to the efficient frontiers that needed to be found, can be seen in Tables 10.5-10.7.

Table 10.5: USGC-JAP: Mathematical Approximations of the Efficient Frontiers as Deduced by Regression Analysis

Measure of Risk	Risk Attitude	Regression Equation for the Efficient Frontier	Value of r^2
Variance	Averse	$y = 83 + 8.65x + 0.545x^2$	97.9%
	Prone	$y = 271 + 210x + 53.5x^2$	100.0%
Standard Deviation	Averse	$y = 9.15 + 0.515x + 0.0295x^2$	98.2%
	Prone	$y = 7.69 + 1.35x + 0.891x^2$	99.4%
Interquartile Range	Prone	$y = -4.71 - 6.12x + 0.568x^2$	99.9%
Minimum Return	Prone	$y = -17.5 - 2.45x - 1.16x^2$	99.8%

Table 10.6: HR-JAP: Mathematical Approximations of the Efficient Frontiers as Deduced by Regression Analysis

Measure of Risk	Risk Attitude	Regression Equation for the Efficient Frontier	Value of r^2
Variance	Averse	$y = 52.6 - 14.3x + 2.87x^2$	100.0%
Standard Deviation	Averse	$y = 8.65 + 2.27x - 5.38\sqrt{x}$	99.9%
Interquartile Range	Averse	$y = 16.0 + 4.35x - 12.1\sqrt{x}$	100.0%
Minimum Return	Averse	$y = -1.97 - 0.595x - 0.0134x^2$	99.7%
	Prone	$y = -35.4 + 0.16x - 0.000153x^2$	100.0%

Table 10.7: BRZ-NWE: Mathematical Approximations of the Efficient Frontiers as Deduced by Regression Analysis

Measure of Risk	Risk Attitude	Regression Equation for the Efficient Frontier	Value of r^2
Variance	Averse	$y = 22.7 + 0.791x + 1.39x^2$	100.0%
Standard Deviation	Averse	$y = 3.93 + 0.766x + 0.0137x^2$	99.9%
Interquartile Range	Averse	$y = 5.67 + 1.77x + 0.045x^2$	99.7%
Minimum Return	Averse	$y = -14.5 - 0.937x - 0.0129x^2$	99.8%

As can be seen from the exceptionally high values of r^2 obtained for each of these equations, there is clearly a very strong relationship between risk and return. This feature supports the theoretical tenet that the degree of risk increases as the expected return increases.

10.2 The Portfolio Selection Procedure

Having determined the efficient frontiers of the different sets of efficient portfolios, it is now necessary to deduce where on those frontiers the investors' choices will lie. As has been stated, this depends on their utility function. An efficient frontier, which shall be denoted $R(x)$, represents an interpolating curve between all the true efficient portfolios within a set. For a risk averse investor, for example, movement along that curve implies either a reduction in the level of expected return and in the risk *or* an increase in the level of expected return but with an associated increase in the level of risk assumed, depending upon which direction the investor is moving. The choice of a specific risk/return trade-off is a matter for personal preference.

The utility function $U(x)$ represents these personal preferences. Implicitly, therefore, the actual investment portfolio selection is dependent upon the interaction of these two conceptual and mathematical processes. In Chapter 5, representative utility functions for both risk averse and risk prone investors were derived. It is the task of this analysis to now integrate those two utility functions with the efficient frontiers which have been derived in this chapter.

Before proceeding with the analysis, it is necessary to return to a discussion of the properties of utility curves. Because they are derived from calculations based on index values, two extremely important properties which they exhibit are:

1. They are independent of scale.

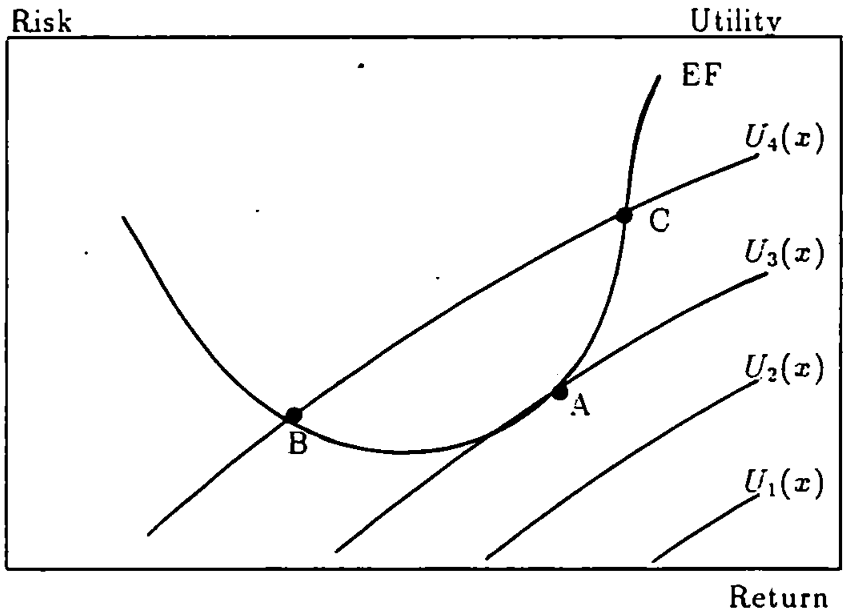
2. They are independent of intercept.

In the original derivation, utility index values were associated with choices relating to a probabilistic loss of \$3m and a probabilistic profit of \$30m. The attached utility index values would be the same if the values involved were just \$3 and \$30. The important feature is that the degree of relative preference, implied by the utility index values, is maintained. This obviously implies that the utility curves that have been derived on the basis of the original values can now be used with any values, irrespective of the scale of those values or their units. A similar result can be imputed if the utility index values are varied. That is, the extrema of the utility index scale could equally well have been 0 and 1 rather than 0 and 100. In fact, the extrema could take any values, since the utility index only relates one outcome or option relatively to another. Thus, the original utility curves can be applied to returns on investment, expressed as percentages, and to the range of returns on investment which are inherent in the data of this study.

The fact that utility curves are independent of intercept can easily be deduced from the fact that the same relative levels of utility would have been achieved had the extrema of the monetary values of the outcomes been $0m and $33m rather than -$3m and $30m. For example, the risk neutral attitude towards the probabilistic outcomes of the utility analysis would be encapsulated in a utility curve which is a straight line that passes through the point (-3,0). Had the lower extremum of the outcomes been $0m, then the same risk neutral attitude, embodied in a straight line, would then pass through the point (0,0). The relativity of all probabilistic outcomes is maintained since the risk attitude has remained constant, but the utility function now has a different intercept with the y-axis.

What these features imply for this stage of the actual application of the Modern Portfolio Theory methodology, is that the utility functions, as derived in Chapter 5, can be applied directly to the magnitude and range of the returns implicit in the efficient frontiers. However, because of the independence of the intercept, there are infinite utility functions which can be superimposed over a plot of an efficient frontier in risk/return space. They are obtained simply by varying the value of the intercept. This aspect is shown explicitly in Figure 10.13.

Figure 10.13: The Interaction of the Efficient Frontier and an Investor's Utility Curves



There are many more utility curves than those shown in Figure 10.13. In fact, they can go through any intercept as long as they remain parallel to each other. This is due to the fact that it is only in that circumstance that they then represent exactly the same risk attitude. The interpretation of Figure 10.13 is central to the further progression of the analytical process.

As a consequence, it is necessary to discuss it in some detail.

The methodology implies a search for the interaction of an investor's risk/return preferences, inherent in the utility curves, with the available investment opportunities implicit in the efficient frontier. Obviously, therefore, utility curves $U_1(x)$ and $U_2(x)$ are impossible in a practical sense since no investment opportunities are available at any point along them. It only remains, therefore, to observe the situations along $U_3(x)$ and $U_4(x)$.

The total utility derived on each of these curves increases as one moves along each of them from bottom left to top right. This might suggest that portfolio C, lying on both the efficient frontier and $U_4(x)$, is preferable to both portfolio A and portfolio B. This could be implied from the fact that it lies further along its utility curve and, therefore, has an associated higher total utility. It can be seen that utility curve $U_4(x)$ cuts through the efficient frontier in two places. However, remembering that the efficient frontier represents merely the edge of all the available portfolios, $U_4(x)$ passes through other portfolios between portfolio B and portfolio C. These other portfolios are inefficient and are represented by the dots on the utility curve. The utility curve denoted by $U_4(x)$, therefore, yields a number of possible portfolio choices. This feature does not gel with the general principle of Modern Portfolio Theory that a unique solution is obtained.

Although portfolio C does yield the highest total utility, this does not take into account the cost incurred in achieving that high utility. In fact, it is the utility curve denoted by $U_3(x)$ that should be used for the derivation of the optimal portfolio selection. The interaction of this curve with the efficient frontier yields a single unique portfolio choice of portfolio A. This feature coincides with the general principle of Modern Portfolio Theory. Although it is clear that portfolio A accrues greater total utility than portfolio B, this cannot be used as the reason for its preference because it is also clear that portfolio C accrues even greater total utility. The justification for preferring portfolio A to both portfolio B and portfolio C lies with the relationship between improving utility at the cost of increasing risk.

The efficient frontier is tangential to $U_3(x)$ at portfolio A. This implies that at portfolio A, the marginal risk is equal to the marginal utility, or in mathematical terms:

$$\frac{dR(x)}{dx} = \frac{dU(x)}{dx}$$

Using this mathematical property, it is obvious that at portfolio B:

$$\frac{dR(x)}{dx} < \frac{dU(x)}{dx}$$

...and at portfolio C:

$$\frac{dR(x)}{dx} > \frac{dU(x)}{dx}$$

The term 'marginal' in the context of economics relates to the rate of change of a variable. Consequently, at portfolio B, the rate of change of risk is less than the rate of change of utility. The opposite is true at portfolio C. What this means is that at portfolio B, a percentage change in risk will lead to an even greater percentage change in utility. At portfolio C, however, a percentage change in risk will lead to a smaller percentage change in utility.

The ultimate conclusion that may be drawn from these properties is that if an investor has invested in portfolio B, he will achieve greater utility for only a small cost, in terms of risk, as he moves along the efficient frontier to the right until he reaches portfolio A. If, on the other hand, an investor holds portfolio C, he sacrifices only small amounts of utility in return for making large reductions in his risk by moving along the efficient frontier until he reaches portfolio A. All other portfolios that lie on $U_4(x)$, between portfolio B and portfolio C, are not viable since they are inefficient and, therefore, other portfolios must exist which are preferred to these purely on the basis of risk and expected return. One may conclude from this analysis that portfolio A is the subjectively optimal portfolio in this instance since it matches investor preferences with what is available. Consequently, $U_3(x)$ is the appropriate utility curve to consider because of the nature of its interaction with the efficient frontier. One may deduce, therefore, that the means by which the subjectively optimal portfolio is determined is by solving for x the relationship given by:

$$\frac{dR(x)}{dx} = \frac{dU(x)}{dx}$$

The utility functions of risk averse and risk prone investors in the shipping industry, as derived in Chapter 5, are provided in Table 10.8. Taking these functions as $U(x)$ and the equations of the efficient frontiers, provided in Tables 10.5-10.7, as $R(x)$, it is now possible to derive solutions to x such that $\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$. The mathematics involved for each situation covered by this analysis can be seen in the next few subsections.

Table 10.8: Specification of the Utility Functions $U(x)$ in Shipping

Risk Attitude	Utility Function
Risk Averse	$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$
Risk Prone	$U(x) = 5.1169 + 1.09494x + 0.053361x^2$

10.2.1 USGC-JAP, 30,000 Dwt., Grain

Variance as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = 83 + 8.65x + 0.545x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = 8.65 + 1.09x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+.5}} = 8.65 + 1.09x$$

$$\frac{91.2025}{(x+.5)} = 74.8225 + 18.857x + 1.881x^2$$

$$91.2025 = 74.8225x + 18.857x^2 + 1.881x^3 + 3.5[74.8225 + 18.857x + 1.881x^2]$$

Thus :

$$0 = \underline{1.881x^3 + 23.01535x^2 + 140.822x + 170.67625}$$

Variance as the Measure of Risk: Risk Prone Investor Preferences

$$\begin{aligned} U(x) &= 5.1169 + 1.09494x + 0.053361x^2 \\ R(x) &= 271 + 210x + 53.5x^2 \end{aligned}$$

$$\begin{aligned} \frac{dU(x)}{dx} &= 1.09494 + 0.106722x \\ \frac{dR(x)}{dx} &= 210 + 107x \end{aligned}$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\begin{aligned} 1.09494 + 0.106722x &= 210 + 107x \\ -208.90506 &= 106.893278x \end{aligned}$$

Thus :

$$x = \underline{-1.9543331}$$

Standard Deviation as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = 9.15 + 0.515x + 0.0295x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = 0.515 + 0.059x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = 0.515 + 0.059x$$

$$\frac{91.2025}{(x+3.5)} = 0.265225 + 0.06077x + 0.003481x^2$$

$$91.2025 = 0.265225x + 0.06077x^2 + 0.003481x^3 + 3.5[0.265225 + 0.06077x + 0.003481x^2]$$

Thus :

$$0 = \underline{0.003481x^3 + 0.073x^2 + 0.478x - 90.274}$$

Standard Deviation as the Measure of Risk: Risk Prone Investor Preferences

$$U(x) = 5.1169 + 1.09494x + 0.053361x^2$$

$$R(x) = 7.69 + 1.35x + 0.891x^2$$

$$\frac{dU(x)}{dx} = 1.09494 + 0.106722x$$

$$\frac{dR(x)}{dx} = 1.35 + 1.782x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$1.09494 + 0.106722x = 1.35 + 1.782x$$

$$-0.25506 = 1.675278x$$

$$Thus:$$

$$x = \underline{-0.1522493}$$

Interquartile Range as the Measure of Risk: Risk Prone Investor Preferences

$$
\begin{aligned}
U(x) &= 5.1169 + 1.09494x + 0.053361x^2 \\
R(x) &= -4.71 - 6.12x + 0.568x^2
\end{aligned}
$$

$$
\begin{aligned}
\tfrac{dU(x)}{dx} &= 1.09494 + 0.106722x \\
\tfrac{dR(x)}{dx} &= -6.12 + 1.136x
\end{aligned}
$$

$$
\tfrac{dU(x)}{dx} = \tfrac{dR(x)}{dx}
$$

$$
\begin{aligned}
1.09494 \div 0.106722x &= -6.12 + 1.136x \\
7.21494 &= 1.029278x
\end{aligned}
$$

Thus :

$$
x = \underline{7.01}
$$

Minimum Return as the Measure of Risk: Risk Prone Investor Preferences

$$U(x) = 5.1169 + 1.09494x + 0.053361x^2$$

$$R(x) = -17.5 - 2.45x - 1.16x^2$$

$$\frac{dU(x)}{dx} = 1.09494 + 0.106722x$$

$$\frac{dR(x)}{dx} = -2.45 - 2.32x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$1.09494 + 0.106722x = -2.45 - 2.32x$$

$$3.54494 = -2.426722x$$

Thus :

$$x = \underline{-1.4608}$$

10.2.2 HR-JAP, 55,000 Dwt., Coal

Variance as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = 52.6 - 14.3x + 2.87x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = -14.3 + 5.74x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = -14.3 + 5.74x$$

$$\frac{91.2025}{(x+3.5)} = 204.49 - 164.164x + 32.9476x^2$$

$$91.2025 = 204.49x - 164.164x^2 + 32.9476x^3 + 3.5[204.49 - 164.164x + 32.9476x^2]$$

Thus :

$$0 = \underline{32.9476x^3 - 48.8474x^2 - 370.084x + 624.5125}$$

Standard Deviation as the Measure of Risk: Risk Averse Investor Preferences

$$
\begin{aligned}
U(x) &= -9.96 + 19.1\sqrt{x + 3.5} \\
R(x) &= 8.65 + 2.27x - 5.39\sqrt{x}
\end{aligned}
$$

$$
\begin{aligned}
\frac{dU(x)}{dx} &= \frac{9.55}{\sqrt{x+3.5}} \\
\frac{dR(x)}{dx} &= 2.27 - \frac{2.695}{\sqrt{x}}
\end{aligned}
$$

$$
\frac{dU(x)}{dx} = \frac{dR(x)}{dx}
$$

$$
\begin{aligned}
\frac{9.55}{\sqrt{x+3.5}} &= 2.27 - \frac{2.695}{\sqrt{x}} \\
\frac{9.55\sqrt{x}}{\sqrt{x+3.5}} &= 2.27\sqrt{x} - 2.695 \\
\frac{91.2025x}{(x+3.5)} &= 5.1529x - 12.2353\sqrt{x} + 7.263025 \\
\frac{17.7x}{(x+3.5)} &= x - 2.37445\sqrt{x} + 1.4095 \\
2.37445\sqrt{x} &= x - \frac{17.7x}{(x+3.5)} + 1.4095 \\
2.37445\sqrt{x} &= \frac{(x+3.5)x - 17.7x + 1.4095(x+3.5)}{(x+3.5)} \\
(x + 3.5)2.37445\sqrt{x} &= x^2 + 3.5x - 17.7x + 1.4095x + 4.93325 \\
(x + 3.5)2.37445\sqrt{x} &= x^2 - 12.7905x + 4.93325 \\
(x + 3.5)^2 5.638x &= x^4 - 25.581x^3 + 173.4635x^2 - 126.19746x + 24.337 \\
Thus &: \\
0 &= \underline{x^4 - 31.219x^3 + 133.9975x^2 - 195.26296x + 24.337}
\end{aligned}
$$

Interquartile Range as the Measure of Risk: Risk Averse Investor Preferences

$$
\begin{aligned}
U(x) &= -9.96 + 19.1\sqrt{x + 3.5} \\
R(x) &= 16.0 + 4.35x - 12.1\sqrt{x}
\end{aligned}
$$

$$
\begin{aligned}
\frac{dU(x)}{dx} &= \frac{9.55}{\sqrt{x+3.5}} \\
\frac{dR(x)}{dx} &= 4.35 - \frac{6.05}{\sqrt{x}}
\end{aligned}
$$

$$
\frac{dU(x)}{dx} = \frac{dR(x)}{dx}
$$

$$
\begin{aligned}
\frac{9.55}{\sqrt{x+3.5}} &= 4.35 - \frac{6.05}{\sqrt{x}} \\
\frac{9.55\sqrt{x}}{\sqrt{x+3.5}} &= 4.35\sqrt{x} - 6.05 \\
\frac{91.2025x}{(x+3.5)} &= 18.9225x - 52.635\sqrt{x} + 36.6025 \\
52.635\sqrt{x} &= 18.9225x + 36.6025 - \frac{91.2025x}{(x+3.5)} \\
52.635\sqrt{x} &= \frac{(x+3.5)18.9225x + 36.6025(x+3.5) - 91.2025x}{(x+3.5)} \\
\frac{(x+3.5)52.635\sqrt{x}}{18.9225} &= (x + 3.5)x + 1.9343374(x + 3.5) - 4.8198x \\
2.78161(x + 3.5)\sqrt{x} &= x^2 + 3.5x + 1.9343374x + 6.7702 - 4.8198x \\
2.78161(x + 3.5)\sqrt{x} &= x^2 + 0.6145374x + 6.7702 \\
7.7373542(x + 3.5)^2 x &= (x^2 + 0.6145374x + 6.7702)^2 \\
7.7373542(x^2 + 7x + 12.25)x &= x^4 + 1.229x^3 + 13.9181x^2 + 8.3210822x + 45.835608
\end{aligned}
$$

Thus :

$$
0 = x^4 - 6.5084x^3 - 40.2434x^2 - 86.4615x + 45.8356
$$

Minimum Return as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = -1.97 - 0.595x - 0.0134x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = -0.595 - 0.0268x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = -0.595 - 0.0268x$$

$$\frac{91.2025}{(x+3.5)} = 0.354025 + 0.031892x + 0.00071824x^2$$

$$91.2025 = 0.354025x + 0.031892x^2 + 0.00071824x^3 +$$

$$3.5[0.354025 + 0.031892x + 0.00071824x^2]$$

Thus :

$$0 = \underline{0.00071824x^3 + 0.0344058x^2 + 0.465647x - 89.963412}$$

Minimum Return as the Measure of Risk: Risk Prone Investor Preferences

$$U(x) = 5.1169 + 1.09494x + 0.053361x^2$$
$$R(x) = -35.4 + 0.16x - 0.000153x^2$$

$$\frac{dU(x)}{dx} = 1.09494 + 0.106722x$$
$$\frac{dR(x)}{dx} = 0.16 - 0.000306x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$1.09494 + 0.106722x = 0.16 - 0.000306x$$
$$0.93494 = -0.107028x$$

Thus :

$$x = \underline{-8.735471}$$

10.2.3 BRZ-NWE, 120,000 Dwt., Iron Ore

Variance as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = 22.7 + 0.791x + 1.39x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = 0.791 + 2.78x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = 0.791 + 2.78x$$

$$\frac{91.2025}{(x+3.5)} = 0.625681 + 4.39796x + 7.7284x^2$$

$$\begin{aligned} 91.2025 &= 0.625681x + 4.39796x^2 + 7.7284x^3 + \\ &\quad 3.5[0.625681 + 4.39796x + 7.7284x^2] \end{aligned}$$

Thus :

$$0 = \underline{7.7284x^3 + 31.44736x^2 + 16.018541x - 89.012616}$$

Standard Deviation as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = 3.93 + 0.766x + 0.0137x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = 0.766 + 0.0274x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = 0.766 + 0.0274x$$

$$\frac{91.2025}{(x+3.5)} = 0.5868 + 0.04198x + 0.00075x^2$$

$$91.2025 = 0.5868x + 0.04198x^2 + 0.00075x^3 + 3.5[0.5868 + 0.04198x + 0.00075x^2]$$

Thus :

$$0 = \underline{0.00075x^3 + 0.044605x^2 + 0.73345x - 89.1487}$$

Interquartile Range as the Measure of Risk: Risk Averse Investor Preferences

$$
\begin{aligned}
U(x) &= -9.96 + 19.1\sqrt{x + 3.5} \\
R(x) &= 5.67 + 1.77x + 0.045x^2
\end{aligned}
$$

$$
\begin{aligned}
\frac{dU(x)}{dx} &= \frac{9.55}{\sqrt{x+3.5}} \\
\frac{dR(x)}{dx} &= 1.77 + 0.09x
\end{aligned}
$$

$$
\frac{dU(x)}{dx} = \frac{dR(x)}{dx}
$$

$$
\begin{aligned}
\frac{9.55}{\sqrt{x+3.5}} &= 1.77 + 0.09x \\
\frac{91.2025}{(x+3.5)} &= 3.1329 + 0.3186x + 0.0081x^2 \\
91.2025 &= 3.1329x + 0.3186x^2 + 0.0081x^3 + \\
&\quad 3.5[3.1329 + 0.3186x + 0.0081x^2]
\end{aligned}
$$

Thus :

$$
0 = \underline{0.0081x^3 + 0.34695x^2 + 4.248x - 80.23735}
$$

Minimum Return as the Measure of Risk: Risk Averse Investor Preferences

$$U(x) = -9.96 + 19.1\sqrt{x + 3.5}$$

$$R(x) = -14.5 - 0.937x - 0.0129x^2$$

$$\frac{dU(x)}{dx} = \frac{9.55}{\sqrt{x+3.5}}$$

$$\frac{dR(x)}{dx} = -0.937 - 0.0258x$$

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

$$\frac{9.55}{\sqrt{x+3.5}} = -0.937 - 0.0258x$$

$$\frac{91.2025}{(x+3.5)} = 0.878 + 0.0483492x + 0.00066564x^2$$

$$\begin{aligned} 91.2025 = {} & 0.878x + 0.0483492x^2 + 0.00066564x^3 + \\ & 3.5[0.878 + 0.0483492x + 0.00066564x^2] \end{aligned}$$

Thus :

$$0 = \underline{0.00066564x^3 + 0.050679x^2 + 1.04722x - 88.1295}$$

From the above analysis, it is apparent that the optimal value of x can only be determined exactly on relatively few occasions. In most instances the final result is in the form of a polynomial in x. Each polynomial has a number of solutions to the value of x equal to the order of the polynomial. Thus, a polynomial of degree 4 has four roots. This implies that there are four points of tangency between the two curves. Remember, of course, that the curves are merely mathematical approximations to the utility function and the efficient frontier. To all intents and purposes, the only viable permissible roots to the polynomials must be contained within, or be as close as possible to, the region of interest. This region is bounded by the smallest and highest values of expected return of the portfolios within the efficient set being considered. Although this greatly simplifies the problem, it maintains realism and makes a practical solution possible. Although analytical methods, involving the application of Galois Theory, do exist to determine the roots of these polynomials (to give the required values of x) as illustrated by Stewart (1973), it is much simpler to solve for the roots of the polynomials using numerical methods.

To this end, a **FORTRAN** program (see Appendix M) was written to locate a single root of a given polynomial by providing an initial rough estimate of the root. This estimate should obviously be related to the interval of interest. Consequently, the mid-point of each interval of viable portfolio expected return for each efficient set constituted this initial value. Having located the nearest root to the mid-point value, the end-points of the interval of interest were then used as the initial estimates in order to check whether more than one root existed within the interval. The specific root-trapping algorithm upon which the program was based was that of Newton's Divided

Difference method as described by Burden & Faires (1985).

Before providing the results of the exercise, it might be advantageous to reiterate what exactly is trying to be achieved. By solving the initial problem of:

$$\frac{dU(x)}{dx} = \frac{dR(x)}{dx}$$

...a value of x is determined. This value relates to the level of expected return achieved by a portfolio which the investor would choose, in accordance with his risk attitudes, given a range of alternatives. Consequently, this value of x is the expected return achieved by the subjectively optimal portfolio. Obviously, for the investor to choose a remotely feasible portfolio, that value of expected return, denoted by x, must lie between the highest and lowest values of expected return derived from portfolios contained within the efficient set. By supplementing the values of x which were derived directly by solving the above equation, with those derived from the solution of polynomials, the values of x (expected return) for each situation where the investor has an investment choice can be seen in Tables 10.9-10.11.

Table 10.9: USGC-JAP: The Level of Expected Return (x) of the Subjectively Optimal Portfolio on Each Efficient Frontier

Measure of Risk	Risk Attitude	Method of Deduction	Optimal Value of x
Variance	Averse	*Polynomial*	-1.592%
	Prone	*Direct*	-1.954%
Standard Deviation	Averse	*Polynomial*	22.818%
	Prone	*Direct*	-0.15%
Interquartile Range	Prone	*Direct*	7.01%
Minimum Return	Prone	*Direct*	-1.4608%

Table 10.10: HR-JAP: The Level of Expected Return (x) of the Subjectively Optimal Portfolio on Each Efficient Frontier

Measure of Risk	Risk Attitude	Method of Deduction	Optimal Value of x
Variance	Averse	*Polynomial*	3.137%
Standard Deviation	Averse	*Polynomial*	26.426%
Interquartile Range	Averse	*Polynomial*	10.895%
Minimum Return	Averse	*Polynomial*	35.131%
	Prone	*Direct*	-8.735%

Table 10.11: BRZ-NWE: The Level of Expected Return (x) of the Subjectively Optimal Portfolio on Each Efficient Frontier

Measure of Risk	Risk Attitude	Method of Deduction	Optimal Value of x
Variance	Averse	*Polynomial*	1.286%
Standard Deviation	Averse	*Polynomial*	31.212%
Interquartile Range	Averse	*Polynomial*	9.624%
Minimum Return	Averse	*Polynomial*	28.806%

No reference has yet been made to whether or not these values of x (expected return) lie inside the interval of interest. For each set of efficient portfolios, the interval of interest lies between the lowest expected return provided by any portfolio in the set and the highest expected return provided by any portfolio in the set. The relevant intervals of interest for each circumstance can be seen in Table 10.12 and then compared to the derived optimal values of x as shown in Tables 10.9-10.11.

Table 10.12: The Intervals of Interest of Each Efficient Frontier

Trade	Measure of Risk	Risk Attitude	Interval of Interest	
			Lower Limit	Upper Limit
USGC-JAP	Variance	Averse	-7.68%	-1.6%
		Prone	-6.25%	-1.6%
	Standard Deviation	Averse	-7.68%	-1.6%
		Prone	-6.25%	-1.6%
	Interquartile Range	Prone	-6.25%	-1.6%
	Minimum Return	Prone	-6.25%	-1.6%
HR-JAP	Variance	Averse	0.28%	29.43%
	Standard Deviation	Averse	0.28%	29.43%
	Interquartile Range	Averse	2.15%	29.43%
	Minimum Return	Averse	10.33%	29.43%
		Prone	-16.56%	29.43%
BRZ-NWE	Variance	Averse	-2.41%	19.1%
	Standard Deviation	Averse	-2.41%	19.1%
	Interquartile Range	Averse	-1.17%	19.1%
	Minimum Return	Averse	-2.41%	19.1%

By comparing the optimal values of x, as shown in Tables 10.9-10.11, to their associated intervals of interest, it is clear that some of the x values lie outside the interval of interest. Since no portfolios exist outside the interval, then such a result can be deemed to imply either a desire to invest in the portfolio with the maximum expected return (where x is greater than the upper limit of the interval of interest) or a desire to invest in the portfolio with the minimum expected return (where x is less than the lower limit of the interval of interest). In such instances, the identification of the portfolio which exhibits such features is comparatively simple. However, where the derived value of x lies within the interval of interest, it is then necessary to precisely identify the portfolio which yields that expected return.

For every derived value of x (expected return) that lies within the appropriate interval of interest, there is an associated value of y (risk) which can be determined by substituting the x value back into the equation of the efficient frontier. Having done so, this yields the (x, y) coordinates of the subjectively optimal portfolio. However, because the efficient frontier is merely a theoretical approximation of the relationship between risk and expected return which interpolates the levels of risk and expected return of actual real available portfolios, it is highly probable that these coordinates do not actually relate to a real portfolio choice. Remembering that each portfolio is uniquely defined by its $(return, risk)$ coordinates, it is now necessary to determine the real portfolio choice which lies closest to the theoretically derived portfolio as defined by its (x, y) coordinates. This is easily achieved by the application of coordinate geometry and, in particular, by the application of Pythagoras' Theorem.

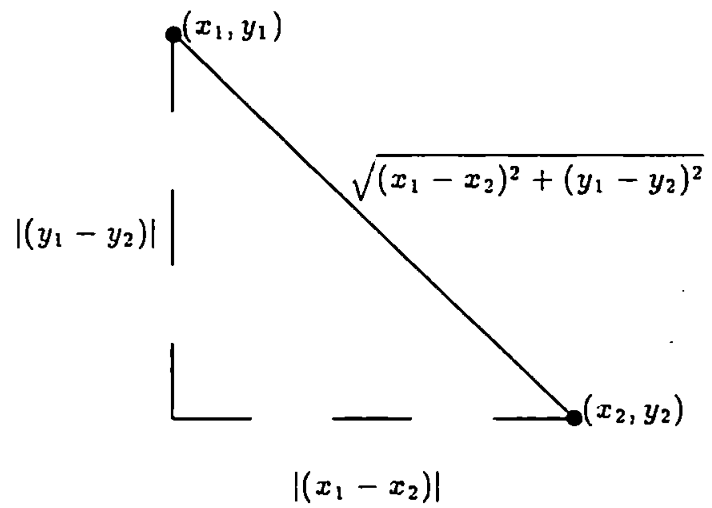
The distance between two coordinate locations denoted (x_1, y_1) and (x_2, y_2)

is derived from Pythagoras' Theorem and is given by:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

A graphical interpretation of this result is shown in Figure 10.14 below:

Figure 10.14: Graphical Presentation of the Minimum Distance Between Two Points



The distance between the modelled (x, y) coordinates and the $(return, risk)$ coordinates of each of the real available portfolios within an efficient set can be determined using this formula. The minimum of these values will show the real portfolio which is closest to the theoretical subjectively optimal portfolio and this then constitutes the portfolio that should be selected by the investor.

The subjectively optimal portfolios that are ultimately derived by the application of these various filtering techniques are defined in terms of 10% holdings of the individual investments of which they are composed. Thus, the stage that the analysis has now reached, means that for every possible combination of circumstance (*vis a vis* trade, measure of risk and risk attitude), there is a unique portfolio which is the subjectively optimal and is defined in terms of a 10% chunk-size. If, for example, such an optimal portfolio is defined as 10% voyage charter, 10% time charter and 80% freight futures, then this portfolio is subjectively preferable to all others where the holdings of the individual investments are defined in multiples of 10%.

If the holdings of the individual investments that compose this portfolio are allowed to be in multiples of 5%, then there may be a subjectively optimal portfolio which is preferable to that defined as above, but which is composed of 5% holdings. It is clear, however, that if such a portfolio should exist, the individual investments that compose it must fall within the following ranges: voyage charters 0%-20%, time charters 0%-20% and freight futures 70%-90%. If the characteristics of the possible portfolios that fall within this range constraint are now estimated (that is, their expected return and associated risk according to the different measures), it is then possible to re-apply the minimum distance technique to locate the subjectively optimal portfolio defined in terms of 5% holdings of the individual investments.

If the subjectively optimal portfolio is now found to be, for example, 15% voyage charters, 10% time charters and 75% freight futures, these values then provide constraints on the subjectively optimal portfolio where holdings of the individual investments are in multiples of 1%. In fact, the constraints would be: voyage charters 10%-20%, time charters 5%-15% and freight futures 70%-80%. If the process just outlined is now repeated for portfolios composed of 1% holdings of the individual investments, the final subjectively optimal portfolio for each circumstance is now more precisely defined in that the holdings of the individual investments are to the nearest 1%.

This iterative process allows the determination of a very accurate subjectively optimal portfolio without the need to become involved in the numerous calculations resulting from the consideration of a massive number of possible portfolios. Performing the above analysis finally results in the selection of the subjectively optimal portfolios defined in Tables 10.13-10.15 for each circumstance *vis a vis* trade, measure of risk and attitude towards risk.

Table 10.13: USGC-JAP: Subjectively Optimal Portfolio Selections

Measure of Risk	Risk Attitude	Portfolio holdings *Voyage charters*	*Time charters*	*Freight futures*	Expected return	Coefficient of risk
Variance	Averse	0%	0%	100%	-1.6%	71.74
	Prone	5%	1%	94%	-2.04%	64.87
	Neutral	0%	0%	100%	-1.6%	71.74
Standard Deviation	Averse	0%	0%	100%	-1.6%	8.47
	Prone	0%	0%	100%	-1.6%	8.47
	Neutral	0%	0%	100%	-1.6%	8.47
Interquartile Range	Averse	0%	0%	100%	-1.6%	7.28
	Prone	0%	0%	100%	-1.6%	7.28
	Neutral	0%	0%	100%	-1.6%	7.28
Minimum Return	Averse	0%	0%	100%	-1.6%	-16.86
	Prone	0%	0%	100%	-1.6%	-16.86
	Neutral	0%	0%	100%	-1.6%	-16.86

Table 10.14: HR-JAP: Subjectively Optimal Portfolio Selections

Measure of Risk	Risk Attitude	Portfolio holdings *Voyage charters*	*Time charters*	*Freight futures*	Expected return	Coefficient of risk
Variance	Averse	0%	9%	91%	0.47%	37.49
	Prone	100%	0%	0%	29.43%	2118.76
	Neutral	100%	0%	0%	29.43%	2118.76
Standard Deviation	Averse	89%	0%	11%	26.43%	40.97
	Prone	100%	0%	0%	29.43%	46.03
	Neutral	100%	0%	0%	29.43%	46.03
Interquartile Range	Averse	32%	0%	68%	10.88%	23.39
	Prone	100%	0%	0%	29.43%	78.28
	Neutral	100%	0%	0%	29.43%	78.28
Minimum Return	Averse	100%	0%	0%	29.43%	-30.86
	Prone	17%	83%	0%	-8.74%	-36.819
	Neutral	100%	0%	0%	29.43%	-30.86

Table 10.15: BRZ-NWE: Subjectively Optimal Portfolio Selections

Measure of Risk	Risk Attitude	Portfolio holdings *Voyage charters*	*Time charters*	*Freight futures*	Expected return	Coefficient of risk
Variance	Averse	12%	1%	87%	1.14%	25.99
	Prone	100%	0%	0%	19.1%	545.22
	Neutral	100%	0%	0%	19.1%	545.22
Standard Deviation	Averse	100%	0%	0%	19.1%	23.35
	Prone	100%	0%	0%	19.1%	23.35
	Neutral	100%	0%	0%	19.1%	23.35
Interquartile Range	Averse	53%	0%	47%	9.57%	26.73
	Prone	100%	0%	0%	19.1%	55.0
	Neutral	100%	0%	0%	19.1%	55.0
Minimum Return	Averse	100%	0%	0%	19.1%	-37.19
	Prone	100%	0%	0%	19.1%	-37.19
	Neutral	100%	0%	0%	19.1%	-37.19

The objective of the analysis having been achieved, the results presented in Tables 10.13-10.15 represent the portfolios which shipowners in the dry bulk shipping market should seek to hold if their objective is to maximize their utility with respect to the potential trade-offs between risk and expected return. Clearly, the actual subjectively optimal portfolio for a given shipowner depends upon how he perceives and, therefore, measures risk. The following chapter concludes this study by discussing this aspect and other specific issues raised by the results and the methodology used to achieve those results. Similarly, it also provides a general perspective on the application of Modern Portfolio Theory to market investment decisions and discusses the implications for shipping in general and shipowners specifically.

Chapter 11

Conclusions and Further Research

11.1 Comment on Results Achieved

The results achieved for the three sample trades considered within this study are presented in Tables 10.13-10.15 on the previous few pages. The results for the USGC-JAP, 30.000 Dwt., grain trade are interesting because Modern Portfolio Theory recommends an almost exclusive investment in freight futures rather than in the physical market. In fact, the one exception to this result is a statistical 'fluke' since the portfolio which is chosen for a risk prone investor where variance is the measure of risk yields less return *and* less risk than the standard choice. This is entirely illogical for a risk prone investor since he is only willing to sacrifice expected returns for *more* risk. This incongruity is the result of using a quadratic utility function as an approximation to an investor's risk preferences. The disadvantages of using this form of function have been theoretically discussed in Chapter 4, but this result now provides practical evidence of its shortcomings.

Apart from this single outlier, the methodology of Modern Portfolio Theory recommends a 100% investment in freight futures in this trade, for all types of investor despite the measure of risk adopted. Because the risk neutral investor prefers this portfolio, it must yield the highest return of all the portfolios considered. Depending on the measure of risk, this portfolio must also represent either the portfolio with minimum risk thus attracting the risk averse investor, or the portfolio with maximum risk thus attracting the risk prone investor. Where these circumstances are not fulfilled, then one can only deduce that this portfolio is selected because either;

1. For the risk averse investor, the reduction in revenue, brought about by partially investing in the physical market, is so great that it cannot be made up for by the only marginal reduction in the level of risk, or;

2. For the risk prone investor, the reduction in revenue, brought about by partially investing in the physical market, is so great that it cannot be made up for by the only marginal increase in the level of risk.

If it is assumed that this sample trade (USGC-JAP) is representative of the handy-sized market, the results constitute a sad reflection on the state of that market. Because of the importance of this trade, as shown in Chapter 8, this would seem to be a fair assumption. Since the returns on freight futures were derived from the assumption of a 'blind' hedging policy, there is obvious scope for improvement by implementing some form of strategy where futures profit becomes an objective rather than a happy coincidence. This aspect, together with the results achieved in the analysis, suggest that shipowners would be better off in the short-term selling their handy-sized ships and merely speculating on BIFFEX.

When inspecting the results for the HR-JAP coal trade, it is clear that apart from the case where minimum return is the measure of risk employed, then the risk prone and risk neutral investors prefer to operate under voyage charter. It is entirely logical that the results imply that the risk averse investor prefers to hedge his investment in the physical market usually by investment in freight futures. This aspect suggests that BIFFEX theoretically succeeds in fulfilling its purpose, at least insofar as the results suggest that it provides a worthwhile hedging mechanism for the risk averse investor involved in the Panamax market. This result is especially pertinent given that BIFFEX is often criticized as leaning too heavily towards the Panamax trades. In all cases, the portfolios selected by the risk averse investor are logical in that they sacrifice expected return for a reduction in the level of risk which they face. In general, however, the results reflect the relatively healthy state of the Panamax spot market.

Where the minimum level of return is used as a measure of risk, it is the risk prone investor who prefers to invest in a mix of time charters and voyage charters in order to increase the level of risk which he faces in return for a sacrifice in the level of expected return. This sacrifice is undertaken to such an extent that he actually prefers to face a negative expected return for the small chance of making a large actual return. Given the trend in freight rates over the period of study, this result suggests that where the minimum level of return is used as the measure of risk, the risk prone shipowner should be prepared, to a certain extent, to speculate on a fall in spot charter rates by choosing to invest a proportion of his capital in time charters.

For the BRZ-NWE iron ore trade, the results almost unanimously suggest that shipowners should be playing the spot voyage charter market. This again suggests a fairly healthy Cape-sized shipping market. The only exceptions are again logical in that for the risk averse investor, where either variance or interquartile range is the measure of risk, it is preferable to hedge his physical market investments by recourse to the freight futures market. The risk averse shipowner thereby reduces the level of his expected return for a concurrent reduction in the level of risk which he faces.

When appraising the results provided by the different measures of risk from an overall perspective, several interesting points can be made. On those occasions where the methodology recommends a deviation away from a 100% commitment to a single market investment, the specification of the recommended portfolios differ depending on whether variance or standard deviation is used as the measure of risk. According to the assumptions implicit in the pure Markowitz Portfolio Theory, standard deviation and variance yield the same optimum portfolio if the returns from the available portfolios are normally distributed. The results obtained within this study, therefore, point to the fact that returns in shipping are not normally distributed and that the consequent use of standard deviation and/or variance as the measure of risk is questionable.

With the notable exception of the risk prone investor in the HR-JAP Panamax trade where minimum return is the measure of risk, time charters have been virtually ignored in the composition of the subjectively optimal portfolios. As Gray (1987) points out, time charters have been regarded in the past as the prominent means of hedging voyage charter investments. The results contained within this study suggest that freight futures have, or at least should have, displaced the time charter in this role. Because of the nature of the dry bulk market during the period which forms the basis of the analysis, the time charter cannot be totally ignored as a potential contributor to a subjectively optimal portfolio. There may well be a place for its inclusion in such a portfolio where the underlying nature of the market differs from that prevalent during this analysis. However, the time charter can no longer be regarded as the most effective means of hedging a voyage charter. It has to stand on its own merits.

Apart from the conceptual difficulties associated with the use of the minimum level of return as a measure of risk, its inconsistency is illustrated by the result that is obtained for the risk prone investor operating in the Panamax market. This result constitutes empirical evidence, to support the theoretical assertion, that the minimum level of return is an inadequate measure of risk. This inadequacy arises primarily from the fact that this measure makes no allowance whatsoever for probabilities. Thus, an investment which has a one in a million chance of earning zero return, representing the lowest return possible, is ranked on a par with an investment which has a one in a million chance of not earning zero return.

It is obvious that the recommended portfolios, as prescribed by Modern Portfolio Theory, are highly dependent on the measure of risk that is employed in the analysis. It is important, therefore, to ascertain an optimal risk measure for the shipping industry. As a consequence of the comments made above, the best risk estimate is clearly that provided by the interquartile range. The logical consistency of the results obtained under this measure suggest that it best copes with the fact that the returns within shipping markets are not normally distributed. The subjectively optimal portfolios which are selected under this measure of risk point to the fact that, in the Panamax and Cape-sized trades, there is potential for the implementation of a successful hedging strategy to better fulfil the investment criteria of a risk averse investor. In the handy-sized market, however, the situation is so bleak that all effort should be aimed at maximizing return rather than attempting to avert risks. The results of the analysis imply, therefore, that players in the handy-sized market currently exist in a 'do or die' environment.

11.2 A General Perspective on the Methodology Adopted and the Implications for the Shipping Industry

The foregoing analysis proves that Modern Portfolio Theory can be applied to real investment decisions in the dry bulk shipping sector. It is possible to determine the necessary inputs to the model, which forms the core of the theory, and it is then possible to apply the theory to processing those inputs to arrive at logically consistent outputs from the model. Of course, this analysis has necessarily been based on a number of generalizations and simplifications which inevitably do not apply to the real world of market investment in the shipping industry. However, these do not detract from the viability of the methodology as a means of portfolio investment selection for shipowners.

The results achieved from the implementation of the Modern Portfolio Theory methodology provide the optimal apportioning of a shipowner's market investment budget given his attitude towards risk. This apportionment between individual investments constitutes a specification of an optimal portfolio. Because Modern Portfolio Theory is essentially a static model of optimal market investment and because the analysis was undertaken on data relevant to the end of December 1988, the results achieved relate to the optimal decisions that should be taken in January 1989. Thus, at this point in time, a risk averse shipowner with a potential contract of carriage for coal between Hampton Roads and Japan should invest 32% of his market investment budget in voyage charters and 68% in freight futures assuming that the interquartile range is the most appropriate measure of risk and that he is seeking to employ a Panamax ship on the route.

This result causes a particular arithmetic problem because of the indivisibility of the amounts that can be invested in the physical market. The analysis undertaken has modelled the total monthly cost of operating a Panamax ship under voyage charter on this route as $529,613. Consequently, when looking at the employment of a single ship on this trade, if the optimal proportional investments are to be maintained it is necessary that this amount represents 32% of the total invested. Thus, $1,125,428 needs to be invested in freight futures. The cost of freight futures is totally dependent on the price of the futures contract which is traded (assumed to be the nearest or *spot* futures contract) and the number of futures contracts involved. Commission also needs to be accounted for at a rate of $30 per contract. The problem then becomes the determination of the number of futures contracts that need to be invested in. This amount can be calculated as follows:

$$n \times P_{FF} + n \times \$30 = \$1,125,428$$

where:

$n =$ the number of freight futures contracts to be traded.

$P_{FF} =$ the price of the relevant freight futures contract.

At the start of January 1989, the value of the nearest spot futures contract, maturing at the end of January 1989, was 1605 which at $10 per index point means that a single contract would cost $16,050. Using this figure in the above equation means that, according to the prescribed optimum portfolio, the shipowner should trade 70 contracts. As is implied by the use of the term 'trade', one flaw with the Modern Portfolio Theory methodology lies with the fact that it does not prescribe what form the freight futures investment should take. That is, it does not define whether this number of contracts should be bought or sold. This decision is beyond the scope of the theory, but must necessarily hinge on the shipowner's forward position *vis a vis* future employment.

This prescribed level of futures investment represents a hedge against physical risk exposure which is not 'blind' but depends solely on the risk attitude of the investing shipowner. Clearly, the indivisibility of the amounts invested in physical market contracts means that the total market investment budget needs to be greater than a preset amount per ship per trade in order to properly apply the methodology. In relation to the example just used, the level of this budget can be minimally specified as $1,655,041 per month per Panamax ship on this route with this cargo.

The fact that risk attitude is incorporated in the methodology means that the shipowner does prefer this high level of investment in freight futures rather than in the physical market. However, this amount is exaggerated since it relates to investment in terms of commitment of resources. The fact that BIFFEX investment is highly geared means that the actual cash commitment is much smaller than this level of required investment. In fact, the level of cash commitment is only $500 per contract so the total cash commitment to freight futures implied by a total investment of $1,125,428 is only $35,000.

The indivisibility of the amounts invested in the physical market would cause immense problems where the application of the Modern Portfolio Theory methodology results in a recommended portfolio involving investment in voyage charters and time charters. It would be extremely difficult, in such a case, to apportion the total amount invested in the appropriate balance that is recommended by the analysis. The shipowner should then attempt to come as close as possible to the recommended balance within the constraint of a total market investment budget. The achievement of such an aim will still be advantageous in that, although strictly suboptimal, the final chosen portfolio is very close to the best available and, therefore, better than virtually all other alternatives.

Where it is not possible to invest at anywhere near the recommended portfolio, it might be deduced that the Modern Portfolio Theory can only successfully be applied in situations where indivisibility can be overcome.

For example, it might be the case that the theory is best applied solely to the interaction of voyage charters and freight futures. Fortunately, in the analysis undertaken within this work, the vast majority of optimal portfolios do not suffer from such an insoluble problem. However, the problem might come to the fore should the underlying structure of the market change.

It could be construed that the optimal portfolio discovered through the application of Modern Portfolio Theory represents the balance of investment that should pertain for a particular trade throughout the whole of the market. Thus, for example, in January 1989 for the HR-JAP 55,000 Dwt., coal trade to be operating at the optimal, there should no shipowners operating under time charter between Hampton Roads and Japan. All contracts of carriage should be voyage charters and, if the interquartile range is the best measure of risk, these should represent 32%, of the total market investment if freight futures are also included. However, the optimal portfolio is derived from the interaction of a particular utility function with the available investment opportunities. The utility function that this study has employed is an average for the shipping industry. As such, it is merely *representative* of an individual shipowner's specific utility function. Consequently, no such inferences may be drawn concerning the optimization of a particular trade route. Since a number of shipowners within the trade will use the methodology to optimize their own utility function, the overall balance of investment is still optimal but may not coincide with the levels prescribed when an industry average utility curve is used. It is very likely, for example, that the application of the methodology to one of the shipowners engaged in the trade may well result in an optimal portfolio which does involve time charters.

Clearly, the degree of risk aversion and risk proneness and the incidence of each, will affect the overall optimal portfolio specification. There is thus no easy way of predicting this from an analysis based on averages. If, however, some optimal balance on a specific trade was deduced, possibly by aggregating the optimal portfolios that should be held by the individual players in that market, an important question that is then raised is whether or not this optimal portfolio coincides with the actual trade portfolio. The answer to this question will determine whether Modern Portfolio Theory is really prescriptive with respect to the optimal solutions that it supplies or whether it constitutes merely a behavioural model. This is an important point insofar as the answer will determine whether shipowners will or will not make better decisions by its conscious implementation. It is usually assumed that the theory is prescriptive, but a test of its behavioural features has never really been implemented, presumably because of the extreme difficulty in doing so.

The static nature of Modern Portfolio Theory has already been alluded to. The implication is that the methodology has to be implemented on a regular basis in order to keep pace with the underlying dynamics of the shipping industry. For a number of reasons, as will be seen, this does not create any real problems. However, at every point in time that a solution is derived, the shipowner's market investment decision, at least with respect to the physical market, is constrained by what is available. The methodology may well recommend a certain proportion of a shipowner's portfolio to be held in time charters for a specific trade, but those time charters may just not be available within the market. Similarly, problems might arise from the shipowner being locked into contracts recommended by the application of the methodology from the previous time period. Clearly, there is great scope for tailoring the dynamic application of Modern Portfolio Theory to the needs of the shipowner.

The second of the problems which have just been raised is extremely difficult to surmount and is certainly beyond the scope of this work. However, the former can be alleviated by expanding the application of the methodology. Rather than applying the methodology to the solution of which contract the shipowner should invest in for a particular trade, the universal set of potential individual investments could include all trades *and* associated contracts that the shipowner is considering for the employment of a fleet composed of a specific ship size. Thus, rather than only looking at the interaction of say, voyage charters, time charters and freight futures for a 120,000 Dwt. ship employed on BRZ-NWE, the shipowner could add other available potential trades and contracts to the universal set for further consideration and analysis via the application of the Modern Portfolio Theory model.

The application of the principles and mathematical routines of Modern

Portfolio Theory to this more wide-ranging universal set of potential investments greatly increases the complexity of the problem. However, the increasing prevalence of high technology amongst the business community in general and, indeed, among shipowners means that the implementation of the investment selection process could be automated to such an extent that dealing with large universal sets of individual investments becomes increasingly viable. The increasing influence of computerization means that it is feasible that the stage may even be reached where subjective portfolio selection does become an almost routine part of the business.

If such a stage can be reached, it then becomes viable to increase the number of individual investments that can be included in a portfolio. Given the correct computerized optimal portfolio selection procedure, there is no necessity to constrain the proportion of the portfolio that a specific individual investment might comprise. This is especially the case where a shipowner has decided on a specific measure of risk to use rather than a range of measures as was the case in this study. Obviously, in order to arrive at a 'best' measure of risk, further research needs to be undertaken, but this work contributes to that research effort in the sense that it highlights the importance of the distribution of returns in shipping.

As far as the complete computerization of the methodology is concerned, this should be a relatively simple task. The individual components that comprise the methodology have already been computerized. For example, programs already exist for the determination of utility functions and for the derivation of an efficient set of portfolios. It is only necessary to integrate each of these individual programs into an overall package aimed at the determination of subjectively optimal portfolios.

A specific shipowner will be able to apply large parts of the Modern Portfolio Theory methodology in a manner which is much more simple than that outlined in this study. For example, a shipowner who is already involved in certain trades or who is looking to move into certain trades, has no cause to model his costs and returns. They are already to hand. The access to such privileged information was denied this study, so it was absolutely necessary to attempt some form of modelling process for the derivation of even just the simple inputs to the ultimate Modern Portfolio Theory model. A shipowner has day-to-day access to his own database of information with regard to costs and revenues and, through his own contacts in the industry, will have access to most, if not all, the additional information that he requires in running the methodology. Similarly, the utility function that he applies to an efficient set of portfolios should be his own.

This implies that the computerized procedure for portfolio selection should also be integrated with a shipowner's operational database since most of the information that the optimization procedure requires is already stored there. The collection of data, and the subsequent analysis of information, relating to a decision maker's utility function becomes much simpler within a computerized environment. This is evidenced in the work of Jones, Bradley & Ampt (1987) with respect to the computerized application of state preference theory.

This study has employed historical data as the basis of the calculation of expected return. This approach need not necessarily be adopted. A shipowner, in applying the methodology in his own right, may have a much better insight into the expected return from a particular contract or trade than that supplied by the analysis of historical data. Similarly, a shipowner in undertaking his own analysis, might want to include forecast values of expected return and risk. The shipowner is free to select a particular forecasting technique from a whole gamut of possibilities as described by Hampton (1986).

The fact that a shipowner can supply much better input information is particularly evident where that shipowner has already instigated a freight futures investment strategy. He need not make the assumption that futures hedging is undertaken on a 'blind' basis with the associated high risks and low returns, relative to some alternative strategy, that this implies. A shipowner who is already operating a successful futures investment strategy can build in these improved results into the model. Where a shipowner's futures investment strategy is not so successful, the application of the Modern Portfolio Theory approach may help to indicate, and subsequently eradicate, his errors.

One major advantage of the Modern Portfolio Theory approach is that it formally recognizes the importance to the investment decision of the values and attitudes, especially with regard to risk, of the decision maker. The emphasis which the methodology places upon this aspect may well serve to reinforce its importance to a decision maker in the real world. If the decision maker, when faced with a real decision, knows that his attitude to risk must be formalized in order to properly apply the approach, there is much greater likelihood of that decision maker more accurately and precisely specifying exactly what his attitudes are. Consequently, although values and attitudes, especially towards risk, do change in the light of changing circumstances, there is a much greater chance that the decision maker will become more consistent in the values and attitudes that he adopts and/or exercises. Even where this is not the case, there is a greater likelihood of the decision maker attempting to consciously explain any extant change in attitude. There is considerable benefit, therefore, merely in this formalization process which can theoretically progress to a stage whereby corporate attitude is capable of specification.

One further windfall benefit from the application of this methodology, lies with the fact that should a shipowner's information database be insufficient or inappropriate to its successful application, there is immediate motivation for an improvement in the company's information collection and collation processes. Obviously, this will prove beneficial to aspects of the shipping operation other than those relating to optimizing market investment.

Clearly, the Modern Portfolio Theory approach is based on the existence of synergistic effects in holding combinations of individual market investments. This synergy, together with a requirement for the adoption of an holistic view of market investment, forms the central core of the methodology. The adoption of this approach by shipowners would prove advantageous merely if shipowners came to perceive the benefits to be had from taking an integrated view of their general business organization and operation. In other words, the adoption of the methodology might reinforce the importance of an integrated approach to business.

In summary, the major result of this study is that Modern Portfolio Theory, in the modified form discovered and recommended herein, would constitute a major aid to management in the shipping industry if it were adopted and used. This study has concentrated on shipowners in the dry bulk sector, but the recommended modified methodology need not be limited solely to this group. Other parts of the industry may benefit equally well. Indeed, the approach does not have to be limited to market investment. Perhaps the greatest rewards to be reaped from its application lie in the area of general strategic management where the subjectively optimal portfolio relates to the employment of all a company's assets.

This study has shown some of the modifications to the pure theory which are necessary for a successful application of the model to shipping. Particularly important in this respect are the modifications that have been undertaken to facilitate the application of the methodology to the risk prone investor. This is especially significant given the comparative prevalence of such investors in shipping. These modifications and several other features need to be analysed in much greater detail. It is to this area that the next section addresses itself. However, it must be emphasized at this point that, despite the necessary modifications to the original theory, the underlying feature of the shipowning industry that makes the application of this technique feasible is that the objective of the participants in the industry is clearly not, in most cases, one of profit maximization.

Modern Portfolio Theory does cater for shipowners who *are* only interested in maximizing their profit, but additionally provides logical recommended portfolio selections where the objective of the company is not profit maximization. This study has shown that the majority of shipowners do have an attitude to risk. By definition, therefore, they cannot be profit maximizers since this attitude affects their decisions. The application of Modern Portfolio Theory is based on the more broadly defined objective of maximizing utility. This makes this methodology much more applicable than the many that are based solely on the assumption of profit maximization, especially when authorities, such as Marris (1964), have shown that the most prevalent corporate objective is for growth.

11.3 Avenues for Further Research

Inevitably, a work such as this raises more questions than it answers. Perhaps the most important area for further research lies with an analysis aimed at widening the application of Modern Portfolio Theory. This study has concentrated on the selection of optimum portfolios of contracts on specific routes. As such, the study is macro-industrial. There is great scope for the application of the theory to the actual selection of trades as well as the contracts under which those trades should operate. Because of the degree of detailed information that is required to undertake such an analysis, it is probably best implemented within the confines of a single shipping company. As a consequence, the whole-hearted cooperation of a company is required in order to facilitate such a micro-economic study.

Clearly, even if the Modern Portfolio Theory methodology does prove, theoretically, to be of invaluable assistance to shipping decision makers, this is not really of much benefit unless the shipping community accepts it as such. A study of shipping companies, such as that undertaken by Pike (1982) for the general business community, aimed at determining the investment appraisal techniques that are actively used in the industry would provide a base knowledge of the level of decision making sophistication in shipping. This could be added to by analysing the degree of acceptance or use of new decision making techniques by shipowners and then imputing the implications for

Modern Portfolio Theory. Obviously, such attitudinal analysis would involve a fair degree of sociological and psychological input.

Modern Portfolio Theory is essentially an American concept. As Amling (1984p591) points out:

> "Several national brokerage firms use MPT concepts, but their use is not widespread. The entire industry has been influenced by MPT, but its exclusive use and application is limited to about 10 percent of the investment industry."

If possible, a comparison of the degree of acceptance achieved by Modern Portfolio Theory in the United States shipping sector with that pertaining in other countries might provide a useful scale of decision making sophistication. Realistically, this is likely to be extremely low in all cases since Modern Portfolio Theory has, in the past, been practically applied almost exclusively to share investment portfolios. Consequently, its potential acceptance is likely to be much more important than its actual acceptance.

The likelihood of Modern Portfolio Theory gaining greater acceptance as a decision making tool would be greatly facilitated if an integrated suite of computer programs could be developed for its successful implementation. Because of the peculiarities of the shipping industry, it is recommended that such a development should be tailored, certainly to the industry as a whole but possibly even, to a specific company. To this end, the collaboration of an experienced exponent and user of Modern Portfolio Theory with a competent software house is required.

A great deal of scope remains for the study of appropriate risk measures in shipping. This work suggests that the best type of measure is one which does not assume a normal distribution of returns. A more detailed and wider-ranging analysis of the returns in shipping should be undertaken in an effort to confirm this characteristic of non-normality. If such a confirmation is achieved, an investigation of alternatives other than the interquartile range, but within the same family of measures, would prove extremely beneficial to the development of the methodology especially with respect to its successful implementation in the shipping industry. Examples of such measures which could be further investigated are; the semi-interquartile range, the semi-variance and the various measures of kurtosis and skewness.

Related to the measurement of risk, a much more sophisticated analysis of the application of the Capital Asset Pricing Model to shipping could prove extremely worthwhile. This study has shown that the more general simplified versions of the model are not applicable to market investment in dry bulk shipping. An analysis of the applicability of more complicated transformed versions should be undertaken. The advantage of using the Capital Asset Pricing Model to measure risk is that the measure it provides relates to the inherent risk of an individual investment once it is included in a portfolio. As a result, this measure is theoretically consistent through time and across portfolios. The successful application of a particular form of the model would thus lead to specific unique risk measures for each individual investment that is included in a portfolio. This aspect of further research is particularly important since the applied use of the Capital Asset Pricing Model is now state of the art in the U.S.A. where there is already a massive lead in the application of financial economics to real industrial decision making. Also, the determination of such a consistent risk measure facilitates the potential application of linear programming techniques to the derivation of a subjectively optimal portfolio.

The question still remains as to whether Modern Portfolio Theory constitutes a normative or a positive theory with respect to shipping. This aspect can only be investigated by undertaking a complete methodological application and then comparing prescribed results to actual results. One peculiarity of the philosophy underlying the theory is that should any difference between these two arise, then in every case, by definition, the actual result will be 'worse' than the result that leads from the prescribed portfolio of the theory. The importance of answering this question lies with the fact that if the theory is behavioural then shipping companies are already utility maximizers and, as a consequence, cannot improve their performance by implementing the Modern Portfolio Theory decision making technique.

A vast area of potential research and analysis exists within the sphere of futures trading in general and, specifically, with regard to BIFFEX. Although scope still exists for the study of futures markets in general, academic and applied literature on the subject is quite extensive. The same cannot be said in relation to freight futures. There is a complete dearth of adequate and appropriate literature and actual analysis of the market is virtually non-existent. This study has shown that the level of acceptance of freight futures as a market investment, and specifically as a hedging instrument, is minimal amongst shipowners. This assertion can be proved or disproved by an in-depth analysis of the volume of business on BIFFEX, especially with respect to levels of open interest and holding periods.

Most of the literature pertaining to BIFFEX is directed at marketing freight futures. It is limited in this respect, in that this study has shown that quite a large proportion of shipowners have used other futures markets. This would suggest that the concept of futures is not as unfamiliar to shipowners as the body of marketing literature would seem to imply and that, therefore, the reluctance of shipowners to participate in the market is probably due to a healthy distrust of the validity of the market. This can only be reinforced by the absence of objective analysis and appraisal. The BIFFEX marketing effort can at best, therefore, be regarded as patronizing and inappropriate. On reading the available marketing literature, this author has found several instances where the information presented is certainly misleading and on a few occasions, actually and grossly erroneous.

The existence of objective analysis of the freight futures market may well lead to an increased acceptance of BIFFEX, especially since its flaws will inevitably be highlighted. Shipowners, and other potential users of freight futures, must invariably be wary of any financial opportunity which is portrayed in such a good light as BIFFEX is. As this study has shown, freight futures do provide a novel and useful means of risk reduction in the dry bulk sector. It is a shame, therefore, that its full potential has not been recognized. This can hardly be unexpected, however, when the very people who control and market BIFFEX are those that are going to benefit from its increased use. This author would prefer to see the control of BIFFEX taken out of the incestuous hands of the shipping community itself, in the guise of shipbroking companies, and placed under the control of a more objective financial institution with a wider knowledge of futures markets.

The final recommendation for future work is much more general in nature and perhaps, as a consequence, the most important of all. This work has focussed on an analysis of a novel methodology for market investment. As such, it constitutes just one meagre contribution to a body of literature concerned with corporate decision making and the techniques used therein. It is extremely important that this body of knowledge is disseminated to members of the shipping community so that better decision making is facilitated. Increasing the level of financial education and awareness should be a matter of great priority in shipping circles. It is only by doing so, that the problems met during periods of shipping recession can be alleviated and minimized and the benefits to be derived from shipping booms can be fully reaped. The addition of any new technique to the armoury of decision making tools can only prove beneficial to the decisions that are made. If a decision maker is, at least, aware of a particular decision making aid or method, it is then at his discretion whether he chooses to implement the results that are derived from it. Entrepreneurial spirit need not be quelled by the adoption of such techniques since on any particular occasion there is still scope for intuitive judgement and adherence to the philosophy embodied in the saying:

> "There are three ways of losing money — horses, women and taking the advice of experts. Horses — that is the quickest; women — that is the most pleasant; but taking the advice of experts — that is the most certain."

It is the task of management educationalists, and the exponents of the various management techniques now available, to subjugate the prevalence of such feelings amongst industrial practitioners. The burden of this responsibility is not a light one, but its achievement is absolutely vital to the success of business enterprise in general and the continued survival of shipping in particular, especially in the high cost traditional maritime nations.

References

Abrahamsson; B.J. (1980) "*International Ocean Shipping: Current Concepts and Principles*", Westview Press, Boulder, Colorado.

Alderton; P.M. (1984) "*Sea Transport Operation and Economics*", 3rd ed., Thomas Reid, London.

Alexander; G.J. (1976) "The Derivation of Efficient Sets", *Journal of Financial and Quantitative Analysis*, Dec.

Amling; F. (1984) "*Investments: An Introduction to Analysis and Management*", Prentice-Hall, Englewood Cliffs, New Jersey.

Anderson; R.W. [ed.] (1984) "*The Industrial Organization of Futures Markets*", Center for Futures Markets Studies, Columbia University Graduate School of Business.

Archer; S.H. & Francis; J.C. (1979) "*Portfolio Analysis*", 2nd ed., Prentice-Hall, Englewood Cliffs, New Jersey.

Arditti; F.D. (1967) "Risk and the Required Return on Equity", *Journal of Finance*, 22, March, pp. 19-36.

Arrow; K.J. (1958) "Utility, Attitudes and Choices", *Econometrica*, Jan.

Arrow; K.J. (1971) "*Essays in the Theory of Risk-Bearing*", North-Holland Publishing, Amsterdam.

Bawa; V.S., Brown; S.J. & Klein; R.W. (1979) "*Estimation Risk and Optimal Portfolio Choice*", North-Holland Publishing, Amsterdam.

Bawa; V.S. & Chakrin; L.M. (1979) "Optimal Portfolio Choice and Equilibrium in a Lognormal Securities Market", in *Portfolio Theory, 25 Years After*, Elton; E.J. & Gruber; M.J. [eds.], North-Holland Publishing, Amsterdam.

Bayes; T. (1763) "An Essay Towards Solving a Problem in the Doctrine of Chances", in *Philosophical Transactions of the Royal Society*, Vol. 53, pp. 370-418.

Beenstock; M. & Brasse; V. (1984) "*Using Options to Price Maturity Guarantees*", Working Paper No. 67, City University Business School, London.

Bernoulli; D. (1738) "Exposition of a New Theory on the Measurement of Risk", Reprinted in *The Theory of Business Finance: A Book of Readings*, 2^{nd} ed., Archer; S.H. & D'Ambrosio; C.A. [eds.] (1976), Macmillan Publishing, New York.

Bierman; H. & Smidt; S. (1984) "*The Capital Budgeting Decision: Economic Analysis of Investment Projects*, 6^{th} ed., Macmillan Publishing, New York.

Black; F. (1976) "The Pricing of Commodity Contracts", *Journal of Financial Economics*, 3, pp. 167-179.

Black; F., Fisher; F. & Scholes; M. (1973) "The Pricing of Options and Other Corporate Liabilities", *Journal of Political Economy*, 81, May-June, pp. 637-654.

Blume; M. & Friend; I. (1975) "The Asset Structure of Individual Portfolios", *Journal of Finance*, 30, May, pp. 585-603.

Bodie; Z. & Rosansky; V.J. (1980) "Risk and Return in Commodity Futures", *Financial Analysts' Journal*, 36, pp. 3-14.

Bookstaber; R.M. (1950) "*Option Pricing and Strategies in Investing*", Addison-Wesley, Massachusetts.

Borch; K.H. (1968) "*The Economics of Uncertainty*", Princeton University Press, Princeton.

Box; G.E.P & Jenkins; G.M. (1970) "*Time Series Analysis: Forecasting and Control*", Holden-Day, San Francisco.

Branch; A.E. (1982) "*Economics of Shipping Practice and Management*", Chapman & Hall, London.

Branch; A.E. (1989) "*Elements of Shipping*", 6^{th} ed., Chapman & Hall, London.

Brealey; R. (1983) "*An Introduction to Risk and Return*", 2^{nd} ed., Basil Blackwell Publishing, Oxford.

Brehmer; B. (1987) "The Psychology of Risk", in *Risk and Decisions*, Singleton; W.T. & Hoveden; J. [eds.], Wiley & Sons, New York.

Bromwich; M. (1976) "*The Economics of Capital Budgeting*", Penguin Books, Middlesex.

Brown; B. (1979) "*Commodity Futures Markets: Their Relation to Multiple Currency Systems*", Unpublished Ph.D. thesis, London University.

Brown; B. & Geisst; C.R. (1983) "*Financial Futures Markets*", Macmillan, London.

Brown; C.P. (1975) "*Primary Commodity Control*", Oxford University Press, London.

Brown; C.P. (1980) "*The Political and Social Economy of Commodity Control*", Macmillan Press, London.

Burden; R.L. & Faires; J.D. (1985) "*Numerical Analysis*", 3^{rd} ed., PWS Publishers, Boston, Massachusetts.

Callimanopulos; G.P. (1986) "*Seatrade Business Review*", July-August, Seatrade Publications, Colchester.

Carter; S. (1987) "The Baltic Freight Index (BFI) and the BFI Contract", paper presented to seminar entitled *Freight Futures: A Practical Approach*, Cambridge, May.

Casas; J. (1981) "*Shipping Costs and Revenues*", Institute of Shipping Economics, Bremen.

Chatterjee; S. & Price; B. (1977) "*Regression Analysis by Example*", Wiley Press, New York.

Chryssos; A. (1979) "*Contribution to the Discussion on the Elements of the Investment Process Theory in Shipping and the Shipping Cycle*", Institute of Shipping Economics, Bremen.

Chrzanowski; I. (1985) "*An Introduction to Shipping Economics*", Fairway Publications, London.

Chrzanowski; I., Krzyzanowski; M & Luks; K. (1979) "*Shipping Economics and Policy: A Socialist View*", Fairplay Publications, London.

Clarkson Research Studies (1987) "*Dry Bulk Review (1987)*", Clarksons, London.

Clubley; S. (1986) "*Trading in Oil Futures*", Woodhead-Faulkner, Cambridge.

Cooley; P., Roenfeldt; R. & Modani; N.K. (1977) "Interdependence of Market Risk Measures", *Journal of Business*, 50, July, pp 356-363.

Copeland; T.E. & Weston; J.F. (1980) "*Financial Theory and Corporate Policy*", Addison-Wesley, Reading, Massachusetts.

Couper; A.D. (1972) "*The Geography of Sea Transport*", Hutchinson, London.

Cox; J.C. & Rubinstein; M. (1985) "*Options Markets*", Prentice-Hall, Englewood Cliffs, New Jersey.

Cragg; P.B. (1987) "Implementing Dillman's TDM Approach in the Design and Use of a Mail Questionnaire", *Graduate Management Research*, Vol. 3, No. 4, Autumn.

Cramer; G. (1750) "*Introduction a l'analyse des lignes courbes algébriques*", Geneva.

Croxson; R.C. (1985) "*Charter Planning in Bulk Shipping Companies Under Conditions of Uncertainty*", Unpublished M.Phil thesis, Plymouth Polytechnic.

Cullinane; K.P.B. (1989) "*A Box-Jenkins Approach to Modelling the Baltic Freight Index*", Unpublished Working Paper, Polytechnic South West, March.

Dabrowski; K. (1981) "Comments on the Mechanisms of the World Shipping Market", *Maritime Policy and Management*, Vol. 8, No. 2, pp. 85-98.

De Borger; B. & Nonneman; N. (1981) "Statistical Cost Functions for Dry Bulk Carriers", *Journal of Transport Economics and Policy*, May.

Devanney; J.W. (1971) "*Marine Decisions Under Uncertainty*", MIT, Cornell Maritime Press, Cambridge, Maryland.

Dillman; D.A. (1978) "*Mail and Telephone Surveys: The Total Design Method*", Wiley & Sons, New York.

Douglas; E.J. (1983) "*Managerial Economics: Theory, Practice and Problems*", Prentice-Hall, Englewood Cliffs, New Jersey.

Downard; J.M. (1981) "*Running Costs*", Fairway Publications, London.

Draper; N.R. & Smith; H. (1981) "*Applied Regression Analysis*", Wiley & Sons, New York.

Drewry Shipping Consultants (1986) "*The Market for Secondhand Tankers and Bulkers*", London.

Dusak; K. (1973) "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums", *Journal of Political Economy*, 81, pp. 1387-1406.

Elton; E.J. & Gruber; H.J. [eds.] (1979) "*Portfolio Theory, 25 Years After*", North-Holland Publishing, Amsterdam.

Ewart; W.D. (1983) "*Bulk Carriers*", Fairway Publications, London.

Fama; E.F. & Miller; M.H. (1972) "*The Theory of Finance*", Holt, Rinehart & Winston, New York.

Figlewski; S. (1986) "*Hedging with Financial Futures for Institutional Investors*", Ballinger,

Fischer; D.E. & Jordan; R.J. (1983) "*Security Analysis and Portfolio Management*", 3rd ed., Prentice-Hall, Englewood Cliffs, New Jersey.

Franks; J.R., Broyles; J.E. & Carleton; W.T. (1985) "*Corporate Finance: Concepts and Applications*", Kent Publishing, Boston, Massachusetts.

Friedman; M. (1976) "*Price Theory*", Aldine Publishing, Chicago, Illinois.

Friedman; M. & Savage; L.J. (1948) "The Utility Analysis of Choices Involving Risk", *Journal of Political Economy*, Vol. 56, No. 4, August.

Friedman; M. & Savage; L.J. (1952) "The Expected Utility Hypothesis and the Measurement of Utility", *Journal of Political Economy*, Vol. 60, pp. 463-474.

Gemmill; G. (1985) "*The Behaviour of the Baltic Freight Index*", confidential paper to the BIFFEX Committee.

Gemmill; G. & Dickins; P. (1984) "*An Examination of the Efficiency of the London Traded Options Market*", Working Paper No. 69, City University Business School, London.

Gitman; Joehnk; & Pinches; (1985) "*Managerial Finance*", Harper & Row, New York.

Glen; D. (1987) "*Differentiation in the Oil Tanker Market*", Unpublished Ph.D. thesis, University of London.

Glen; D. (1988) "*Shipping Cost Models: Theory and Practice*", paper presented to the Association of Polytechnic Teachers in Economics, Plymouth Polytechnic, March.

Goss; B.A. [ed.] (1986) "*Futures Markets: Their Establishment and Performance*", Croom Helm, London.

Goss; R.O. (1985) "Ship's Costs: The Overall Problem and Some Solutions", *Maritime Policy and Management*, Vol. 12, No. 1.

Goss; R.O. & Jones; C.D. (1971) "*The Economies of Size in Dry Bulk Carriers*", HMSO, London.

Gough; J. & Hill; S. (1979) "*Fundamentals of Managerial Economics*", Macmillan Press, London.

Granger; C.W.J. (1983) "*Trading in Commodities*", 4^{th} ed., Woodhead-Faulkner, Cambridge.

Gray; J.W. (1986) "*Financial Risk Management in the Shipping Industry*", Fairway Publications, London.

Gray; J.W. (1987) "*Futures and Options for Shipping*", Lloyd's of London Press, Colchester.

Green; H.A.J. (1976) "*Consumer Theory*", Macmillan Press, London.

Hampton; M. (1986) "Analysis of Shipping Cycles", *Seatrade*, Seatrade Publications, Colchester, Jan-Feb.

Hardy; D. (1979) "Marine Risk Financing", *Norwegian Shipping News*, No. 9.

Hardy Ivamy; E.R. (1979) "*Carriage of Goods by Sea*", Butterworths, London.

Harrington; D.R. (1983) "*Modern Portfolio Theory and the Capital Asset Pricing Model*", Prentice-Hall, New York.

Heaver; T. (1969) "*Economies of Vessel Size: A Study of Shipping Costs and Their Implications for Port Investment*", Ottawa N.H. Board, Ottawa.

Heaver; T. (1985) "The Treatment of Ship's Operating Costs", *Maritime Policy and Management*, 12, No.1, Jan-Mar, pp. 35-46.

Heckinger; R.A. (1985) "*Innovation and Competition in the U.S. Futures Industry Since 1960*", Unpublished M.Phil Thesis, London University, London.

Hemming; L.A.P. (1986) "*A Strategy to be Adopted by Effective Ship Investment Strategy*", Unpublished M.Sc. Thesis, Plymouth Polytechnic, Plymouth.

Herstein; I.N. (1964) "*Topics in Algebra*", Xerox College, Waltham, Massachusetts.

Herstein; T.N. & Milnor; J. (1953) "An Axiomatic Approach to Measurable Utility", *Econometrica*, pp. 291-297.

Hertz; D. (1983) "*Risk Analysis*", Wiley & Sons, New York.

Hertz; D. (1984) "*Practical Risk Analysis*", Wiley & Sons, New York.

Heywood; J. (1984) "*Using the Futures, Forward and Options Markets*", Black Publishers, London.

Hicks; J.R. (1962) "Liquidity", *Economic Journal*, Vol. 72.

Hillier; F.S. (1971) "*The Evaluation of Risky Interrelated Investments*", North-Holland, Amsterdam.

Hudig; J. (1975) "Development of Chartering and Functioning of Freight Markets", in *The Management and Techniques of Ship Chartering*, ESCAP Training Course, Singapore, Jan/Feb.

Ihre; R., Gorton; L. & Sandevärn; A. (1984) "*Shipbroking and Chartering Practice*", 2^{nd} ed., Lieberhermods, Malmö, Sweden.

Jackson; G.C. (1960) "*Drilling Decisions by Oil and Gas Operators*", Division of Research, Graduate School of Business Administration, Harvard University.

JAMRI (1983) "*Medium and Long Term Analysis of the Shipping Market (1983-1990)*", Tokyo, Sept.

JAMRI (1988) "*Medium and Long Term Analysis of the Shipping Market (1988-2000)*", Tokyo, Sept.

Jansson; J. & Shneerson; D. (1982) "The Optimal Ship Size", *Journal of Transport Economics and Policy*, 16, No. 3., September, pp. 217-238.

Jansson; J. & Shneerson; D. (1987) "*Liner Shipping Economics*", Chapman & Hall, New York.

Jefferys; H. (1931) "*Scientific Inference*", Cambridge University Press, Cambridge.

Jensen; M. (1975) "*Tests of Capital Market Theory and Implications of the Evidence*", Financial Analysts Research Foundation, Charlottesville, Virginia.

Jones; P.M., Bradley; H. & Ampt; E. (1987) "*Forecasting Household Responses to Policy Measures Using Computerised, Activity-Based, Stated Preference Techniques*", paper presented to the 5^{th} International Conference on Travel Behaviour, La Baume-Les-Aix, France.

Kates; R.W. (1976) "*Risk Assessment of Environmental Hazard*", SCOPE Report No. 8., International Council of Scientific Unions, Scientific Committee of Problems of the Environment, Paris.

Keynes; J.M. (1936) "*The General Theory of Employment, Interest and Money*", reprinted by Papermac, London (1963).

King; B. (1966) "Markets and Industry Factors in Stock Price Behaviour", *Journal of Business*, 39, Jan., pp. 139-190.

Knight; F. (1921) "*Risk, Uncertainty and Profit*", Houghton Mifflin, Boston, Massachusetts.

Kraus; A. & Litzenberger; H. (1976) "Skewness Preference and the Valuation of Risky Assets", *Journal of Finance*, 1, Sept., pp. 1085-1100.

Kroes; E.P. & Sheldon; R.J. (1988) "Stated Preference Methods: An Introduction", *Journal of Transport Economics and Policy*, Vol. 22, No. 1, Jan.

Lee, K.N. (1976) "'Assessing Danger': Book Review", *Science*, Vol. 193, July 9^{th}, p.139.

Lindley; D.V. (1965) "*Introduction to Probability and Statistics from a Bayesian Viewpoint*", Parts I & II, Cambridge University Press, Cambridge.

Lintner; J. (1965) "The Valuation of Risky Assets: The Selection of Risky Investments in Stock Portfolios and Capital Budgets", *Review of Economics and Statistics*, 47, Feb., pp. 13-37.

Lorange; P. & Norman; V.D. (1970) "*Risk Preference Patterns Among Scandinavian Tankship Operators*", Institute for Shipping Research, Bergen.

Lorange; P. & Norman; V.D. (1971) "*Risk Preference and Strategic Decision Making in Large Scandinavian Shipping Enterprises*", Institute for Shipping Research, Bergen.

Luce; R.D. & Raiffa; H. (1971) "*Games and Decisions: Introduction and Critical Survey*", Wiley & Sons, New York.

Mao; J.C.T. & Brewster; J.F. (1970) "An E-Sh Model of Capital Budgeting", *Engineering Economist*, 15, Jan-Feb, pp. 103-121.

Markowitz; H.M. (1952) "Portfolio Selection", *Journal of Finance*, March, pp. 77-91.

Markowitz; H.M. (1959) "*Portfolio Selection: Efficient Diversification of Investments*", Wiley & Sons, New York.

Marlow; P.B. & Gardner; B. (1980) "Some Thoughts on the Dry Bulk Shipping Sector", *Journal of Industrial Economics*, Vol. 29, No. 1, pp. 71-84.

Marris; R. (1964) "*Economic Theory of Managerial Capitalism*", Macmillan, London.

Martin; A.D. (1955) "Mathematical Programming of Portfolio Selections", *Management Science*, Vol. 1, No. 2, pp. 152-166.

McGuigan; J.R. & Moyer; R.C. (1983) "*Managerial Economics*", 3rd ed., West Publishing, Minnesota.

McLaney; E.J. (1986) "*Business Finance: Theory and Practice*", Pitman, London.

Metcalfe; J.V. (1959) "*The Principles of Ocean Transportation*", Simmons-Boardman, New York.

Molenaar; H.J. (1987) "Overcapacity in Bulk: Curative and Preventive Measures", *Lloyd's Shipping Economist*, Vol. 9, No. 1, p. 33, Jan.

Moreby; D.H. (1987) "*Research into Freight Futures*", Private Report to BIFFEX Committee, Sept.

Mosteller; F. & Nogee; P. (1951) "An Experimental Measure of Utility", *Journal of Political Economy*, Vol. 59, No. 5, pp. 371-404.

Nappi; C. (1979) "*Commodity Market Controls*", Lexington Books, Massachusetts.

Naylor; T.H., Vernon; J.M. & Wertz; K.L. (1983) "*Managerial Economics: Corporate Economics and Strategy*", McGraw-Hill, Tokyo.

Nersesian; R.L. (1981) "*Ships and Shipping: A Comprehensive Guide*", Pennwell Books, Tulsa.

Norman; V.D. (1981) "Market Strategies in Bulk Shipping", in *Studies in Shipping Economics*, Hope; E. [ed.], Bedriftsokonomen Forlay, Oslo.

Norman; V.D. (1982) "Profit Opportunities in Shipping", in *The Platou Report*, Oscar-Andersens, Trykkener.

100A1 (1985) "The Workhorse of the Seas", Jan.

Oakes; J. (1986) "Analysis: A Survey of Bankers' Opinion of the Shipping Industry", *Seatrade*, March, p. 25.

O'Loughlin; C. (1967) "*The Economics of Sea Transport*", Pergamon Press, Oxford.

Otway; H.J. (1973) "Risk Estimation and Evaluation", in *Proceedings of the IIASA Planning Conference on Energy Systems*, Laxenburg, Austria.

Open Univesity; The (1973) "*Galois Theory*", M202 Unit 33, The OU Press, Milton Keynes.

Packard; W.V. (1978) "*Voyage Estimating*", Fairplay Publications, London.

Packard; W.V. (1986) "*Sea-Trading*", Fairplay Publications, London.

Penfold; A. [ed.] (1982) "*Seaborne Coal Trade: Development Prospects and Bulk Carrier Employment*", Worcester Park, Surrey.

Philippatos; G.C. (1973) "*Financial Management: Theory and Techniques*", Holden-Day, San Francisco.

Phillips; H.E. & Ritchie; J.C. (1983) "*Investment Analysis and Portfolio Selection*", South-Western Publishing, Cincinatti, Ohio.

Pike; R.H. (1982) "*Capital Budgeting in the 1980's*", Institute of Cost and Management Accounting, London.

Pink; J. (1985) "*Tax Aspects of Commodity and Financial Futures*", Butterworths, London.

Ramsey; F.P. (1931) "Truth and Probability", in *Foundations of Mathematics and Other Logical Essays*, Kegan-Paul.

Ratcliffe; K.M. (1979) "*The Changing World of Dry Bulk*", paper presented to 'Commodities and Bulk Shipping in the 80's ' conference, London, Dec.

Rebell; A.L., Gordon; G. & Platwick; K.B. (1984) "*Financial Futures and Investment Strategy*", Dow Jones Irwin, Homewood, Illinois.

Reekie; W.D. (1975) "*Managerial Economics*", Philip Allan Publishers, Deddington, Oxford.

Richardson; J. (1986): Introductory Address to *International Bulk Congress*, Fairplay Publications, London.

Rinman; T. & Linden; R. (1978) "*Shipping: How it Works*", Rinman & Linden AB, Gothenberg, Sweden.

Ross; S.A. (1976) "The Arbitrage Theory of Capital Asset Pricing", *Journal of Economic Theory*, 13, pp. 341-360.

Rowe; W.D. (1977) "*An Anatomy of Risk*", Wiley & Sons, New York.

Rudd; A. & Rosenberg; B. (1979) "Realistic Portfolio Optimization", in *Portfolio Theory: 25 Years After*, Elton; E.J. & Gruber; M.J. [eds.], North-Holland Publishing, Amsterdam.

Russell; A.H. (1984) "*Optimum Margins in Traded Options*", Working Paper No. 61, City University Business School, London.

Ryan; T.M. (1978) "*Theory of Portfolio Selection*", Macmillan Press, London.

Schlaiffer; R. (1969) "*Analysis of Decisions Under Uncertainty*", McGraw-Hill, New York.

Sharpe; W.F. (1963) "A Simplified Model for Portfolio Analysis", *Management Science*, Jan., pp. 277-293.

Sharpe; W.F. (1970) "*Portfolio Theory and Capital Markets*", McGraw-Hill, New York.

Sharpe; W.F. (1985) "*Investments*", 3^{rd} ed., Prentice-Hall, Englewood Cliffs, New Jersey.

Shimojo; T. (1978) "*Cost Analysis and Business Simulation for Shipping Decision Making — Japanese Traditions*", Paper No. 18/19, Institute of Shipping Economics, Bremen.

Simkowitz; M.A. & Beedles; W.L. (1978) "Diversification in a Three-Moment World", *Journal of Finance and Quantitative Analysis*, 13, Dec., pp. 903-925.

Singleton; W.T. & Hoveden; J. [eds.] (1987) "*Risk and Decisions*", Wiley & Sons, New York.

Sloggett; J.E. (1984) "*Shipping Finance*", Fairplay Publications, London.

Stein; J.L. (1986) "*The Economics of Futures Trading*", Basil Blackwell, Oxford.

Stewart; I. (1973) "*Galois Theory*", Chapman & Hall, New York.

Stopford; M. (1988) "*Maritime Economics*", Unwin Hyman, London.

Taylor; S. (1986) "*Modelling Financial Time Series*", Wiley & Sons, Chichester.

UNCTAD (1975) "*Charter-Parties*", Report No. TD/B/C./74, Geneva.

Vandell; R.F., Harrington; D. & Levkoff; S. (1978) "*Cyclical Timing: More Return for Less Risk*", Darden School Working Paper No. 78-12, Darden Graduate School of Business Administrat; n, Charlottesville, Virginia.

Veldhuizen; P.J. (1988) "*Freight Futures: Targeting the 90's*", Lloyd's of London Press, Colchester.

Volk; B. (1984) "*Shipping Investment in Recession*", Institute of Shipping Economics, Bremen.

Von Neumann; J. & Morgenstern; O. (1953) "*Theory of Games and Economic Behaviour*", Princeton University Press, Princeton.

Wergeland; T. (1979) "A Forecasting Model for Bulk Trades", *Norwegian Shipping News*, No. 9.

Weston; J.F. & Brigham; E.F. (1979) "*Managerial Economics*, Holt, Rinehart & Winston, London.

Willett; A. (1901) "*The Economic Theory of Risk and Insurance*", University of Pennsylvania Press, Philadelphia.

Williams; J. (1986) "*The Economic Function of Futures Markets*", Cambridge University Press, Cambridge.

Yamey; B.S., Sandor; R.L. & Hindley; B. (1985) "*How Commodity Futures Markets Work*", Thames Essay No. 42, Trade Policy Research Centre, London.

Yolland; J.B. (1978) "*The Development and Supply of Specialised Dry Bulk Carriers*", Unpublished M.Phil Thesis, Plymouth Polytechnic.

Yolland; J.B. (1979) "Ship Finance and Euromarkets", *Maritime Policy and Management*, Vol. 6, NO. 3, pp. 175-181.

Yolland; J.B. (1981) "*Forecasting in Shipping*", paper presented to Lloyd's of London Press Seminar "Bulk Shipping Markets", London, Dec.

Zannetos; Z. (1972) "*Market and Cost Structure in Shipping*, Proceedings of Shipping Management Seminar, Institute of Shipping Research, Bergen.

Appendix A

The Questionnaire

Plymouth Polytechnic

Director: R.F.M. Robbins. CBE. BSc. PhD. CChem. FRSC.

Drake Circus. Plymouth. Devon. PL4 8AA. United Kingdom.
Phone: (0752) 221312 Telex: 45423 PPLRC G.

Institute of Marine Studies
Department of Shipping and Transport
Head: Professor D.H. Moreby. Extra Master. PhD. FNI.
Phone: (0752) 264667

Reply to:

Our ref:

Your ref:

Date:

Dear Sir,

Please find enclosed a questionnaire which I would be very grateful if you could complete and return in the FREEPOST envelope supplied.

This questionnaire forms part of a major research project currently being undertaken at Plymouth Polytechnic. The research is aimed at assessing current investment behaviour in the shipping industry and then attempting to develop an improved investment methodology geared towards maximising the returns while minimising the risk of an investment.

It is sincerely hoped that the fruits of these labours will be of real practical use to the shipping industry and that the application of the resultant approach to investment in shipping will prove to be a viable commercial tool.

Implicit in any investigation of investment behaviour is the requirement to assess attitudes towards risk. It is to this aspect which the questionnaire primarily addresses itself. The questionnaire also asks certain questions about your view of BIFFEX which again is relevant to an analysis of investment behaviour in shipping.

Rest assured that any responses that you make will be treated in the strictest confidence.

However, should you feel in any way apprehensive about the sensitive nature of some of the questions asked, please feel free to ignore questions 1-4 in Section A.

I would very much appreciate your cooperation in this matter and look forward to receiving your completed form. Thank you very much, in anticipation, for your time and effort.

Yours sincerely,

Kevin P.B. Cullinane

FOR OFFICE USE ONLY

S				

SECTION A

1. Name ______________________________

2. Position in Company ______________________

3. Name of Company ______________________

4. Address of Company ______________________

____

5. Are you familiar with the term "BIFFEX" (Baltic International Freight Futures Exchange)?

PLEASE TICK ONE BOX

Yes	☐	1
No	☐	2

(1)

6. How well do you understand how BIFFEX works?

PLEASE TICK ONE BOX

Very well	☐	1
Fairly well	☐	2
Only slightly	☐	3
Not at all	☐	4

(2)

7. Has your company ever used BIFFEX for hedging purposes?

PLEASE TICK ONE BOX

Yes	☐	1
No	☐	2
Don't know	☐	3

(3)

8. Has your company ever used BIFFEX for speculative purposes?

PLEASE TICK ONE BOX

Yes	☐	1
No	☐	2
Don't know	☐	3

(4)

9. Has your company ever made use of other futures markets, apart from BIFFEX, for either hedging or speculative purposes?

PLEASE TICK ONE BOX

Yes	☐	1
No	☐	2
Don't know	☐	3

(5)

FOR OFFICE USE ONLY

10. Are you familiar with the concept of an options market?

PLEASE TICK ONE BOX

Yes	☐	1	(6)
No	☐	2	

N.B. If your answer is "No", then go to Question 12.

11. If they were available, would your company trade freight options on the BIFFEX market?

PLEASE TICK ONE BOX

Yes	☐	1	(7)
No	☐	2	
Depends	☐	3	
Don't know	☐	4	

If "Depends" then please specify:- ____________

____

____

12. Do you see BIFFEX as a major innovation in the shipping industry?

PLEASE TICK ONE BOX

Yes	☐	1	(8)
No	☐	2	
Don't know	☐	3	

13. Do you think it is possible that BIFFEX contracts (in their present form) could be used as security on a loan, in much the same way as time charter contracts have been in the past?

PLEASE TICK ONE BOX

Yes	☐	1	(9)
No	☐	2	
Don't know	☐	3	

SECTION B

Guidelines to Section B

In this section you will be given a series of questions regarding your decisions in several hypothetical investment choice situations. As far as possible you should treat each choice as if it were an actual decision that you would have to make as a top executive of your company. Before making your decisions by answering the questions you should note the following points:

1. The probabilities provided should be treated as totally objective, i.e. they should be accepted as given facts where there is no possibility of deviation away from the probabilities given.

2. The payoffs referred to in each hypothetical choice situation are to be regarded as nett income figures, i.e. initial investments have already been deducted from the payoffs provided. Also, these nett figures represent discounted income streams. Thus, they should be regarded as the actual potential addition to or diminution of company wealth as a result of making the decision.

3. Each of the hypothetical choice situations should be treated as independent, so that no hypothetical or perceived gain or loss in one situation should be allowed to influence other choices.

N.B. Please read through the questions in this section before starting to answer them.

FOR OFFICE USE ONLY

Scenario 1

For the following three questions assume that your company has what you regard as a satisfactory liquidity situation, i.e. a loss of $3m would not put your company into any danger of insolvency.

1. Your company is committed to a contract which has a 25% chance of losing $3m and a 75% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (10-17)

2. Your company is committed to a contract which has a 50% chance of losing $3m and a 50% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (18-25)

3. Your company is committed to a contract which has a 75% chance of losing $3m and a 25% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (26-33)

FOR OFFICE USE ONLY

<u>Scenario 2</u>

For the following three questions assume that your company has what you regard as a weak liquidity position, i.e. A loss of $3m can be sustained without running into serious problems, but any subsequent losses could pose a serious threat to the solvency of the company.

4. Your company is committed to a contract which has a 25% chance of losing $3m and a 75% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (34-41)

5. Your company is committed to a contract which has a 50% chance of losing $3m and a 50% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (42-49)

6. Your company is committed to a contract which has a 75% chance of losing $3m and a 25% chance of making a profit of $30m. An opportunity arises whereby you may sell this contract to some third party. What is the minimum amount that you would accept for the contract?

Amount = [ ] (50-57)

FOR OFFICE USE ONLY

SECTION C

1. What is the approximate value of your company's assets? ________________ (58-62)

2. (a) In value terms, what is the main shipping activity of your company?

PLEASE TICK ONE BOX

Ship operating	☐	1
Chartering	☐	2
Shipowning	☐	3
Shipbroking	☐	4
Ship Agency	☐	5
Ship Management	☐	6
Other (Please specify)	☐	7

________________________ (63)

(b) Approximately what percentage (in value terms) of your company's total operation does the activity ticked in 2(a) represent?

PLEASE TICK ONE BOX

0-19%	☐	1
20-39%	☐	2
40-59%	☐	3
60-79%	☐	4
80-100%	☐	5

(64)

3. In terms of value, with which particular part of the shipping market does your company have most involvement?

PLEASE TICK ONE BOX

Dry cargo	☐	1
Liquid cargo	☐	2
Unitised cargo	☐	3
Passengers	☐	4
General cargo	☐	5
Cars	☐	6
Other (Please specify)	☐	7

________________________ (65)

FOR OFFICE USE ONLY

4. What is your opinion of the present financial state of the shipping industry in general?

PLEASE TICK ONE BOX

Extremely healthy	☐	1	(66)
Very healthy	☐	2	
Fairly healthy	☐	3	
Fairly depressed	☐	4	
Very depressed	☐	5	
Extremely depressed	☐	6	

5. Over the next two years, do you think dry bulk shipping markets will

PLEASE TICK ONE BOX

Improve	☐	1	(67)
Stay the same	☐	2	
Get worse	☐	3	
Don't know	☐	4	

6. How would you describe your company's current liquidity situation?

PLEASE TICK ONE BOX

Excellent	☐	1	(68)
Good	☐	2	
Average	☐	3	
Poor	☐	4	
Bad	☐	5	

7. How does this compare to the average situation over the last five years?

PLEASE TICK ONE BOX

Better	☐	1	(69)
Same	☐	2	
Worse	☐	3	

8. In general, how would you describe your company's attitude to risk as exemplified by the decisions that are made?

PLEASE TICK ONE BOX

Risk averse	☐	1	(70)
Risk prone	☐	2	
Risk neutral	☐	3	
Totally variable	☐	4	

FOR OFFICE USE ONLY

9. If necessary would you be willing to provide further assistance on this project, i.e. would you be willing to answer a follow-up questionnaire?

PLEASE TICK ONE BOX

Yes	☐	1	
No	☐	2	(71)

N.B. IF YOU ANSWERED 'YES' TO THIS QUESTION PLEASE ENSURE THAT YOU HAVE FILLED IN QUESTIONS 1-4 IN SECTION A

Appendix B

The Calculation of Voyage Charter Returns on Investment

B.1 USGC-JAP 30,000 DWT. Grain

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	327,826	37,697	365,523	63,950	429,473
FEB	343,436	38,467	381,903	63,950	445,853
MAR	337,582	37,697	375,280	63,950	439,230
APR	312,215	37,390	349,604	63,950	413,554
MAY	294,653	36,620	331,273	63,950	395,223
JUN	259,529	36,312	295,841	63,950	359,791
JUL	279,042	36,466	315,508	63,950	379,458
AUG	279,042	36,312	315,355	63,950	379,305
SEPT	286,847	36,466	323,314	63,950	387,264
OCT	282,945	37,082	320,027	63,950	383,977
NOV	261,480	37,390	298,870	63,950	362,820
DEC	286,847	38,313	325,160	63,950	389,110
JAN 1986	261,480	38,313	299,793	63,950	363,743
FEB	195,134	29,850	224,984	63,950	288,934
MAR	193,183	26,157	219,340	63,950	283,290
APR	152,205	26,157	178,362	63,950	242,312
MAY	119,032	23,080	142,112	63,950	206,062
JUN	138,545	23,080	161,625	63,950	225,575
JUL	126,837	22,772	149,610	63,950	213,560
AUG	119,032	20,772	139,804	63,950	203,754
SEPT	142,448	22,157	164,605	63,950	228,555
OCT	148,302	22,003	170,305	63,950	234,255
NOV	150,253	21,541	171,795	63,950	235,745
DEC	146,351	21,541	167,892	63,950	231,842
JAN 1987	177,572	23,849	201,422	63,950	265,372
FEB	202,940	24,926	227,866	64,950	292,816
MAR	189,280	24,465	213,745	64,950	278,695
APR	210,745	24,465	235,210	64,950	300,160
MAY	234,161	24,619	258,780	64,950	323,730
JUN	224,404	25,080	249,485	64,950	314,435
JUL	224,404	24,619	249,023	64,950	313,973
AUG	230,259	25,388	255,646	64,950	320,596
SEPT	206,842	24,619	231,461	64,950	296,411
OCT	200,988	24,311	225,299	64,950	290,249
NOV	191,232	24,926	216,158	64,950	281,108
DEC	175,621	24,926	200,547	64,950	265,497
JAN 1988	146,351	24,619	170,969	64,950	235,919

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	154,156	24,926	179,082	64,950	244,032
MAR	124,886	24,926	149,812	64,950	214,762
APR	152,205	24,619	176,823	64,950	241,773
MAY	158,059	25,080	183,139	64,950	248,089
JUN	158,059	24,772	182,831	64,950	247,781
JUL	130,740	24,003	154,743	64,950	219,693
AUG	148,302	24,157	172,459	64,950	237,409
SEPT	161,962	23,849	185,811	64,950	250,761
OCT	122,935	24,003	146.938	64,950	211,888
NOV	113,178	23,849	137,027	64,950	201,977
DEC	144,399	24,619	169,018	64,950	233,968

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	516,000	12,900	503,100	73,627	2,153
FEB	510,000	12,750	497,250	51,397	1,503
MAR	519,000	12,975	506,025	66,795	1,954
APR	522,000	13,050	508,950	95,396	2,790
MAY	504,000	12,600	491,400	96,177	2,813
JUN	489,000	12,225	476,775	116,984	3,421
JUL	390,000	9,750	380,250	792	23
AUG	420,000	10,500	409,500	30,195	883
SEPT	450,000	11,250	438,750	51,486	1,506
OCT	450,000	11,250	438,750	54,773	1,602
NOV	450,000	11,250	438,750	75,930	2,221
DEC	450,000	11,250	438,750	49,640	1,452
JAN 1986	420,000	10,500	409,500	45,757	1,338
FEB	429,000	10,725	418,275	129,341	3,783
MAR	405,000	10,125	394,875	111,585	3,263
APR	330,000	8,250	321,750	79,438	2,323
MAY	315,000	7,875	307,125	101,063	2,956
JUN	315,000	7,875	307,125	81,550	2,385
JUL	270,000	6,750	263,250	49,690	1,453
AUG	282,000	7,050	274,950	71,196	2,082
SEPT	411,000	10,275	400,725	172,170	5,035
OCT	375,000	9,375	365,625	131,370	3,842
NOV	420,000	10,500	409,500	173,755	5,082
DEC	411,000	10,275	400,725	168,883	4,939
JAN 1987	465,000	11,625	453,375	188,003	5,498
FEB	462,000	11,550	450,450	157,634	4,610
MAR	510,000	12,750	497,250	218,555	6,392
APR	528,000	13,200	514,800	214,640	6,277
MAY	585,000	14,625	570,375	246,645	7,213
JUN	480,000	12,000	468,000	153,565	4,491
JUL	555,000	13,875	541,125	227,152	6,643
AUG	630,000	15,750	614,250	293,654	8,588
SEPT	615,000	15,375	599,625	303,214	8,868
OCT	603,000	15,075	587,925	297,676	8,706
NOV	585,000	14,625	570,375	289,267	8,460
DEC	660,000	16,500	643,500	378,003	11,055
JAN 1988	750,000	18,750	731,250	495,331	14,487

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	870,000	21,750	848,250	604,218	17,671
MAR	915,000	22,875	892,125	677,363	19,810
APR	750,000	18,750	731,250	489,477	14,315
MAY	735,000	18,375	716,625	468,536	13,703
JUN	645,000	16,125	628,875	381,094	11,146
JUL	654,000	16,350	637,650	417,957	12,224
AUG	675,000	16,875	658,125	420,716	12,304
SEPT	705,000	17,625	687,375	436,614	12,769
OCT	750,000	18,750	731,250	519,362	15,189
NOV	795,000	19,875	775,125	573,148	16,762
DEC	810,000	20,250	789,750	555,782	16,254

Month	Daily Net Surplus	Return on Investment
JAN 1985	-6,241	-29.26%
FEB	-6,891	-31.60%
MAR	-6,441	-29.79%
APR	-5,604	-26.85%
MAY	-5,581	-27.47%
JUN	-4,973	-25.80%
JUL	-8,371	-42.33%
AUG	-7,511	-37.95%
SEPT	-6,888	-34.36%
OCT	-6,792	-34.04%
NOV	-6,174	-31.93%
DEC	-6,942	-34.53%
JAN 1986	-7,092	-36.60%
FEB	-4,648	-27.03%
MAR	-5,167	-30.37%
APR	-6,107	-38.75%
MAY	-5,475	-37.28%
JUN	-6,045	-39.62%
JUL	-6,977	-46.91%
AUG	-6,348	-43.49%
SEPT	-3,395	-22.02%
OCT	-4,588	-29.50%
NOV	-3,349	-21.42%
DEC	-3,491	-22.51%
JAN 1987	-2,968	-17.92%
FEB	-3,856	-22.20%
MAR	-2,075	-12.21%
APR	-2,189	-12.42%
MAY	-1,253	-6.82%
JUN	-3,975	-22.07%
JUL	-1,823	-10.10%
AUG	122	0.66%
SEPT	401	2.28%
OCT	239	1.38%
NOV	-7	-0.04%
DEC	2,589	15.49%
JAN 1988	5,984	37.51%

Month	Daily Net Surplus	Return on Investment
FEB	9,168	56.33%
MAR	11,308	73.18%
APR	5,813	36.05%
MAY	5,200	31.91%
JUN	2,643	16.29%
JUL	3,721	24.15%
AUG	3,802	23.85%
SEPT	4,267	26.09%
OCT	6,687	43.85%
NOV	8,260	55.10%
DEC	7,752	48.64%

B.2 HR-JAP 55,000 DWT. Coal

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	230,630	23,079	253,709	93,325	347,034
FEB	241,613	23,550	265,163	93,325	358,488
MAR	237,494	23,079	260,573	93,325	353,898
APR	219,648	22,891	242,539	93,325	335,864
MAY	207,293	22,420	229,712	93,325	323,037
JUN	182,582	22,231	204,814	93,325	298,139
JUL	196,310	22,325	218,636	93,325	311,961
AUG	196,310	22,231	218,542	93,325	311,867
SEPT	201,802	22,325	224,127	93,325	317,452
OCT	199,056	22,702	221,758	93,325	315,083
NOV	183,955	22,891	206,846	93,325	300,171
DEC	201,802	23,456	225,257	93,325	318,582
JAN 1986	183,955	23,456	207,411	93,325	300,736
FEB	137,280	18,275	155,555	93,325	248,880
MAR	135,907	16,014	151,921	93,325	245,246
APR	107,078	16,014	123,092	93,325	216,417
MAY	83,741	14,130	97,871	93,325	191,196
JUN	97,469	14,130	111,599	93,325	204,924
JUL	89,232	13,942	103,174	93,325	196,499
AUG	83,741	12,717	96,458	93,325	189,783
SEPT	100,214	13,565	113,779	93,325	207,104
OCT	104,333	13,471	117,803	93,325	211,128
NOV	105,706	13,188	118,894	93,325	212,219
DEC	102,960	13,188	116,148	93,325	209,473
JAN 1987	124,925	14,601	139,526	93,325	232,851
FEB	142,771	15,260	158,032	94,325	252,357
MAR	133,162	14,978	148,139	94,325	242,464
APR	148,262	14,978	163,240	94,325	257,565
MAY	164,736	15,072	179,808	94,325	274,133
JUN	157,872	15,355	173,227	94,325	267,552
JUL	157,872	15,072	172,944	94,325	267,269
AUG	161,990	15,543	177,533	94,325	271,858
SEPT	145,517	15,072	160,589	94,325	254,914
OCT	141,398	14,884	156,282	94,325	250,607
NOV	134,534	15,260	149,795	94,325	244,120
DEC	123,552	15,260	138,812	94,325	233,137
JAN 1988	102,960	15,072	118,032	94,325	212,357

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	108,451	15,260	123,712	94,325	218,037
MAR	87,859	15,260	103,120	94,325	197,445
APR	.107,078	15,072	122,150	94,325	216,475
MAY	111,197	15,355	126,551	94,325	220,876
JUN	111,197	15,166	126,363	94,325	220,688
JUL	91,978	14,695	106,673	94,325	200,998
AUG	104,333	14,789	119,122	94,325	213,447
SEPT	113,942	14,601	128,543	94,325	222,868
OCT	86,486	14,695	101,182	94,325	195,507
NOV	79,622	14,601	94,223	94,325	188,548
DEC	101,587	15,072	116,659	94,325	210,984

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	676,500	16,913	659,588	312,553	9,954
FEB	709,500	17,738	691,763	333,275	10,614
MAR	742,500	18,563	723,938	370,039	11,785
APR	770,000	19,250	750,750	414,886	13,213
MAY	715,000	17,875	697,125	374,088	11,914
JUN	632,500	15,813	616,688	318,549	10,145
JUL	577,500	14,438	563,063	251,102	7,997
AUG	572,000	14,300	557,700	245,833	7,829
SEPT	577,500	14,438	563,063	245,611	7,822
OCT	605,000	15,125	589,875	274,792	8,751
NOV	594,000	14,850	579,150	278,979	8,885
DEC	594,000	14,850	579,150	260,568	8,298
JAN 1986	550,000	13,750	536,250	235,514	7,500
FEB	550,000	13,750	536,250	287,370	9,152
MAR	467,500	11,688	455,813	210,566	6,706
APR	396,000	9,900	386,100	169,683	5,404
MAY	385,000	9,625	375,375	184,179	5,866
JUN	385,000	9,625	375,375	170,451	5,428
JUL	357,500	8,938	348,563	152,064	4,843
AUG	352,000	8,800	343,200	153,417	4,886
SEPT	561,000	14,025	546,975	339,871	10,824
OCT	522,500	13,063	509,438	298,309	9,500
NOV	511,500	12,788	498,713	286,494	9,124
DEC	478,500	11,963	466,537	257,064	8,187
JAN 1987	621,500	15,538	605,963	373,112	11,883
FEB	594,000	14,850	579,150	326,793	10,407
MAR	671,000	16,775	654,225	411,761	13,113
APR	742,500	18,563	723,938	466,372	14,853
MAY	836,000	20,900	815,100	540,967	17,228
JUN	687,500	17,188	670,313	402,761	12,827
JUL	814,000	20,350	793,650	526,381	16,764
AUG	907,500	22,688	884,813	612,954	19,521
SEPT	869,000	21,725	847,275	592,361	18,865
OCT	913,000	22,825	890,175	639,568	20,368
NOV	869,000	21,725	847,275	603,155	19,209
DEC	907,500	22,688	884,813	651,675	20,754
JAN 1988	1,072,500	26,813	1,045,688	833,331	26,539

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	1,155,000	28,875	1,126,125	908,088	28,920
MAR	1,292,500	32,313	1,260,188	1,062,743	33,845
APR	1,100,000	27,500	1,072,500	856,025	27,262
MAY	1,155,000	28,875	1,126,125	905,249	28,830
JUN	962,500	24,063	938,438	717,750	22,858
JUL	935,000	23,375	911,625	710,627	22,631
AUG	907,500	22,688	884,813	671,365	21,381
SEPT	946,000	23,650	922,350	699,482	22,276
OCT	990,000	24,750	965,250	769,743	24,514
NOV	990,000	24,750	965,250	776,702	24,736
DEC	1,045,000	26,125	1,018,875	807,891	25,729

Month	Daily Net Surplus	Return on Investment
JAN 1985	45	0.21%
FEB	705	3.22%
MAR	1,876	8.62%
APR	3,304	15.57%
MAY	2,005	9.65%
JUN	236	1.19%
JUL	-1,912	-9.42%
AUG	-2,080	-10.25%
SEPT	-2,087	-10.19%
OCT	-1,157	-5.67%
NOV	-1,024	-5.14%
DEC	-1,610	-7.85%
JAN 1986	-2,389	-12.00%
FEB	-737	-4.04%
MAR	-3,183	-17.61%
APR	-4,485	-26.23%
MAY	-4,024	-24.71%
JUN	-4,461	-26.68%
JUL	-5,046	-30.71%
AUG	-5,003	-30.86%
SEPT	935	5.52%
OCT	-389	-2.28%
NOV	-765	-4.49%
DEC	-1,702	-10.05%
JAN 1987	2,013	11.32%
FEB	538	2.93%
MAR	3,244	17.90%
APR	4,983	26.70%
MAY	7,359	38.20%
JUN	2,957	15.62%
JUL	6,894	36.23%
AUG	9,651	50.14%
SEPT	8,996	48.16%
OCT	10,499	56.51%
NOV	9,339	50.94%
DEC	10,885	60.41%
JAN 1988	16,689	95.55%

Month	Daily Net Surplus	Return on Investment
FEB	19,070	107.66%
MAR	23,996	139.78%
APR	17,412	98.82%
MAY	18,980	106.61%
JUN	13,009	73.73%
JUL	12,782	75.21%
AUG	11,531	66.39%
SEPT	12,427	70.21%
OCT	14,664	86.96%
NOV	14,886	89.45%
DEC	15,879	91.26%

B.3 BRZ-NWE 120,000 DWT. Iron Ore

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	231,186	23,460	254,647	105,658	360,305
FEB	239,840	23,460	263,301	105,658	368,959
MAR	216,351	23,989	240,340	105,658	345,998
APR	213,878	23,989	237,867	105,658	343,525
MAY	176,790	22,192	198,982	105,658	304,640
JUN	170,608	22,192	192,800	105,658	298,458
JUL	170,608	21,664	192,272	105,658	297,930
AUG	178,026	22,615	200,641	105,658	306,299
SEPT	182,971	24,094	207,065	105,658	312,723
OCT	170,608	25,046	195,654	105,658	301,312
NOV	190,389	25,363	215,751	105,658	321,409
DEC	182,971	24,517	207,488	105,658	313,146
JAN 1986	179,262	24,200	203,462	105,658	309,120
FEB	123,629	18,916	142,545	105,658	248,203
MAR	124,865	19,233	144,099	105,658	249,757
APR	101,376	19,550	120,926	105,658	226,584
MAY	77,886	14,901	92,787	105,658	198,445
JUN	70,469	11,942	82,410	105,658	188,068
JUL	64,287	10,356	74,643	105,658	180,301
AUG	82,831	12,576	95,407	105,658	201,065
SEPT	102,612	12,893	115,505	105,658	221,163
OCT	95,194	11,942	107,136	105,658	212,794
NOV	93,958	11,836	105,794	105,658	211,452
DEC	93,958	11,836	105,794	105,658	211,452
JAN 1987	124,865	15,429	140,294	105,658	245,952
FEB	111,266	14,795	126,061	135,342	261,403
MAR	121,156	14,583	135,740	135,342	271,082
APR	143,410	14,795	158,205	135,342	293,547
MAY	143,410	15,640	159,050	135,342	294,392
JUN	139,701	15,323	155,024	135,342	290,366
JUL	139,701	15,535	155,235	135,342	290,577
AUG	138,465	15,852	154,316	135,342	289,658
SEPT	121,156	14,795	135,951	135,342	271,293
OCT	124,865	15,006	139,872	135,342	275,214
NOV	116,211	15,323	131,535	135,342	266,877
DEC	108,794	15,640	124,434	135,342	259,776
JAN 1988	105,085	15,429	120,514	135,342	255,856

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	95,194	13,738	108,932	147,711	256,643
MAR	84,068	12,470	96,538	147,711	244,249
APR	111,266	15,006	126,272	147,711	273,983
MAY	96,431	14,266	110,697	147,711	258,408
JUN	97,667	13,527	111,194	147,711	258,905
JUL	89,013	12,681	101,694	147,711	249,405
AUG	91,485	12,893	104,378	147,711	252,089
SEPT	87,777	11,730	99,507	147,711	247,218
OCT	65,523	10,356	75,880	147,711	223,591
NOV	76,650	11,202	87,852	147,711	235,563
DEC	86,540	13,632	100,173	147,711	247,884

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	636,000	15,900	620,100	259,795	12,906
FEB	648,000	16,200	631,800	262,841	13,058
MAR	684,000	17,100	666,900	320,902	15,942
APR	744,000	18,600	725,400	381,875	18,971
MAY	660,000	16,500	643,500	338,860	16,834
JUN	600,000	15,000	585,000	286,542	14,235
JUL	480,000	12,000	468,000	170,070	8,449
AUG	504,000	12,600	491,400	185,101	9,196
SEPT	552,000	13,800	538,200	225,477	11,202
OCT	552,000	13,800	538,200	236,888	11,768
NOV	624,000	15,600	608,400	286,991	14,258
DEC	624,000	15,600	608,400	295,254	14,668
JAN 1986	504,000	12,600	491,400	182,280	9,056
FEB	444,000	11,100	432,900	184,697	9,176
MAR	468,000	11,700	456,300	206,543	10,261
APR	444,000	11,100	432,900	206,316	10,250
MAY	408,000	10,200	397,800	199,355	9,904
JUN	360,000	9,000	351,000	162,932	8,094
JUL	324,000	8,100	315,900	135,599	6,736
AUG	456,000	11,400	444,600	243,535	12,099
SEPT	444,000	11,100	432,900	211,737	10,519
OCT	516,000	12,900	503,100	290,306	14,422
NOV	480,000	12,000	468,000	256,548	12,745
DEC	432,000	10,800	421,200	209,748	10,420
JAN 1987	456,000	11,400	444,600	198,648	9,869
FEB	324,000	8,100	315,900	54,497	2,707
MAR	336,000	8,400	327,600	56,518	2,808
APR	540,000	13,500	526,500	232,953	11,573
MAY	672,000	16,800	655,200	360,808	17,925
JUN	564,000	14,100	549,900	259,534	12,894
JUL	720,000	18,000	702,000	411,423	20,439
AUG	756,000	18,900	737,100	447,442	22,229
SEPT	648,000	16,200	631,800	360,507	17,910
OCT	744,000	18,600	725,400	450,186	22,365
NOV	864,000	21,600	842,400	575,523	28,592
DEC	816,000	20,400	795,600	535,824	26,619
JAN 1988	852,000	21,300	830,700	574,844	28,558

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	912,000	22,800	889,200	632,557	31,425
MAR	1,080,000	27,000	1,053,000	808,751	40,178
APR	744,000	18,600	725,400	451,417	22,426
MAY	840,000	21,000	819,000	560,592	27,850
JUN	660,000	16,500	643,500	384,595	19,107
JUL	708,000	17,700	690,300	440,895	21,903
AUG	816,000	20,400	795,600	543,511	27,001
SEPT	768,000	19,200	748,800	501,582	24,918
OCT	804,000	20,100	783,900	560,309	27,836
NOV	888,000	22,200	865,800	630,237	31,310
DEC	1,020,000	25,500	994,500	746,616	37,092

Month	Daily Net Surplus	Return on Investment
JAN 1985	667	2.16%
FEB	819	2.61%
MAR	3,703	12.23%
APR	6,732	22.27%
MAY	4,595	16.30%
JUN	1,996	7.18%
JUL	-3,790	-13.71%
AUG	-3,044	-10.84%
SEPT	-1,038	-3.65%
OCT	-471	-1.69%
NOV	2,018	6.96%
DEC	2,429	8.50%
JAN 1986	-3,184	-11.28%
FEB	-3,064	-12.20%
MAR	-1,978	-7.84%
APR	-1,990	-8.27%
MAY	-2,335	-10.33%
JUN	-4,145	-18.82%
JUL	-5,503	-25.48%
AUG	-141	-0.62%
SEPT	-1,720	-7.23%
OCT	2,183	9.31%
NOV	506	2.17%
DEC	-1,819	-7.81%
JAN 1987	-2,371	-9.47%
FEB	-9,532	-37.19%
MAR	-9,431	-36.10%
APR	-666	-2.42%
MAY	5,685	20.53%
JUN	654	2.39%
JUL	8,200	29.74%
AUG	9,989	36.24%
SEPT	5,671	21.38%
OCT	10,126	37.73%
NOV	16,352	61.54%
DEC	14,380	54.97%
JAN 1988	16,319	62.74%

Month	Daily Net Surplus	Return on Investment
FEB	19,186	73.45%
MAR	27,939	108.65%
APR	10,187	38.05%
MAY	15,611	59.76%
JUN	6,867	26.49%
JUL	9,664	37.89%
AUG	14,762	57.27%
SEPT	12,679	49.77%
OCT	15,597	64.06%
NOV	19,071	76.15%
DEC	24,852	96.25%

Appendix C

The Calculation of Time Charter Returns on Investment

C.1 USGC-JAP 30,000 DWT. Grain

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	327,826	37,697	365,523	63,950	429,473
FEB	343,436	38,467	381,903	63,950	445,853
MAR	337,582	37,697	375,280	63,950	439,230
APR	312,215	37,390	349,604	63,950	413,554
MAY	294,653	36,620	331,273	63,950	395,223
JUN	259,529	36,312	295,841	63,950	359,791
JUL	279,042	36,466	315,508	63,950	379,458
AUG	279,042	36,312	315,355	63,950	379,305
SEPT	286,847	36,466	323,314	63,950	387,264
OCT	282,945	37,082	320,027	63,950	383,977
NOV	261,480	37,390	298,870	63,950	362,820
DEC	286,847	38,313	325,160	63,950	389,110
JAN 1986	261,480	38,313	299,793	63,950	363,743
FEB	195,134	29,850	224,984	63,950	288,934
MAR	193,183	26,157	219,340	63,950	283,290
APR	152,205	26,157	178,362	63,950	242,312
MAY	119,032	23,080	142,112	63,950	206,062
JUN	138,545	23,080	161,625	63,950	225,575
JUL	126,837	22,772	149,610	63,950	213,560
AUG	119,032	20,772	139,804	63,950	203,754
SEPT	142,448	22,157	164,605	63,950	228,555
OCT	148,302	22,003	170,305	63,950	234,255
NOV	150,253	21,541	171,795	63,950	235,745
DEC	146,351	21,541	167,892	63,950	231,842
JAN 1987	177,572	23,849	201,422	63,950	265,372
FEB	202,940	24,926	227,866	64,950	292,816
MAR	189,280	24,465	213,745	64,950	278,695
APR	210,745	24,465	235,210	64,950	300,160
MAY	234,161	24,619	258,780	64,950	323,730
JUN	224,404	25,080	249,485	64,950	314,435
JUL	224,404	24,619	249,023	64,950	313,973
AUG	230,259	25,388	255,646	64,950	320,596
SEPT	206,842	24,619	231,461	64,950	296,411
OCT	200,988	24,311	225,299	64,950	290,249
NOV	191,232	24,926	216,158	64,950	281,108
DEC	175,621	24,926	200,547	64,950	265,497
JAN 1988	146,351	24,619	170,969	64,950	235,919

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	154,156	24,926	179,082	64,950	244,032
MAR	124,886	24,926	149,812	64,950	214,762
APR	152,205	24,619	176,823	64,950	241,773
MAY	158,059	25,080	183,139	64,950	248,089
JUN	158,059	24,772	182,831	64,950	247,781
JUL	130,740	24,003	154,743	64,950	219,693
AUG	148,302	24,157	172,459	64,950	237,409
SEPT	161,962	23,849	185,811	64,950	250,761
OCT	122,935	24,003	146,938	64,950	211,888
NOV	113,178	23,849	137,027	64,950	201,977
DEC	144,399	24,619	169,018	64,950	233,968

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	555,985	13,900	542,086	112,613	3,293
FEB	579,204	14,480	564,724	118,871	3,477
MAR	569,161	14,229	554,932	115,703	3,384
APR	540,067	13,502	526,565	113,011	3,305
MAY	525,155	13,129	512,026	116,803	3,416
JUN	486,303	12,158	474,146	114,355	3,344
JUL	492,294	12,307	479,986	100,528	2,940
AUG	495,559	12,389	483,170	103,866	3,038
SEPT	496,680	12,417	484,263	96,999	2,837
OCT	500,231	12,506	487,725	103,749	3,034
NOV	492,751	12,319	480,432	117,613	3,440
DEC	525,880	13,147	512,733	123,623	3,616
JAN 1986	483,417	12,085	471,331	107,588	3,147
FEB	405,189	10,130	395,059	106,125	3,104
MAR	389,287	9,732	379,555	96,265	2,815
APR	348,309	8,708	339,601	97,289	2,845
MAY	305,220	7,631	297,590	91,528	2,677
JUN	324,734	8,118	316,615	91,040	2,663
JUL	312,718	7,818	304,900	91,340	2,671
AUG	306,331	7,658	298,673	94,919	2,776
SEPT	348,229	8,706	339,523	110,968	3,245
OCT	350,510	8,763	341,747	107,492	3,144
NOV	348,580	8,715	339,866	104,121	3,045
DEC	341,258	8,531	332,727	100,885	2,950
JAN 1987	385,045	9,626	375,419	110,048	3,218
FEB	412,490	10,312	402,178	109,362	3,198
MAR	425,723	10,643	415,080	136,385	3,989
APR	467,703	11,693	456,011	155,851	4,558
MAY	504,950	12,624	492,326	168,597	4,931
JUN	485,397	12,135	473,262	158,828	4,645
JUL	491,774	12,294	479,480	165,507	4,840
AUG	508,655	12,716	495,939	175,343	5,128
SEPT	484,470	12,112	472,358	175,947	5,146
OCT	478,308	11,958	466,350	176,101	5,150
NOV	472,586	11,815	460,772	179,664	5,254
DEC	480,910	12,023	468,887	203,390	5,948
JAN 1988	482,106	12,053	470,053	234,134	6,848

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	497,057	12,426	484,631	240,598	7,037
MAR	478,045	11,951	466,094	251,331	7,350
APR	505,056	12,626	492,429	250,656	7,331
MAY	504,533	12,613	491,920	243,831	7,131
JUN	493,968	12,349	481,618	233,837	6,839
JUL	493,233	12,331	480,903	261,209	7,639
AUG	504,111	12,603	491,508	254,099	7,431
SEPT	537,978	13,449	524,529	273,768	8,007
OCT	502,524	12,563	489,961	278,073	8,133
NOV	499,452	12,486	486,966	284,989	8,335
DEC	534,862	13,372	521,491	287,523	8,409

Month	Daily Net Surplus	Return on Investment
JAN 1985	-5,101	-23.88%
FEB	-4,918	-22.50%
MAR	-5,010	-23.14%
APR	-5,089	-24.37%
MAY	-4,978	-24.48%
JUN	-5,050	-26.20%
JUL	-5,454	-27.47%
AUG	-5,357	-26.99%
SEPT	-5,557	-27.67%
OCT	-5,360	-26.81%
NOV	-4,955	-25.58%
DEC	-4,779	-23.71%
JAN 1986	-5,284	-27.21%
FEB	-5,327	-31.01%
MAR	-5,615	-33.03%
APR	-5,585	-35.41%
MAY	-5,754	-39.19%
JUN	-5,768	-37.78%
JUL	-5,759	-38.64%
AUG	-5,654	-38.69%
SEPT	-5,185	-33.74%
OCT	-5,287	-34.02%
NOV	-5,385	-34.57%
DEC	-5,480	-35.44%
JAN 1987	-5,248	-31.79%
FEB	-5,268	-30.40%
MAR	-4,478	-26.45%
APR	-3,908	-22.22%
MAY	-3,536	-19.32%
JUN	-3,821	-21.21%
JUL	-3,626	-20.14%
AUG	-3,338	-18.33%
SEPT	-3,321	-18.99%
OCT	-3,316	-19.16%
NOV	-3,212	-18.86%
DEC	-2,518	-15.19%
JAN 1988	-1,655	-10.51%

Month	Daily Net Surplus	Return on Investment
FEB	-1,466	-9.16%
MAR	-1,152	-7.61%
APR	-1,172	-7.35%
MAY	-1,372	-8.50%
JUN	-1,664	-10.33%
JUL	-863	-5.65%
AUG	-1,071	-6.77%
SEPT	-496	-3.06%
OCT	-370	-2.46%
NOV	-168	-1.14%
DEC	-94	-0.60%

C.2 HR-JAP 55,000 DWT. Coal

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	230,630	23,079	253,709	93,325	347,034
FEB	241,613	23,550	265,163	93,325	358,488
MAR	237,494	23,079	260,573	93,325	353,898
APR	219,648	22,891	242,539	93,325	335,864
MAY	207,293	22,420	229,712	93,325	323,037
JUN	182,582	22,231	204,814	93,325	298,139
JUL	196,310	22,325	218,636	93,325	311,961
AUG	196,310	22,231	218,542	93,325	311,867
SEPT	201,802	22,325	224,127	93,325	317,452
OCT	199,056	22,702	221,758	93,325	315,083
NOV	183,955	22,891	206,846	93,325	300,171
DEC	201,802	23,456	225,257	93,325	318,582
JAN 1986	183,955	23,456	207,411	93,325	300,736
FEB	137,280	18,275	155,555	93,325	248,880
MAR	135,907	16,014	151,921	93,325	245,246
APR	107,078	16,014	123,092	93,325	216,417
MAY	83,741	14,130	97,871	93,325	191,196
JUN	97,469	14,130	111,599	93,325	204,924
JUL	89,232	13,942	103,174	93,325	196,499
AUG	83,741	12,717	96,458	93,325	189,783
SEPT	100,214	13,565	113,779	93,325	207,104
OCT	104,333	13,471	117,803	93,325	211,128
NOV	105,706	13,188	118,894	93,325	212,219
DEC	102,960	13,188	116,148	93,325	209,473
JAN 1987	124,925	14,601	139,526	93,325	232,851
FEB	142,771	15,260	158,032	94,325	252,357
MAR	133,162	14,978	148,139	94,325	242,464
APR	148,262	14,978	163,240	94,325	257,565
MAY	164,736	15,072	179,808	94,325	274,133
JUN	157,872	15,355	173,227	94,325	267,552
JUL	157,872	15,072	172,944	94,325	267,269
AUG	161,990	15,543	177,533	94,325	271,858
SEPT	145,517	15,072	160,589	94,325	254,914
OCT	141,398	14,884	156,282	94,325	250,607
NOV	134,534	15,260	149,795	94,325	244,120
DEC	123,552	15,260	138,812	94,325	233,137
JAN 1988	102,960	15,072	118,032	94,325	212,357

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	108,451	15,260	123,712	94,325	218,037
MAR	87,859	15,260	103,120	94,325	197,445
APR	107,078	15,072	122,150	94,325	216,475
MAY	111,197	15,355	126,551	94,325	220,876
JUN	111,197	15,166	126,363	94,325	220,688
JUL	91,978	14,695	106,673	94,325	200,998
AUG	104,333	14,789	119,122	94,325	213,447
SEPT	113,942	14,601	128,543	94,325	222,868
OCT	86,486	14,695	101,182	94,325	195,507
NOV	79,622	14,601	94,223	94,325	188,548
DEC	101,587	15,072	116,659	94,325	210,984

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	516,594	12,915	503,680	156,645	4,989
FEB	524,908	13,123	511,785	153,297	4,882
MAR	517,178	12,929	504,249	150,351	4,788
APR	496,004	12,400	483,604	147,740	4,705
MAY	476,897	11,922	464,975	141,938	4,520
JUN	448,859	11,221	437,637	139,499	4,443
JUL	450,121	11,253	438,868	126,907	4,042
AUG	453,167	11,329	441,837	129,971	4,139
SEPT	458,752	11,469	447,283	129,831	4,135
OCT	459,523	11,488	448,035	132,952	4,234
NOV	457,171	11,429	445,742	145,571	4,636
DEC	481,862	12,047	469,816	151,233	4,816
JAN 1986	442,036	11,051	430,985	130,249	4,148
FEB	382,330	9,558	372,772	123,892	3,946
MAR	378,696	9,467	369,229	123,983	3,948
APR	342,017	8,550	333,467	117,050	3,728
MAY	321,506	8,038	313,468	122,272	3,894
JUN	335,234	8,381	326,853	121,929	3,883
JUL	318,959	7,974	310,985	114,486	3,646
AUG	316,953	7,924	309,029	119,246	3,798
SEPT	348,404	8,710	339,694	132,590	4,223
OCT	360,278	9,007	351,271	140,143	4,463
NOV	353,519	8,838	344,681	132,462	4,219
DEC	335,073	8,377	326,696	117,223	3,733
JAN 1987	389,851	9,746	380,105	147,254	4,690
FEB	409,357	10,234	399,123	146,766	4,674
MAR	415,164	10,379	404,785	162,321	5,169
APR	445,965	11,149	434,816	177,251	5,645
MAY	493,933	12,348	481,585	207,452	6,607
JUN	471,652	11,791	459,860	192,309	6,124
JUL	474,509	11,863	462,646	195,377	6,222
AUG	516,778	12,919	503,859	232,001	7,389
SEPT	493,554	12,339	481,215	226,301	7,207
OCT	526,927	13,173	513,754	263,147	8,380
NOV	526,720	13,168	513,552	269,432	8,581
DEC	515,737	12,893	502,844	269,707	8,589
JAN 1988	542,057	13,551	528,506	316,149	10,068

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	594,837	14,871	579,966	361,929	11,526
MAR	621,345	15,534	605,811	408,366	13,005
APR	640,375	16,009	624,366	407,891	12,990
MAY	613,376	15,334	598,042	377,166	12,012
JUN	558,238	13,956	544,282	323,594	10,306
JUL	514,998	12,875	502,123	301,125	9,590
AUG	583,967	14,599	569,368	355,921	11,335
SEPT	612,228	15,306	596,923	374,054	11,913
OCT	578,587	14,465	564,122	368,615	11,739
NOV	581,048	14,526	566,522	377,974	12,037
DEC	603,484	15,087	588,397	377,413	12,020

Month	Daily Net Surplus	Return on Investment
JAN 1985	-4,920	-23.02%
FEB	-5,027	-23.12%
MAR	-5,121	-23.72%
APR	-5,204	-24.78%
MAY	-5,389	-26.19%
JUN	-5,466	-27.66%
JUL	-5,867	-29.04%
AUG	-5,770	-28.56%
SEPT	-5,774	-28.33%
OCT	-5,675	-27.94%
NOV	-5,273	-26.59%
DEC	-5,092	-24.92%
JAN 1986	-5,741	-28.97%
FEB	-5,944	-32.80%
MAR	-5,941	-33.00%
APR	-6,161	-36.13%
MAY	-5,995	-36.93%
JUN	-6,006	-36.00%
JUL	-6,243	-38.07%
AUG	-6,091	-37.64%
SEPT	-5,667	-33.81%
OCT	-5,426	-32.11%
NOV	-5,671	-33.50%
DEC	-6,156	-36.58%
JAN 1987	-5,180	-29.44%
FEB	-5,195	-28.50%
MAR	-4,700	-26.22%
APR	-4,224	-22.93%
MAY	-3,263	-17.18%
JUN	-3,745	-19.96%
JUL	-3,647	-19.44%
AUG	-2,481	-13.10%
SEPT	-2,662	-14.48%
OCT	-1,489	-8.15%
NOV	-1,289	-7.13%
DEC	-1,280	-7.23%
JAN 1988	219	1.28%

Month	Daily Net Surplus	Return on Investment
FEB	1,677	9.71%
MAR	3,156	18.97%
APR	3,140	18.20%
MAY	2,162	12.44%
JUN	456	2.63%
JUL	-260	-1.56%
AUG	1,485	8.68%
SEPT	2,063	11.83%
OCT	1,890	11.43%
NOV	2,188	13.41%
DEC	2,170	12.73%

C.3 BRZ-NWE 120,000 DWT. Iron Ore

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
JAN 1985	231,186	23,460	254,647	105,658	360,305
FEB	239,840	23,460	263,301	105,658	368,959
MAR	216,351	23,989	240,340	105,658	345,998
APR	213,878	23,989	237,867	105,658	343,525
MAY	176,790	22,192	198,982	105,658	304,640
JUN	170,608	22,192	192,800	105,658	298,458
JUL	170,608	21,664	192,272	105,658	297,930
AUG	178,026	22,615	200,641	105,658	306,299
SEPT	182,971	24,094	207,065	105,658	312,723
OCT	170,608	25,046	195,654	105,658	301,312
NOV	190,389	25,363	215,751	105,658	321,409
DEC	182,971	24,517	207,488	105,658	313,146
JAN 1986	179,262	24,200	203,462	105,658	309,120
FEB	123,629	18,916	142,545	105,658	248,203
MAR	124,865	19,233	144,099	105,658	249,757
APR	101,376	19,550	120,926	105,658	226,584
MAY	77,886	14,901	92,787	105,658	198,445
JUN	70,469	11,942	82,410	105,658	188,068
JUL	64,287	10,356	74,643	105,658	180,301
AUG	82,831	12,576	95,407	105,658	201,065
SEPT	102,612	12,893	115,505	105,658	221,163
OCT	95,194	11,942	107,136	105,658	212,794
NOV	93,958	11,836	105,794	105,658	211,452
DEC	93,958	11,836	105,794	105,658	211,452
JAN 1987	124,865	15,429	140,294	105,658	245,952
FEB	111,266	14,795	126,061	135,342	261,403
MAR	121,156	14,583	135,740	135,342	271,082
APR	143,410	14,795	158,205	135,342	293,547
MAY	143,410	15,640	159,050	135,342	294,392
JUN	139,701	15,323	155,024	135,342	290,366
JUL	139,701	15,535	155,235	135,342	290,577
AUG	138,465	15,852	154,316	135,342	289,658
SEPT	121,156	14,795	135,951	135,342	271,293
OCT	124,865	15,006	139,872	135,342	275,214
NOV	116,211	15,323	131,535	135,342	266,877
DEC	108,794	15,640	124,434	135,342	259,776
JAN 1988	105,085	15,429	120,514	135,342	255,856

Month	Cost of Heavy Fuel Oil	Cost of Diesel Oil	Total Bunker Cost	Other Voyage Costs	Total Voyage Cost
FEB	95,194	13,738	108,932	147,711	256,643
MAR	84,068	12,470	96,538	147,711	244,249
APR	111,266	15,006	126,272	147,711	273,983
MAY	96,431	14,266	110,697	147,711	258,408
JUN	97,667	13,527	111,194	147,711	258,905
JUL	89,013	12,681	101,694	147,711	249,405
AUG	91,485	12,893	104,378	147,711	252,089
SEPT	87,777	11,730	99,507	147,711	247,218
OCT	65,523	10,356	75,880	147,711	223,591
NOV	76,650	11,202	87,852	147,711	235,563
DEC	86,540	13,632	100,173	147,711	247,884

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
JAN 1985	519,324	12,983	506,341	146,036	7,255
FEB	527,978	13,199	514,779	145,820	7,244
MAR	507,030	12,676	494,354	148,357	7,370
APR	502,544	12,564	489,981	146,456	7,276
MAY	455,608	11,390	444,217	139,578	6,934
JUN	447,413	11,185	436,228	137,770	6,844
JUL	442,859	11,071	431,787	133,858	6,650
AUG	451,228	11,281	439,947	133,648	6,640
SEPT	453,627	11,341	442,286	129,563	6,437
OCT	446,241	11,156	435,085	133,773	6,646
NOV	466,338	11,658	454,680	133,271	6,621
DEC	458,075	11,452	446,623	133,477	6,631
JAN 1986	445,998	11,150	434,848	125,727	6,246
FEB	381,055	9,526	371,529	123,325	6,127
MAR	364,492	9,112	355,380	105,623	5,247
APR	337,294	8,432	328,861	102,277	5,081
MAY	309,154	7,729	301,426	102,981	5,116
JUN	298,778	7,469	291,308	103,240	5,129
JUL	291,011	7,275	283,736	103,434	5,139
AUG	311,775	7,794	303,980	102,915	5,113
SEPT	352,001	8,800	343,201	122,039	6,063
OCT	343,633	8,591	335,042	122,248	6,073
NOV	342,291	8,557	333,733	122,281	6,075
DEC	342,291	8,557	333,733	122,281	6,075
JAN 1987	376,791	9,420	367,371	121,419	6,032
FEB	392,242	9,806	382,436	121,033	6,013
MAR	411,985	10,300	401,686	130,604	6,488
APR	444,514	11,113	433,401	139,855	6,948
MAY	461,463	11,537	449,926	155,534	7,727
JUN	449,385	11,235	438,151	147,785	7,342
JUL	465,700	11,642	454,057	163,480	8,122
AUG	486,923	12,173	474,750	185,091	9,195
SEPT	468,558	11,714	456,844	185,551	9,218
OCT	486,568	12,164	474,404	199,191	9,896
NOV	488,296	12,207	476,088	209,212	10,394
DEC	541,582	13,540	528,043	268,267	13,327
JAN 1988	533,636	13,341	520,295	264,440	13,137

Month	Gross Freight Revenue	Commission	Net Freight Revenue	Gross Voyage Surplus	Daily Gross Voyage Surplus
FEB	540,463	13,512	526,951	270,308	13,429
MAR	558,262	13,957	544,305	300,056	14,907
APR	587,996	14,700	573,296	299,313	14,870
MAY	550,279	13,757	536,522	278,114	13,817
JUN	530,647	13,266	517,380	258,476	12,841
JUL	517,121	12,928	504,193	254,788	12,658
AUG	529,870	13,247	516,623	264,534	13,142
SEPT	533,050	13,326	519,724	272,506	13,538
OCT	525,526	13,138	512,388	288,797	14,347
NOV	537,498	13,437	524,061	288,498	14,332
DEC	549,819	13,745	536,074	288,190	14,317

Month	Daily Net Surplus	Return on Investment
JAN 1985	-4,984	-16.19%
FEB	-4,995	-16.00%
MAR	-4,869	-16.20%
APR	-4,963	-16.58%
MAY	-5,305	-18.99%
JUN	-5,395	-19.53%
JUL	-5,589	-20.26%
AUG	-5,600	-19.99%
SEPT	-5,803	-20.48%
OCT	-5,594	-20.15%
NOV	-5,618	-19.52%
DEC	-5,608	-19.77%
JAN 1986	-5,993	-21.29%
FEB	-6,113	-24.41%
MAR	-6,992	-27.86
APR	-7,158	-29.93%
MAY	-7,123	-31.68%
JUN	-7,110	-32.39%
JUL	-7,101	-32.94%
AUG	-7,126	-31.51%
SEPT	-6,176	-26.10%
OCT	-6,166	-26.53%
NOV	-6,164	-26.61%
DEC	-6.164	-26.61%
JAN 1987	-6,207	-24.90%
FEB	-6,226	-24.22%
MAR	-5,751	-21.94%
APR	-5,291	-19.33%
MAY	-4,512	-16.45%
JUN	-4,897	-17.99%
JUL	-4,118	-15.11%
AUG	-3,044	-11.18%
SEPT	-3,021	-11.49%
OCT	-2,344	-8.84%
NOV	-1,846	-7.07%
DEC	1,088	4.21%
JAN 1988	898	3.51%

Month	Daily Net Surplus	Return on Investment
FEB	1,189	4.64%
MAR	2,667	10.64%
APR	2,630	9.90%
MAY	1,577	6.12%
JUN	602	2.34%
JUL	418	1.66%
AUG	903	3.55%
SEPT	1,299	5.16%
OCT	2,108	8.78%
NOV	2,093	8.51%
DEC	2,078	8.23%

Appendix D

The Calculation of Freight Futures Returns on Investment

D.1 USGC-JAP 30,000 DWT. Grain

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
01-05-1985	17.5	1062	981	16.17	484,958
05-06-1985	17.5	931	882	16.58	497,368
10-07-1985	17.5	792.5	788.5	17.41	522,350
31-07-1985	17.5	725.5	725.5	*****	******
01-08-1985	17.5	718.5	770	18.75	562,630
14-08-1985	17.5	718.5	814	19.83	594,781
18-09-1985	17.5	765	846	19.35	580,588
23-10-1985	17.5	898.5	905	17.63	528,798
31-10-1985	17.5	905	903	*****	******
01-11-1985	16.4	906.5	910	16.46	493,900
27-11-1985	16.4	900	899	16.38	491,453
02-01-1986	16.4	897.5	893.5	16.33	489,807
31-01-1986	16.4	831	853	*****	******
03-02-1986	16.4	827.5	899.5	17.83	534,808
05-02-1986	16.4	811.5	874	17.66	529,893
12-03-1986	16.4	742.5	845	18.66	559,919
16-04-1986	16.4	681	672	16.18	485,498
30-04-1986	16.4	658.5	661.5	*****	******
01-05-1986	10.2	658	657.5	10.19	305,767
21-05-1986	10.2	665	646.5	9.92	297,487
25-06-1986	10.2	620.5	593	9.75	292,438
30-07-1986	10.2	556.5	561	10.28	308,474
31-07-1986	10.2	553.5	560.5	*****	******
01-08-1986	10.2	556	641	11.76	352,781
03-09-1986	10.2	700	826	12.04	361,080
08-10-1986	10.2	795	784	10.06	301,766
31-10-1986	10.2	786.5	786	*****	******
01-11-1986	10.2	784	747.5	9.73	291,754
12-11-1986	14	781	737.5	13.22	396,607
17-12-1986	13.7	700.5	679.5	13.29	398,679
21-01-1987	15.5	853.5	840	15.25	457,645
31-01-1987	15.5	866.5	864.5	*****	******
02-02-1987	15.4	861.5	762	13.62	408,641
25-02-1987	15.4	848.5	795.5	14.44	433,142
01-04-1987	17.6	998	1032	18.20	545,988
30-04-1987	17.6	1019.5	1015	*****	******
01-05-1987	19.5	1025	938	17.84	535,346

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
06-05-1987	19.5	1034	970	18.29	548,791
10-06-1987	16.2	980.5	870	14.37	431,229
15-07-1987	16.2	923.5	926	16.24	487,316
31-07-1987	16.2	976.5	971.5	*****	******
03-08-1987	16.2	982.5	1114	18.37	551,047
19-08-1987	16.2	1129	1180	16.93	507,954
23-09-1987	16.2	1026.5	1071	16.90	507,069
28-10-1987	16.2	1158	1157	16.19	485,580
31-10-1987	16.2	1171.5	1159	*****	******
02-11-1987	16.2	1172.5	1232	17.02	510,663
02-12-1987	22.0	1213.5	1277	23.15	694,536
06-01-1988	25.0	1284.5	1348	26.24	787,077
31-01-1988	25.0	1393	1391	*****	******
01-02-1988	29.0	1399.5	1515	31.39	941,801
10-02-1988	29.0	1516	1549	29.63	888,938
16-03-1988	30.5	1596.5	1670	31.90	957,125
20-04-1988	25.0	1475	1418.5	24.04	721,271
30-04-1988	25.0	1358	1380	*****	******
01-05-1988	24.5	1345	1229.5	22.40	671,883
25-05-1988	24.5	1404	1265	22.07	662,233
29-06-1988	21.5	1224	1205	21.17	634,988
31-07-1988	21.8	1197	1198	*****	******
01-08-1988	22.5	1196	1245	23.42	702,655
03-08-1988	22.5	1192	1240	23.41	702,181
31-08-1988	22.5	1267	1261	*****	******
01-09-1988	23.5	1272	1375	25.40	762,087
07-09-1988	23.5	1277	1347	24.79	743,645
30-09-1988	23.5	1270	1274	*****	******
03-10-1988	25.0	1275	1357	26.61	798,235
12-10-1988	25.0	1305	1357	26.00	779,885
31-10-1988	25.0	1373	1368	*****	******
01-11-1988	26.5	1378	1464	28.15	844,615
16-11-1988	26.5	1473	1520	27.35	820,367
30-11-1988	26.5	1501	1510	*****	******
01-12-1988	27.0	1501	1487	26.75	802,445
21-12-1988	27.0	1523	1566	27.76	832,869
30-12-1988	27.0	1543	1590	*****	******

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
01-05-1985	290,975	30	294,300	buy	900
05-06-1985	298,421	34	299,880	buy	1,020
10-07-1985	313,410	40	315,400	buy	1,200
31-07-1985	******	**	******	***	****
01-08-1985	337,578	44	338,800	buy	1,320
14-08-1985	356,868	44	358,160	buy	1,320
18-09-1985	348,353	42	355,320	buy	1,260
23-10-1985	317,279	36	325,800	buy	1,080
31-10-1985	******	**	******	***	****
01-11-1985	296,340	33	300,300	buy	990
27-11-1985	294,872	33	296,670	buy	990
02-01-1986	293,884	33	294,855	buy	990
31-01-1986	******	**	******	***	****
03-02-1986	320,885	36	323,820	buy	1,080
05-02-1986	317,936	37	323,380	buy	1,110
12-03-1986	335,952	40	338,000	buy	1,200
16-04-1986	291,299	44	295,680	buy	1,320
30-04-1986	******	**	******	***	****
01-05-1986	183,460	28	184,100	buy	840
21-05-1986	178,492	28	181,020	buy	840
25-06-1986	175,463	30	177,900	buy	900
30-07-1986	185,085	33	185,130	buy	990
31-07-1986	******	**	******	***	****
01-08-1986	211,668	34	217,940	buy	1,020
03-09-1986	216,648	27	223,020	buy	810
08-10-1986	181,060	24	188,160	buy	720
31-10-1986	******	**	******	***	****
01-11-1986	175,052	24	179,400	buy	720
12-11-1986	428,335	59	435,125	buy	1,770
17-12-1986	430,573	64	434,880	sell	1,920
21-01-1987	494,257	59	495,600	buy	1,770
31-01-1987	******	**	******	***	****
02-02-1987	441,332	58	441,960	buy	1,740
25-02-1987	467,793	59	469,345	buy	1,770
01-04-1987	589,667	58	598,560	sell	1,740
30-04-1987	******	**	******	***	****
01-05-1987	578,174	62	581,560	sell	1,860

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
06-05-1987	592,694	62	601,400	sell	1,860
10-06-1987	258,737	30	261,000	sell	900
15-07-1987	292,389	32	296,320	sell	960
31-07-1987	******	**	******	***	****
03-08-1987	330,628	30	334,200	sell	900
19-08-1987	304,772	26	306,800	buy	780
23-09-1987	304,241	29	310,590	buy	870
28-10-1987	291,348	26	300,820	buy	780
31-10-1987	******	**	******	***	****
02-11-1987	306,398	25	308,000	buy	750
02-12-1987	750,099	59	753,430	sell	1,770
06-01-1988	850,043	64	862,720	sell	1,920
31-01-1988	******	**	******	***	****
01-02-1988	1,017,145	68	1,030,200	sell	2,040
10-02-1988	960,053	62	960,380	sell	1,860
16-03-1988	1,033,695	62	1,035,400	buy	1,860
20-04-1988	778,973	55	780,175	buy	1,650
30-04-1988	******	**	******	***	****
01-05-1988	725,634	60	737,700	buy	1,800
25-05-1988	715,212	57	721,050	buy	1,710
29-06-1988	685,787	57	686,850	sell	1,710
31-07-1988	******	**	******	***	****
01-08-1988	758,867	61	759,450	sell	1,830
03-08-1988	758,356	62	768,800	buy	1,860
31-08-1988	******	**	******	***	****
01-09-1988	823,054	60	825,000	buy	1,800
07-09-1988	803,137	60	808,200	sell	1,800
30-09-1988	******	**	******	***	****
03-10-1988	862,094	64	868,480	sell	1,920
12-10-1988	842,276	63	854,910	buy	1,890
31-10-1988	******	**	******	***	****
01-11-1988	912,185	63	922,320	buy	1,890
16-11-1988	885,996	59	896,800	buy	1,770
30-11-1988	******	**	******	***	****
01-12-1988	866,641	59	877,330	buy	1,770
21-12-1988	899,499	58	908,280	sell	1,740
30-12-1988	******	**	******	***	****

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
01-05-1985	295,200	*******	*******	*******	*******
05-06-1985	300,900	264,600	-29,700	-29,700	-30,600
10-07-1985	316,600	268,090	-31,790	-31,790	-32,810
31-07-1985	******	290,200	-25,200	-25,200	-26,400
01-08-1985	340,120	*******	*******	*******	*******
14-08-1985	359,480	358,160	19,360	19,360	18,040
18-09-1985	356,580	372,240	14,080	14,080	12,760
23-10-1985	326,880	380,100	24,780	24,780	23,520
31-10-1985	******	325,080	-720	-720	-1,800
01-11-1985	301,290	*******	*******	*******	*******
27-11-1985	297,660	296,670	-3,630	-3,630	-4,620
02-01-1986	295,845	294,855	-1,815	-1,815	-2,805
31-01-1986	******	281,490	-13,365	-13,365	-14,355
03-02-1986	324,900	*******	*******	*******	*******
05-02-1986	324,490	314,640	-9,180	-9,180	-10,260
12-03-1986	339,200	312,650	-10,730	-10,730	-11,840
16-04-1986	297,000	268,800	-69,200	-69,200	-70,400
30-04-1986	******	291,060	-4,620	-4,620	-5,940
01-05-1986	184,940	*******	*******	*******	*******
21-05-1986	181,860	181,020	-3,080	-3,080	-3,920
25-06-1986	178,800	166,040	-14,980	-14,980	-15,820
30-07-1986	186,120	168,300	-9,600	-9,600	-10,500
31-07-1986	******	184,965	-165	-165	-1,155
01-08-1986	218,960	*******	*******	*******	*******
03-09-1986	223,830	280,840	62,900	62,900	61,880
08-10-1986	188,880	211,680	-11,340	-11,340	-12,150
31-10-1986	******	188,640	480	480	-240
01-11-1986	180,120	*******	*******	*******	*******
12-11-1986	436,895	177,000	-2,400	-2,400	-3,120
17-12-1986	436,800	400,905	-34,220	-34,220	-35,990
21-01-1987	497,370	537,600	102,720	-102,720	-104,640
31-01-1987	******	510,055	14,455	14,455	12,685
02-02-1987	443,700	*******	*******	*******	*******
25-02-1987	471,115	461,390	19,430	19,430	17,690
01-04-1987	600,300	608,880	139,535	139,535	137,765
30-04-1987	******	588,700	-9,860	9,860	8,120
01-05-1987	583,420	*******	*******	*******	*******

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
06-05-1987	603,260	601,400	19,840	-19,840	-21,700
10-06-1987	261,900	539,400	-62,000	62,000	60,140
15-07-1987	297,280	277,800	16,800	-16,800	-17,700
31-07-1987	******	310,880	14,560	-14,560	-15,520
03-08-1987	335,100	*******	*******	*******	*******
19-08-1987	307,580	354,000	19,800	-19,800	-20,700
23-09-1987	311,460	278,460	-28,340	-28,340	-29,120
28-10-1987	301,600	335,530	24,940	24,940	24,070
31-10-1987	******	301,340	520	520	-260
02-11-1987	308,750	*******	*******	*******	*******
02-12-1987	755,200	319,250	11,250	11,250	10,500
06-01-1988	864,640	795,320	41,890	-41,890	-43,660
31-01-1988	******	890,240	27,520	-27,520	-29,440
01-02-1988	1,032,240	*******	*******	*******	*******
10-02-1988	962,240	1,053,320	23,120	-23,120	-25,160
16-03-1988	1,037,260	1,035,400	75,020	-75,020	-76,880
20-04-1988	781,825	879,470	-155,930	-155,930	-157,790
30-04-1988	******	759,000	-21,175	-21,175	-22,825
01-05-1988	739,500	*******	*******	*******	*******
25-05-1988	722,760	759,000	21,300	21,300	19,500
29-06-1988	688,560	686,850	-34,200	-34,200	-35,910
31-07-1988	******	682,860	-3,990	3,990	2,280
01-08-1988	761,280	*******	*******	*******	*******
03-08-1988	770,660	756,400	-3,050	3,050	1,220
31-08-1988	******	781,820	13,020	13,020	11,160
01-09-1988	826,800	*******	*******	*******	*******
07-09-1988	810,000	808,200	-16,800	-16,800	-18,600
30-09-1988	******	764,400	-43,800	43,800	42,000
03-10-1988	870,400	*******	*******	*******	*******
12-10-1988	856,800	868,480	0	0	-1,920
31-10-1988	******	861,840	6,930	6,930	5,040
01-11-1988	924,210	*******	*******	*******	*******
16-11-1988	898,570	957,600	35,280	35,280	33,390
30-11-1988	******	890,900	-5,900	-5,900	-7,670
01-12-1988	879,100	*******	*******	*******	*******
21-12-1988	910,020	923,940	46,610	46,610	44,840
30-12-1988	******	922,200	13,920	-13,920	-15,660

Month	Monthly Return	Monthly Costs	Return on Investment
MAY 1985	-27,103	261,463	-10.37%
JUN	-27,870	257,263	-10.83%
JUL	-34,837	393,974	-8.84%
AUG	24,602	524,995	4.69%
SEPT	14,934	307,049	4.86%
OCT	12,984	551,016	2.36%
NOV	-4,941	335,308	-1.47%
DEC	-2,484	263,642	-0.94%
JAN 1986	-14,355	295,845	-4.85%
FEB	-19,055	565,950	-3.37%
MAR	-47,296	296,652	-15.94%
APR	-32,089	422,989	-7.59%
MAY	-8,892	242,096	-3.67%
JUN	-12,648	155,355	-8.14%
JUL	-9,855	334,269	-2.95%
AUG	56,420	199,640	28.26%
SEPT	-3,913	191,989	-2.04%
OCT	-3,017	240,041	-1.26%
NOV	-24,714	442,257	-5.59%
DEC	-65,221	386,918	-16.86%
JAN 1987	-41,130	722,010	-5.70%
FEB	37,371	511,002	7.31%
MAR	118,364	424,513	27.88%
APR	7,840	579,600	1.35%
MAY	22,975	1,031,556	2.23%
JUN	4,845	312,264	1.55%
JUL	-22,600	402,040	-5.62%
AUG	-33,180	466,920	-7.11%
SEPT	-9,763	264,749	-3.69%
OCT	16,933	524,071	3.23%
NOV	10,500	308,750	3.40%
DEC	-38,670	668,891	-5.78%
JAN 1988	-34,430	950,949	-3.62%
FEB	-66,895	1,554,599	-4.30%
MAR	-102,769	884,421	-11.62%
APR	-112,991	1,374,545	-8.22%
MAY	10,266	925,353	1.11%

Month	Monthly Return	Monthly Costs	Return on Investment
JUN	-26,372	628,715	-4.19%
JUL	1,976	596,752	0.33%
AUG	12,380	1,531,940	0.81%
SEPT	23,400	1,636,800	1.43%
OCT	3,120	1,727,200	0.18%
NOV	25,720	1,822,780	1.41%
DEC	29,180	1,789,120	1.63%

D.2 HR-JAP 55,000 DWT. Coal

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
01-05-1985	13.0	1062	981	12.01	660,466
02-06-1985	11.5	931	884	10.92	600,569
04-07-1985	10.5	817.5	820	10.53	579,266
31-07-1985	10.5	725.5	725.5	*****	*******
01-08-1985	10.4	718.5	770	11.15	612,999
05-08-1985	10.4	716	781	11.34	623,927
06-09-1985	10.5	735	814	11.63	639,571
08-10-1985	11.0	883	863.5	10.76	591,639
31-10-1985	11.0	905	903	*****	*******
01-11-1985	10.8	906.5	910	10.84	596,293
09-11-1985	10.8	898.5	868.5	10.44	574,167
11-12-1985	10.8	916	882	10.40	571,952
12-01-1986	10.0	917.5	904.5	9.86	542,207
31-01-1986	10.0	831	853	*****	*******
03-02-1986	10.0	827.5	899.5	10.87	597,855
13-02-1986	10.0	784	883	11.26	619,452
17-03-1986	8.5	744	820	9.37	515,255
18-04-1986	7.2	685	685	7.20	396,000
30-04-1986	7.2	658.5	661.5	*****	*******
01-05-1986	7.0	658	657.5	6.99	384,707
20-05-1986	7.0	664.5	643	6.77	372,543
21-06-1986	7.0	637	606	6.66	366,264
23-07-1986	6.5	569	565	6.45	354,987
31-07-1986	6.5	553.5	560.5	*****	*******
01-08-1986	6.4	556	641	7.38	405,813
24-08-1986	6.4	636	749	7.54	414,541
25-09-1986	10.2	789.5	826	10.67	586,936
27-10-1986	9.5	786	782.5	9.46	520,173
31-10-1986	9.5	786.5	786	*****	*******
03-11-1986	9.3	784	747.5	8.87	487,687
28-11-1986	9.3	737.5	675	8.51	468,153
30-12-1986	8.7	697	712.5	8.89	489,141
31-01-1987	11.3	861.5	864.5	*****	*******
02-02-1987	10.8	866.5	762	10.78	592,629
04-03-1987	12.2	859.5	857	12.16	669,048
05-04-1987	13.5	1033	1080	14.11	776,283
30-04-1987	13.5	1019.5	1015	*****	*******

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
01-05-1987	15.2	1025	938	13.91	765,042
07-05-1987	15.2	1051.5	999	14.44	794,260
08-06-1987	12.5	986.5	850	10.77	592,372
10-07-1987	14.8	923.5	899	14.41	792,405
31-07-1987	14.8	976.5	971.5	*****	*******
03-08-1987	16.5	982.5	1114	18.71	1,028,962
11-08-1987	16.5	1074	1187	18.24	1,002,982
12-09-1987	15.8	1049	1045	15.74	865,686
14-10-1987	16.6	1085.5	1107	16.93	931,083
30-10-1987	16.6	1171.5	1159	*****	*******
02-11-1987	15.8	1172.5	1232	16.60	913,099
15-11-1987	15.8	1155.5	1176	16.08	884,417
17-12-1987	16.5	1264.5	1245	16.25	893,505
18-01-1988	19.5	1386.5	1419.5	19.96	1,098,027
29-01-1988	19.5	1393	1391	*****	*******
01-02-1988	21.0	1399.5	1515	22.73	1,250,322
19-02-1988	21.0	1568.5	1561.5	20.91	1,149,845
22-03-1988	23.5	1647.5	1734	24.73	1,360,361
23-04-1988	20.0	1402.5	1377.5	19.64	1,080,392
29-04-1988	20.0	1358	1380	*****	*******
02-05-1988	21.0	1345	1229.5	19.20	1,055,816
25-05-1988	21.0	1404	1265	18.92	1,040,652
26-06-1988	17.5	1238.5	1206.5	17.05	937,631
28-07-1988	17.0	1197	1197	17.00	935,000
29-07-1988	17.0	1197	1198	*****	*******
01-08-1988	16.5	1196	1245	17.18	944,680
29-08-1988	16.5	1267	1261	16.42	903,202
30-08-1988	16.5	1267	1261	*****	*******
31-08-1988	17.2	1272	1395	18.86	1,037,476
30-09-1988	17.2	1270	1274	*****	*******
03-10-1988	18.0	1275	1357	19.16	1,053,671
31-10-1988	18.0	1373	1368	*****	*******
01-11-1988	18.0	1378	1464	19.12	1,051,785
30-11-1988	18.0	1501	1510	*****	*******
01-12-1988	19.0	1501	1487	18.82	1,035,253
03-12-1988	19.0	1488	1488	19.00	1,045,000
31-12-1988	19.0	1596.5	1590	*****	*******

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
01-05-1985	785,955	81	794,610	sell	2,430
02-06-1985	714,677	81	716,040	sell	2,430
04-07-1985	689,327	85	697,000	buy	2,550
31-07-1985	*******	**	*******	***	*****
01-08-1985	729,469	95	731,500	buy	2,850
05-08-1985	742,474	96	749,760	buy	2,880
06-09-1985	761,090	94	765,160	sell	2,820
08-10-1985	704,051	82	708,070	buy	2,460
31-10-1985	*******	**	*******	***	*****
01-11-1985	709,589	78	709,800	buy	2,340
09-11-1985	683,259	79	686,115	sell	2,370
11-12-1985	680,623	78	687,960	buy	2,340
12-01-1986	645,226	72	651,240	buy	2,160
31-01-1986	*******	**	*******	***	*****
03-02-1986	711,447	80	719,600	buy	2,400
13-02-1986	737,147	84	741,720	sell	2,520
17-03-1986	613,154	75	615,000	sell	2,250
18-04-1986	471,240	69	472,650	buy	2,070
30-04-1986	*******	**	*******	***	*****
01-05-1986	457,802	70	460,250	buy	2,100
20-05-1986	443,326	69	443,670	sell	2,070
21-06-1986	435,854	72	436,320	sell	2,160
23-07-1986	422,434	75	423,750	buy	2,250
31-07-1986	*******	**	*******	***	*****
01-08-1986	482,917	76	487,160	buy	2,280
24-08-1986	493,304	66	494,340	buy	1,980
25-09-1986	698,454	85	702,100	sell	2,550
27-10-1986	619,006	80	626,000	sell	2,400
31-10-1986	*******	**	*******	***	*****
03-11-1986	580,347	78	583,050	sell	2,340
28-11-1986	557,102	83	560,250	buy	2,490
30-12-1986	582,078	82	584,250	sell	2,460
31-01-1987	*******	**	*******	***	*****
02-02-1987	705,228	82	708,890	buy	2,460
04-03-1987	796,167	93	797,010	buy	2,790
05-04-1987	923,776	86	928,800	buy	2,580
30-04-1987	*******	**	*******	***	*****

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
01-05-1987	910,400	98	919,240	buy	2,940
07-05-1987	945,169	95	949,050	buy	2,850
08-06-1987	704,923	83	705,500	buy	2,490
10-07-1987	942,962	105	943,950	sell	3,150
31-07-1987	*******	**	*******	***	*****
03-08-1987	1,224,465	110	1,225,400	sell	3,300
11-08-1987	1,193,548	101	1,198,870	sell	3,030
12-09-1987	1,030,167	99	1,034,550	buy	2,970
14-10-1987	1,107,989	101	1,118,070	sell	3,030
30-10-1987	*******	**	*******	***	*****
02-11-1987	1,086,587	89	1,096,480	sell	2,670
15-11-1987	1,052,456	90	1,058,400	sell	2,700
17-12-1987	1,063,271	86	1,070,700	buy	2,580
18-01-1988	1,306,652	93	1,320,135	buy	2,790
29-01-1988	*******	**	*******	***	*****
01-02-1988	1,487,883	99	1,499,850	buy	2,970
19-02-1988	1,368,316	88	1,374,120	buy	2,640
22-03-1988	1,618,830	94	1,629,960	sell	2,820
23-04-1988	1,285,667	94	1,294,850	sell	2,820
29-04-1988	*******	**	*******	***	*****
02-05-1988	1,256,421	103	1,266,385	sell	3,090
25-05-1988	1,238,376	98	1,239,700	sell	2,940
26-06-1988	1,115,781	93	1,122,045	buy	2,790
28-07-1988	1,112,650	93	1,113,210	sell	2,790
29-07-1988	*******	**	*******	***	*****
01-08-1988	1,124,169	91	1,132,950	sell	2,730
29-08-1988	1,074,811	86	1,084,460	buy	2,580
30-08-1988	*******	**	*******	***	*****
31-08-1988	1,234,597	89	1,241,550	buy	2,670
30-09-1988	*******	**	*******	***	*****
03-10-1988	1,253,868	93	1,262,010	buy	2,790
31-10-1988	*******	**	*******	***	*****
01-11-1988	1,251,624	86	1,259,040	sell	2,580
30-11-1988	*******	**	*******	***	*****
01-12-1988	1,231,951	83	1,234,210	sell	2,490
03-12-1988	1,243,550	84	1,249,920	buy	2,520
31-12-1988	*******	**	*******	***	*****

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
01-05-1985	797,040	*******	*******	*******	*******
02-06-1985	718,470	716,040	-78,570	78,570	76,140
04-07-1985	699,550	664,200	-51,840	51,840	49,410
31-07-1985	*******	616,675	-80,325	-80,325	-82,875
01-08-1985	734,350	*******	******	******	******
05-08-1985	752,640	741,950	10,450	10,450	7,600
06-09-1985	767,980	781,440	31,680	31,680	28,800
08-10-1985	710,530	811,690	46,530	-46,530	-49,350
31-10-1985	*******	740,460	32,390	32,390	29,930
01-11-1985	712,140	*******	******	******	******
09-11-1985	688,485	677,430	-32,370	-32,370	-34,710
11-12-1985	690,300	696,780	10,665	-10,665	-13,035
12-01-1986	653,400	705,510	17,550	17,550	15,210
31-01-1986	*******	614,160	-37,080	-37,080	-39,240
03-02-1986	722,000	*******	******	******	******
13-02-1986	744,240	706,400	-13,200	-13,200	-15,600
17-03-1986	617,250	688,800	-52,920	52,920	50,400
18-04-1986	474,720	513,750	-101,250	101,250	99,000
30-04-1986	*******	456,435	-16,215	-16,215	-18,285
01-05-1986	462,350	*******	******	******	******
20-05-1986	445,740	450,100	-10,150	-10,150	-12,250
21-06-1986	438,480	418,140	-25,530	25,530	23,460
23-07-1986	426,000	406,800	-29,520	29,520	27,360
31-07-1986	*******	420,375	-3,375	-3,375	-5,625
01-08-1986	489,440	*******	******	******	******
24-08-1986	496,320	569,240	82,080	82,080	79,800
25-09-1986	704,650	545,160	50,820	50,820	48,840
27-10-1986	628,400	665,125	-36,975	36,975	34,425
31-10-1986	*******	628,800	2,800	-2,800	-5,200
03-11-1986	585,390	*******	******	******	******
28-11-1986	562,740	526,500	-56,550	56,550	54,210
30-12-1986	586,710	591,375	31,125	31,125	28,635
31-01-1987	*******	624,840	40,590	-40,590	-43,050
02-02-1987	711,350	*******	******	******	******
04-03-1987	799,800	702,740	-6,150	-6,150	-8,610
05-04-1987	931,380	1,004,400	207,390	207,390	204,600
30-04-1987	*******	872,900	-55,900	-55,900	-58,480

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
01-05-1987	922,180	*******	******	******	******
07-05-1987	951,900	979,020	59,780	59,780	56,840
08-06-1987	707,990	807,500	-141,550	-141,550	-144,400
10-07-1987	947,100	746,170	40,670	40,670	38,180
31-07-1987	*******	1,020,075	76,125	-76,125	-79,275
03-08-1987	1,228,700	*******	******	******	******
11-08-1987	1,201,900	1,305,700	80,300	-80,300	-83,600
12-09-1987	1,037,520	1,055,450	-143,420	143,420	140,390
14-10-1987	1,121,100	1,095,930	61,380	61,380	58,410
30-10-1987	*******	1,170,590	52,520	-52,520	-55,550
02-11-1987	1,099,150	*******	******	******	******
15-11-1987	1,061,100	1,046,640	-49,840	49,840	47,170
17-12-1987	1,073,280	1,120,500	62,100	-62,100	-64,800
18-01-1988	1,322,925	1,220,770	150,070	150,070	147,490
29-01-1988	*******	1,293,630	-26,505	-26,505	-29,295
01-02-1988	1,502,820	*******	******	******	******
19-02-1988	1,376,760	1,545,885	46,035	46,035	43,065
22-03-1988	1,632,780	1,525,920	151,800	151,800	149,160
23-04-1988	1,297,670	1,294,850	-335,110	335,110	332,290
29-04-1988	*******	1,297,200	2,350	-2,350	-5,170
02-05-1988	1,269,475	*******	******	******	******
25-05-1988	1,242,640	1,302,950	36,565	-36,565	-39,655
26-06-1988	1,124,835	1,182,370	-57,330	57,330	54,390
28-07-1988	1,116,000	1,113,210	-8,835	-8,835	-11,625
29-07-1988	*******	1,114,140	930	-930	-3,720
01-08-1988	1,135,680	*******	******	******	******
29-08-1988	1,087,040	1,147,510	14,560	-14,560	-17,290
30-08-1988	*******	1,084,460	0	0	-2,580
31-08-1988	1,244,220	*******	******	******	******
30-09-1988	*******	1,133,860	-107,690	-107,690	-110,360
03-10-1988	1,264,800	*******	******	******	******
31-10-1988	*******	1,272,240	10,230	10,230	7,440
01-11-1988	1,261,620	*******	******	******	******
30-11-1988	*******	1,298,600	39,560	-39,560	-42,140
01-12-1988	1,236,700	*******	******	******	******
03-12-1988	1,252,440	1,235,040	830	-830	-3,320
31-12-1988	*******	1,335,600	85,680	85,680	83,160

Month	Monthly Return	Monthly Costs	Return on Investment
MAY 1985	73,761	772,133	9.55%
JUN	47,157	698,473	6.75%
JUL	-78,243	744,454	-10.51%
AUG	31,900	1,369,390	2.33%
SEPT	-34,055	717,584	-4.75%
OCT	19,135	878,526	2.18%
NOV	-43,672	1,185,473	-3.68%
DEC	5,908	668,161	0.88%
JAN 1986	-34,012	890,691	-3.82%
FEB	12,750	1,140,635	1.12%
MAR	74,644	653,519	11.42%
APR	28,121	764,056	3.68%
MAY	-3,453	629,503	-0.55%
JUN	23,213	415,613	5.59%
JUL	13,185	727,455	1.81%
AUG	92,010	613,520	15.00%
SEPT	43,085	504,362	8.54%
OCT	22,770	1,200,928	1.90%
NOV	58,684	673,318	8.72%
DEC	18,780	548,151	3.43%
JAN 1987	-37,669	513,371	-7.34%
FEB	-8,036	663,927	-1.21%
MAR	184,845	772,242	23.94%
APR	-39,299	1,006,361	-3.91%
MAY	-55,973	1,665,852	-3.36%
JUN	-4,146	717,096	-0.58%
JUL	-68,537	1,146,222	-5.98%
AUG	17,305	2,092,566	0.83%
SEPT	77,816	1,018,907	7.64%
OCT	-35,472	1,477,748	-2.40%
NOV	12,745	1,662,859	0.77%
DEC	43,370	1,034,031	4.19%
JAN 1988	44,450	1,859,565	2.39%
FEB	89,678	1,933,058	4.64%
MAR	196,004	1,405,742	13.94%
APR	233,663	2,471,231	9.46%
MAY	-26,058	1,580,135	-1.65%

Month	Monthly Return	Monthly Costs	Return on Investment
JUN	38,613	1,142,887	3.38%
JUL	-13,165	2,029,928	-0.65%
AUG	-19,870	2,222,720	-0.89%
SEPT	-110,360	1,244,220	-8.87%
OCT	7,440	1,264,800	0.59%
NOV	-42,140	1,261,620	-3.34%
DEC	79,840	2,489,140	3.21%

D.3 BRZ-NWE 120,000 DWT. Iron Ore

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
01-05-1985	5.5	1062	981	5.08	609,661
23-05-1985	5.5	974.5	888	5.01	601,416
12-06-1985	5.0	919	890	4.84	581,066
03-07-1985	4.0	838	830	3.96	475,418
24-07-1985	4.0	754.5	753	3.99	479,046
31-07-1985	4.0	725.5	725.5	*****	*******
01-08-1985	4.2	718.5	770	4.50	540,125
14-08-1985	4.2	718.5	814	4.76	570,990
04-09-1985	4.6	739.5	807	5.02	602,385
25-09-1985	4.6	839.5	937	5.13	616,110
16-10-1985	4.6	888.5	914	4.73	567,842
31-10-1985	4.6	905	903	*****	*******
01-11-1985	5.2	906.5	910	5.22	626,409
06-11-1985	5.2	914.5	885	5.03	603,871
27-11-1985	5.2	900	899	5.19	623,307
18-12-1985	5.2	897	881.5	5.11	613,217
08-01-1986	4.2	905.5	910	4.22	506,505
29-01-1986	4.2	846	857.5	4.26	510,851
31-01-1986	4.2	831	853	*****	*******
03-02-1986	3.7	827.5	899.5	4.02	482,632
19-02-1986	3.7	761	854	4.15	498,260
12-03-1986	3.9	742.5	845	4.44	532,606
02-04-1986	3.7	731.5	756	3.82	458,871
23-04-1986	3.7	676	671.5	3.68	441,044
30-04-1986	3.7	658.5	661.5	*****	*******
01-05-1986	3.4	658	657.5	3.40	407,690
14-05-1986	3.4	661	699	3.60	431,455
04-06-1986	3.0	661.5	636.5	2.89	346,395
25-06-1986	3.0	620.5	593	2.87	344,045
16-07-1986	2.7	572.5	560.5	2.64	317,209
31-07-1986	2.7	553.5	560.5	*****	*******
01-08-1986	3.8	556	641	4.38	525,712
06-08-1986	3.8	554.5	669	4.58	550,161
27-08-1986	3.8	644.5	756	4.46	534,889
17-09-1986	3.7	756	801	3.92	470,429
08-10-1986	4.3	795	784	4.24	508,860
29-10-1986	4.3	786.5	782	4.28	513,048

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
31-10-1986	4.3	786.5	786	*****	*******
03-11-1986	4.0	784	747.5	3.81	457,653
19-11-1986	4.0	774.5	724	3.74	448,702
10-12-1986	3.6	708	685	3.48	417,966
31-12-1986	3.6	699	712	3.67	440,034
21-01-1987	3.8	853.5	840	3.74	448,787
31-01-1987	3.8	866.5	864.5	*****	*******
02-02-1987	2.7	861.5	762	2.39	286,579
11-02-1987	3.3	853.5	775.5	3.00	359,810
04-03-1987	3.3	859.5	872	3.35	401,759
25-03-1987	3.3	980	1029.5	3.47	416,002
15-04-1987	3.3	1001	995.5	3.28	393,824
30-04-1987	3.3	1019.5	1015	*****	*******
01-05-1987	3.3	1025	938	3.02	362,388
06-05-1987	3.3	1035	970	3.09	371,130
27-05-1987	3.3	1075	1027	3.15	378,318
17-06-1987	3.3	960.5	851	2.92	350,855
08-07-1987	3.3	919.5	887	3.18	382,003
29-07-1987	3.3	965	965	3.30	396,000
31-07-1987	3.3	976.5	971.5	*****	*******
03-08-1987	3.3	982.5	1114	3.74	449,002
19-08-1987	6.3	1129	1180	6.58	790,151
09-09-1987	5.4	1061.5	1090	5.54	665,398
30-09-1987	5.4	1045	1100.5	5.69	682,415
21-10-1987	6.2	1123.5	1138	6.28	753,602
31-10-1987	6.2	1171.5	1159	*****	*******
02-11-1987	7.2	1172.5	1232	7.57	907,845
11-11-1987	7.2	1172.5	1231	7.56	907,108
02-12-1987	6.8	1213.5	1277	7.16	858,700
23-12-1987	6.8	1262	1282	6.91	828,932
13-01-1988	7.1	1369	1418	7.35	882,495
31-01-1988	7.1	1393	1391	*****	*******
01-02-1988	7.6	1399.5	1515	8.23	987,267
03-02-1988	7.6	1427	1540	8.20	984,219
24-02-1988	7.6	1562	1583	7.70	924,261
16-03-1988	9.0	1596.5	1670	9.41	1,129,721
06-04-1988	6.2	1596.5	1612	6.26	751,223

Date of Trade	Current Freight Rate	Level of BFI	Spot Futures Price	Implied Freight Rate	Expected Revenue
27-04-1988	6.2	1377.5	1380	6.21	745,350
30-04-1988	6.2	1358	1380	*****	*******
03-05-1988	7.0	1345	1229.5	6.40	767,866
18-05-1988	7.0	1455.5	1435	6.90	828,169
08-06-1988	5.5	1287	1287	5.50	660,000
29-06-1988	5.5	1224	1205	5.41	649,755
20-07-1988	5.9	1199	1227	6.04	724,534
31-07-1988	5.9	1197	1198	*****	*******
01-08-1988	6.8	1196	1245	7.08	849,431
10-08-1988	6.8	1191	1243	7.10	851,627
31-08-1988	6.8	1267	1261	*****	*******
01-09-1988	6.4	1272	1375	6.92	830,189
21-09-1988	6.4	1285	1304	6.49	779,356
30-09-1988	6.4	1270	1274	*****	*******
03-10-1988	6.7	1275	1357	7.13	855,708
12-10-1988	6.7	1305	1357	6.97	836,037
31-10-1988	6.7	1373	1368	*****	*******
01-11-1988	7.4	1378	1464	7.86	943,419
02-11-1988	7.4	1390	1455	7.75	929,525
23-11-1988	7.4	1517	1532	7.47	896,780
30-11-1988	7.4	1501	1510	*****	*******
01-12-1988	8.5	1501	1487	8.42	1,010,486
14-12-1988	8.5	1522	1532	8.56	1,026,702
31-12-1988	8.5	1543	1590	*****	*******

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
01-05-1985	658,434	68	667,080	buy	2,040
23-05-1985	649,529	74	657,120	buy	2,220
12-06-1985	627,552	71	631,900	buy	2,130
03-07-1985	513,451	62	514,600	buy	1,860
24-07-1985	517,369	69	519,570	sell	2,070
31-07-1985	*******	**	*******	***	*****
01-08-1985	583,335	76	585,200	sell	2,280
14-08-1985	616,669	76	618,640	buy	2,280
04-09-1985	650,576	81	653,670	buy	2,430
25-09-1985	665,398	72	674,640	buy	2,160
16-10-1985	613,270	68	621,520	buy	2,040
31-10-1985	*******	**	*******	***	*****
01-11-1985	676,522	75	682,500	buy	2,250
06-11-1985	652,181	74	654,900	buy	2,220
27-11-1985	673,171	75	674,250	buy	2,250
18-12-1985	662,275	76	669,940	sell	2,280
08-01-1986	547,025	61	555,100	sell	1,830
29-01-1986	551,719	65	557,375	sell	1,950
31-01-1986	*******	**	*******	***	*****
03-02-1986	521,243	58	521,710	sell	1,740
19-02-1986	538,121	64	546,560	sell	1,920
12-03-1986	575,215	69	583,050	buy	2,070
02-04-1986	495,580	66	498,960	sell	1,980
23-04-1986	476,328	71	476,765	buy	2,130
30-04-1986	*******	**	*******	***	*****
01-05-1986	440,305	67	440,525	buy	2,010
14-05-1986	465,972	67	468,330	sell	2,010
04-06-1986	374,106	59	375,535	buy	1,770
25-06-1986	371,569	63	373,590	buy	1,890
16-07-1986	342,585	62	347,510	buy	1,860
31-07-1986	*******	**	*******	***	*****
01-08-1986	567,769	89	570,490	buy	2,670
06-08-1986	594,173	89	595,410	sell	2,670
27-08-1986	577,680	77	582,120	buy	2,310
17-09-1986	508,063	64	512,640	buy	1,920
08-10-1986	549,569	71	556,640	sell	2,130
29-10-1986	554,091	71	555,220	sell	2,130

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
31-10-1986	*******	**	*******	***	*****
03-11-1986	494,265	67	500,825	sell	2,010
19-11-1986	484,599	67	485,080	sell	2,010
10-12-1986	451,403	66	452,100	sell	1,980
31-12-1986	475,237	67	477,040	buy	2,010
21-01-1987	484,690	58	487,200	sell	1,740
31-01-1987	*******	**	*******	***	*****
02-02-1987	309,506	41	312,420	sell	1,230
11-02-1987	233,877	31	240,405	sell	930
04-03-1987	261,143	30	261,600	sell	900
25-03-1987	270,401	27	277,965	sell	810
15-04-1987	255,986	26	258,830	sell	780
30-04-1987	*******	**	*******	***	*****
01-05-1987	235,552	26	243,880	sell	780
06-05-1987	241,235	25	242,500	buy	750
27-05-1987	245,907	24	246,480	buy	720
17-06-1987	228,056	27	229,770	buy	810
08-07-1987	248,302	28	248,360	buy	840
29-07-1987	257,400	27	260,550	buy	810
31-07-1987	*******	**	*******	***	*****
03-08-1987	291,851	27	300,780	buy	810
19-08-1987	853,363	73	861,400	sell	2,190
09-09-1987	718,630	66	719,400	buy	1,980
30-09-1987	737,009	67	737,335	buy	2,010
21-10-1987	813,890	72	819,360	sell	2,160
31-10-1987	*******	**	*******	***	*****
02-11-1987	980,472	80	985,600	sell	2,400
11-11-1987	979,677	80	984,800	buy	2,400
02-12-1987	927,396	73	932,210	buy	2,190
23-12-1987	895,246	70	897,400	sell	2,100
13-01-1988	953,095	68	964,240	buy	2,040
31-01-1988	*******	**	*******	***	*****
01-02-1988	1,066,248	71	1,075,650	buy	2,130
03-02-1988	1,062,956	70	1,078,000	buy	2,100
24-02-1988	998,202	64	1,013,120	sell	1,920
16-03-1988	1,220,099	74	1,235,800	sell	2,220
06-04-1988	811,321	51	822,120	buy	1,530

Date of Trade	Level of Risk Exposure	Number of Contracts	Futures Cost of Investment	Buy or Sell Decision	Broker's Commission
27-04-1988	804,978	59	814,200	sell	1,770
30-04-1988	*******	**	*******	***	*****
03-05-1988	829,295	68	836,060	sell	2,040
18-05-1988	894,423	63	904,050	buy	1,890
08-06-1988	712,800	56	720,720	sell	1,680
29-06-1988	701,735	59	710,950	sell	1,770
20-07-1988	782,496	64	785,280	sell	1,920
31-07-1988	*******	**	*******	***	*****
01-08-1988	917,386	74	921,300	sell	2,220
10-08-1988	919,757	74	919,820	buy	2,220
31-08-1988	*******	**	*******	***	*****
01-09-1988	896,604	66	907,500	buy	1,980
21-09-1988	841,704	65	847,600	buy	1,950
30-09-1988	*******	**	*******	***	*****
03-10-1988	924,165	69	936,330	buy	2,070
12-10-1988	902,920	67	909,190	buy	2,010
31-10-1988	*******	**	*******	***	*****
01-11-1988	1,018,393	70	1,024,800	buy	2,100
02-11-1988	1,003,887	69	1,003,950	sell	2,070
23-11-1988	968,523	64	980,480	sell	1,920
30-11-1988	*******	**	*******	***	*****
01-12-1988	1,091,325	74	1,100,380	sell	2,220
14-12-1988	1,108,838	73	1,118,360	sell	2,190
31-12-1988	*******	**	*******	***	*****

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
01-05-1985	669,120	*******	*******	*******	*******
23-05-1985	659,340	603,840	-63,240	-63,240	-65,280
12-06-1985	634,030	658,600	1,480	1,480	-740
03-07-1985	516,460	589,300	-42,600	-42,600	-44,730
24-07-1985	521,640	466,860	-47,740	-47,740	-49,600
31-07-1985	*******	500,595	-18,975	18,975	16,905
01-08-1985	587,480	*******	******	******	******
14-08-1985	620,920	618,640	33,440	-33,440	-35,720
04-09-1985	656,100	613,320	-5,320	-5,320	-7,600
25-09-1985	676,800	758,970	105,300	105,300	102,870
16-10-1985	623,560	658,080	-16,560	-16,560	-18,720
31-10-1985	*******	614,040	-7,480	-7,480	-9,520
01-11-1985	684,750	*******	******	******	******
06-11-1985	657,120	663,750	-18,750	-18,750	-21,000
27-11-1985	676,500	665,260	10,360	10,360	8,140
18-12-1985	672,220	661,125	-13,125	-13,125	-15,375
08-01-1986	556,930	691,600	21,660	-21,660	-23,940
29-01-1986	559,325	523,075	-32,025	32,025	30,195
31-01-1986	*******	554,450	-2,925	2,925	975
03-02-1986	523,450	*******	******	******	******
19-02-1986	548,480	495,320	-26,390	26,390	24,650
12-03-1986	585,120	540,800	-5,760	5,760	3,840
02-04-1986	500,940	521,640	-61,410	-61,410	-63,480
23-04-1986	478,895	443,190	-55,770	55,770	53,790
30-04-1986	*******	469,665	-7,100	-7,100	-9,230
01-05-1986	442,535	*******	******	******	******
14-05-1986	470,340	468,330	27,805	27,805	25,795
04-06-1986	377,305	426,455	-41,875	41,875	39,865
25-06-1986	375,480	349,870	-25,665	-25,665	-27,435
16-07-1986	349,370	353,115	-20,475	-20,475	-22,365
31-07-1986	*******	347,510	0	0	-1,860
01-08-1986	573,160	*******	******	******	******
06-08-1986	598,080	595,410	24,920	24,920	22,250
27-08-1986	584,430	672,840	77,430	-77,430	-80,100
17-09-1986	514,560	616,770	34,650	34,650	32,340
08-10-1986	558,770	501,760	-10,880	-10,880	-12,800
29-10-1986	557,350	555,220	-1,420	1,420	-710

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
31-10-1986	*******	558,060	2,840	-2,840	-4,970
03-11-1986	502,835	*******	******	******	******
19-11-1986	487,090	485,080	-15,745	15,745	13,735
10-12-1986	454,080	458,950	-26,130	26,130	24,120
31-12-1986	479,050	469,920	17,820	-17,820	-19,800
21-01-1987	488,940	562,800	85,760	85,760	83,750
31-01-1987	*******	501,410	14,210	-14,210	-15,950
02-02-1987	313,650	*******	******	******	******
11-02-1987	241,335	317,955	5,535	-5,535	-6,765
04-03-1987	262,500	270,320	29,915	-29,915	-30,845
25-03-1987	278,775	308,850	47,250	-47,250	-48,150
15-04-1987	259,610	268,785	-9,180	9,180	8,370
30-04-1987	*******	263,900	5,070	-5,070	-5,850
01-05-1987	244,660	*******	******	******	******
06-05-1987	243,250	252,200	8,320	-8,320	-9,100
27-05-1987	247,200	256,750	14,250	14,250	13,500
17-06-1987	230,580	204,240	-42,240	-42,240	-42,960
08-07-1987	249,200	239,490	9,720	9,720	8,910
29-07-1987	261,360	270,200	21,840	21,840	21,000
31-07-1987	*******	262,305	1,755	1,755	945
03-08-1987	301,590	*******	******	******	******
19-08-1987	863,590	318,600	17,820	17,820	17,010
09-09-1987	721,380	795,700	-65,700	65,700	63,510
30-09-1987	739,345	726,330	6,930	6,930	4,950
21-10-1987	821,520	762,460	25,125	25,125	23,115
31-10-1987	*******	834,480	15,120	-15,120	-17,280
02-11-1987	988,000	*******	******	******	******
11-11-1987	987,200	984,800	-800	800	-1,600
02-12-1987	934,400	1,021,600	36,800	36,800	34,400
23-12-1987	899,500	935,860	3,650	3,650	1,460
13-01-1988	966,280	992,600	95,200	-95,200	-97,300
31-01-1988	*******	945,880	-18,360	-18,360	-20,400
01-02-1988	1,077,780	*******	******	******	******
03-02-1988	1,080,100	1,093,400	17,750	17,750	15,620
24-02-1988	1,015,040	1,108,100	30,100	30,100	28,000
16-03-1988	1,238,020	1,068,800	55,680	-55,680	-57,600
06-04-1988	823,650	1,192,880	-42,920	42,920	40,700

Date of Trade	Total Cost of Investment	Final Value of Futures	Futures Price Difference	Gross Futures Prof/Loss	Net Futures Prof/Loss
27-04-1988	815,970	703,800	-118,320	-118,320	-119,850
30-04-1988	*******	814,200	0	0	-1,770
03-05-1988	838,100	*******	******	******	******
18-05-1988	905,940	975,800	139,740	-139,740	-141,780
08-06-1988	722,400	810,810	-93,240	-93,240	-95,130
29-06-1988	712,720	674,800	-45,920	45,920	44,240
20-07-1988	787,200	723,930	12,980	-12,980	-14,750
31-07-1988	*******	766,720	-18,560	18,560	16,640
01-08-1988	923,520	*******	******	******	******
10-08-1988	922,040	919,820	-1,480	1,480	-740
31-08-1988	*******	933,140	13,320	13,320	11,100
01-09-1988	909,480	*******	******	******	******
21-09-1988	849,550	860,640	-46,860	-46,860	-48,840
30-09-1988	*******	828,100	-19,500	-19,500	-21,450
03-10-1988	938,400	*******	******	******	******
12-10-1988	911,200	936,330	0	0	-2,070
31-10-1988	*******	916,560	7,370	7,370	5,360
01-11-1988	1,026,900	*******	******	******	******
02-11-1988	1,006,020	1,018,500	-6,300	-6,300	-8,400
23-11-1988	982,400	1,057,080	53,130	-53,130	-55,200
30-11-1988	*******	966,400	-14,080	14,080	12,160
01-12-1988	1,102,600	*******	******	******	******
14-12-1988	1,120,550	1,133,680	33,300	-33,300	-35,520
31-12-1988	*******	1,160,700	42,340	-42,340	-44,530

Month	Monthly Return	Monthly Costs	Return on Investment
MAY 1985	-65,632	983,091	-6.68%
JUN	-40,858	919,015	-4.45%
JUL	-36,955	1,098,484	-3.36%
AUG	-42,234	1,119,697	-3.77%
SEPT	96,436	938,174	10.28%
OCT	-22,891	1,106,989	-2.07%
NOV	-15,789	1,470,727	-1.07%
DEC	-28,406	995,790	-2.85%
JAN 1986	23,190	1,340,328	1.73%
FEB	26,844	836,867	3.21%
MAR	-59,273	844,037	-7.02%
APR	41,999	955,981	4.39%
MAY	59,965	845,684	7.09%
JUN	-28,130	551,776	-5.10%
JUL	-17,835	617,570	-2.89%
AUG	-50,150	1,310,390	-3.83%
SEPT	16,107	788,320	2.04%
OCT	-9,947	1,287,640	-0.77%
NOV	29,815	827,562	3.60%
DEC	204	684,879	0.03%
JAN 1987	55,836	899,554	6.21%
FEB	-34,672	532,001	-6.52%
MAR	-47,899	391,684	-12.23%
APR	-669	432,185	-0.15%
MAY	-5,829	546,767	-1.07%
JUN	-26,791	342,063	-7.83%
JUL	24,915	587,420	4.24%
AUG	62,374	918,440	6.79%
SEPT	26,398	1,073,741	2.46%
OCT	2,533	1,455,244	0.17%
NOV	32,800	1,975,200	1.66%
DEC	-44,873	1,362,733	-3.29%
JAN 1988	-71,367	1,437,447	-4.96%
FEB	29,906	2,399,556	1.25%
MAR	-14,814	1,657,664	-0.89%
APR	-109,991	1,993,340	-5.52%
MAY	-214,260	1,528,340	-14.02%

Month	Monthly Return	Monthly Costs	Return on Investment
JUN	18,780	1,073,856	1.75%
JUL	4,700	1,364,164	0.34%
AUG	10,360	1,845,560	0.56%
SEPT	-70,290	1,759,030	-4.00%
OCT	3,290	1,849,600	0.18%
NOV	-51,440	3,015,320	-1.71%
DEC	-80,050	2,223,150	-3.60%

Appendix E

Monthly Voyage Charter Freight Rates ($/Ton of Cargo) for the 'Sample' Trades (1985-1988)

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
JAN 1985	17.2	12.3	5.3
FEB	17	12.9	5.4
MAR	17.3	13.5	5.7
APR	17.4	14	6.2
MAY	16.8	13	5.5
JUN	16.3	11.5	5
JUL	13	10.5	4
AUG	14	10.4	4.2
SEPT	15	10.5	4.6
OCT	15	11	4.6
NOV	15	10.8	5.2
DEC	15	10.8	5.2
JAN 1986	14	10	4.2
FEB	14.3	10	3.7
MAR	13.5	8.5	3.9
APR	11	7.2	3.7
MAY	10.5	7	3.4
JUN	10.5	7	3
JUL	9	6.5	2.7
AUG	9.4	6.4	3.8
SEPT	13.7	10.2	3.7
OCT	12.5	9.5	4.3
NOV	14	9.3	4
DEC	13.7	8.7	3.6
JAN 1987	15.5	11.3	3.8
FEB	15.4	10.8	2.7
MAR	17	12.2	2.8
APR	17.6	13.5	4.5
MAY	19.5	15.2	5.6
JUN	16	12.5	4.7
JUL	18.5	14.8	6
AUG	21	16.5	6.3
SEPT	20.5	15.8	5.4
OCT	20.1	16.6	6.2
NOV	19.5	15.8	7.2
DEC	22	16.5	6.8
JAN 1988	25	19.5	7.1

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
FEB	29	21	7.6
MAR	30.5	23.5	9
APR	25	20	6.2
MAY	24.5	21	7
JUN	21.5	17.5	5.5
JUL	21.8	17	5.9
AUG	22.5	16.5	6.8
SEPT	23.5	17.2	6.4
OCT	25	18	6.7
NOV	26.5	18	7.4
DEC	27	19	8.5

Appendix F

Monthly Time Charter Freight Rates ($/day) for the 'Sample' Trades (1985-1988)

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
JAN 1985	3700	5400	7900
FEB	3900	5300	7900
MAR	3800	5200	8000
APR	3700	5100	7900
MAY	3800	4900	7500
JUN	3700	4800	7400
JUL	3300	4400	7200
AUG	3400	4500	7200
SEPT	3200	4500	7000
OCT	3400	4600	7200
NOV	3800	5000	7200
DEC	4000	5200	7200
JAN 1986	3500	4500	6800
FEB	3400	4250	6600
MAR	3100	4250	5700
APR	3100	4000	5500
MAY	2900	4150	5500
JUN	2900	4150	5500
JUL	2900	3900	5500
AUG	3000	4050	5500
SEPT	3500	4500	6500
OCT	3400	4750	6500
NOV	3300	4500	6500
DEC	3200	4000	6500
JAN 1987	3500	5000	6500
FEB	3500	5000	6500
MAR	4300	5500	7000
APR	4900	6000	7500
MAY	5300	7000	8300
JUN	5000	6500	7900
JUL	5200	6600	8700
AUG	5500	7800	9800
SEPT	5500	7600	9800
OCT	5500	8800	10500
NOV	5600	9000	11000
DEC	6300	9000	14000
JAN 1988	7200	10500	13800

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
FEB	7400	12000	14100
MAR	7700	13500	15600
APR	7700	13500	15600
MAY	7500	12500	14500
JUN	7200	10750	13500
JUL	8000	10000	13300
AUG	7800	11800	13800
SEPT	8400	12400	14200
OCT	8500	12200	15000
NOV	8700	12500	15000
DEC	8800	12500	15000

Appendix G

Monthly Voyage Equivalent Time Charter Freight Rates ($/Ton of Cargo) for the 'Sample' Trades (1985-1988)

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
JAN 1985	18.5	9.4	4.3
FEB	19.3	9.5	4.4
MAR	19.0	9.4	4.2
APR	18.0	9.0	4.2
MAY	17.5	8.7	3.8
JUN	16.2	8.2	3.7
JUL	16.4	8.2	3.7
AUG	16.5	8.2	3.8
SEPT	16.6	8.3	3.8
OCT	16.7	8.4	3.7
NOV	16.4	8.3	3.9
DEC	17.5	8.8	3.8
JAN 1986	16.1	8.0	3.7
FEB	13.5	7.0	3.2
MAR	13.0	6.9	3.0
APR	11.6	6.2	2.8
MAY	10.2	5.8	2.6
JUN	10.8	6.1	2.5
JUL	10.4	5.8	2.4
AUG	10.2	5.8	2.6
SEPT	11.6	6.3	2.9
OCT	11.7	6.6	2.9
NOV	11.6	6.4	2.9
DEC	11.4	6.1	2.9
JAN 1987	12.8	7.1	3.1
FEB	13.7	7.4	3.3
MAR	14.2	7.5	3.4
APR	15.6	8.1	3.7
MAY	16.8	9.0	3.8
JUN	16.2	8.6	3.7
JUL	16.4	8.6	3.9
AUG	17.0	9.4	4.1
SEPT	16.1	9.0	3.9
OCT	15.9	9.6	4.1
NOV	15.8	9.6	4.1
DEC	16.0	9.4	4.5
JAN 1988	16.1	9.9	4.4

Month	USGC-JAP 30,000Dwt. Grain	HR-JAP 55,000Dwt. Coal	BRZ-NWE 120,000Dwt. Iron Ore
FEB	16.6	10.8	4.5
MAR	15.9	11.3	4.7
APR	16.8	11.6	4.9
MAY	16.8	11.2	4.6
JUN	16.5	10.1	4.4
JUL	16.4	9.4	4.3
AUG	16.8	10.6	4.4
SEPT	17.9	11.1	4.4
OCT	16.8	10.5	4.4
NOV	16.6	10.6	4.5
DEC	17.8	11.0	4.6

Appendix H

Monthly Prices ($/Tonne) of Heavy Fuel Oil (1985-1988)

Month	USGC	Rotterdam
JAN 1985	168	187
FEB	176	194
MAR	173	175
APR	160	173
MAY	151	143
JUN	133	138
JUL	143	138
AUG	143	144
SEPT	147	148
OCT	145	138
NOV	134	154
DEC	147	148
JAN 1986	134	145
FEB	100	100
MAR	99	101
APR	78	82
MAY	61	63
JUN	71	57
JUL	65	52
AUG	61	67
SEPT	73	83
OCT	76	77
NOV	77	76
DEC	75	76
JAN 1987	91	101
FEB	104	90
MAR	97	98
APR	108	116
MAY	120	116
JUN	115	113
JUL	115	113
AUG	118	112
SEPT	106	98
OCT	103	101
NOV	98	94
DEC	90	88
JAN 1988	75	85

Month	USGC	Rotterdam
FEB	79	77
MAR	64	68
APR	78	90
MAY	81	78
JUN	81	79
JUL	67	72
AUG	76	74
SEPT	83	71
OCT	63	53
NOV	58	62
DEC	74	70

Appendix I

Monthly Prices ($/Tonne) of Diesel Oil (1985-1988)

Month	USGC	Rotterdam
JAN 1985	245	222
FEB	250	222
MAR	245	227
APR	243	227
MAY	238	210
JUN	236	210
JUL	237	205
AUG	236	214
SEPT	237	228
OCT	241	237
NOV	243	240
DEC	249	232
JAN 1986	249	229
FEB	194	179
MAR	170	182
APR	170	185
MAY	150	141
JUN	150	113
JUL	148	98
AUG	135	119
SEPT	144	122
OCT	143	113
NOV	140	112
DEC	140	112
JAN 1987	155	146
FEB	162	140
MAR	159	138
APR	159	140
MAY	160	148
JUN	163	145
JUL	160	147
AUG	165	150
SEPT	160	140
OCT	158	142
NOV	162	145
DEC	162	148
JAN 1988	160	146

Month	USGC	Rotterdam
FEB	162	130
MAR	162	118
APR	160	142
MAY	163	135
JUN	161	128
JUL	156	120
AUG	157	122
SEPT	155	111
OCT	156	98
NOV	155	106
DEC	160	129

Appendix J

A Program for Calculating the Expected Return, Variance and Standard Deviation of Each Portfolio Possibility

```
c      |-----------------------------------------------------------------|
c      |This program calculates the means, standard deviations and      |
c      |variances of the returns of different portfolio holdings of     |
c      |three assets: voyage charters, time charters and BIFFEX futures.|
c      |It does so by analysing all possible mixes of the three assets  |
c      |given a prescribed base unit eg. 1%, 5% or 10% chunks. This     |
c      |'steplength' is set as an input variable. Other necessary inputs|
c      |are the mean, standard deviation and pairwise correlation       |
c      |coefficients of the three individual assets as if they were     |
c      |held on a 100% basis.                                           |
c      |-----------------------------------------------------------------|
       program portfolio
c
c      ----------C O L L E C T I N G   T H E   D A T A----------
c
       character file*16
c
       print*
       print*,'what filename'
       print*
c
       read (*,'(1a16)') file
c
       open (file=file,unit=5,status='new')
c
       print*
       print*,'What is the deadweight tonnage of the ship you are interes
      +ted in.'
       print*
c
       read*,dwt
c
       print*
       print*,'what is the mean of the voyage charter returns for this sh
      +ip.'
       print*
c
       read*,xvc
c
       print*
       print*,'what is the standard deviation of the voyage charter retur
      +s for this ship.'
```

```
      print*
c
      read*,svc
c
      print*
      print*,'what is the mean of the time charter returns for this ship
     +.'
      print*
c
      read*,xtc
c
      print*
      print*,'what is the standard deviation of the time charter returns
     + for this ship.'
      print*
c
      read*,stc
c
      print*
      print*,'what is the mean of the BIFFEX returns for this ship.'
      print*
c
      read*,xbfi
c
      print*
      print*,'what is the standard deviation of the BIFFEX returns for t
     +his ship.'
      print*
c
      read*,sbfi
c
      print*
      print*,'what is the correlation between voyage and time charter re
     +turns.'
      print*
c
      read*,pvctc
c
      print*
      print*,'what is the correlation between voyage and BIFFEX returns.
     +'
      print*
c
```

```
      read*,pvcbfi
c
      print*
      print*,'what is the correlation between time charter and BIFFEX re
     +turns.'
      print*
c
      read*,ptcbfi
c
      print*
      print*,'what is the required percentage steplength.'
      print*
c
      read*,nstep
c
c     ----------C O M P U T I N G   T H E   S T A T I S T I C S----------
c
      vvc=svc**2
      vtc=stc**2
      vbfi=sbfi**2
c
      cov1=svc*stc*pvctc
      cov2=svc*sbfi*pvcbfi
      cov3=stc*sbfi*ptcbfi
c
      do 1,i=0,100,nstep
      do 2,j=0,100,nstep
      do 3,k=0,100,nstep
c
      if(i+j+k.ne.100)goto 3
      if(i.lt.10)goto 3
      if(i.gt.20)goto 3
      if(j.lt.80)goto 3
      if(j.gt.90)goto 3
      if(k.gt.5)goto 3
c
c
      if(i.eq.0)then
      propi=0
      else
      propi=real(i)/100.0
      endif
c
```

```
      if(j.eq.0)then
      propj=0
      else
      propj=real(j)/100.0
      endif
c
      if(k.eq.0)then
      propk=0
      else
      propk=real(k)/100.0
      endif
c
      av=propi*xvc+propj*xtc+propk*xbfi
      var=propi**2*vvc+propj**2*vtc+propk**2*vbfi+2*(propi*propj*cov1
     ++propi*propk*cov2+propj*propk*cov3)
      std=sqrt(var)
c
      write(5,10) i,j,k,av,std,var
      print*,i,j,k,av,std,var
c
    3 continue
    2 continue
    1 continue
c
      close(5)
c
c
   10 format(i3,3x,i3,3x,i3,3x,f7.2,3x,f7.2,3x,f7.2)
      end
```

Appendix K

Expected Return, Variance and Standard Deviation Results for Portfolios with a 10% Chunk-size

K.1 USGC-JAP 30,000 Dwt. Grain

Portfolio Holdings			Expected Return	Variance	Standard Deviation
Voyage Charters	Time Charters	Freight Futures			
0%	0%	100%	-1.60%	71.70	8.47
0%	10%	90%	-3.63%	59.47	7.71
0%	20%	80%	-5.66%	51.33	7.16
0%	30%	70%	-7.69%	47.28	6.88
0%	40%	60%	-9.72%	47.31	6.88
0%	50%	50%	-11.74%	51.44	7.17
0%	60%	40%	-13.77%	59.64	7.72
0%	70%	30%	-15.80%	71.94	8.48
0%	80%	20%	-17.83%	88.32	9.40
0%	90%	10%	-19.85%	108.79	10.43
0%	100%	0%	-21.88%	133.35	11.55
10%	0%	90%	-2.07%	65.67	8.10
10%	10%	80%	-4.10%	61.95	7.87
10%	20%	70%	-6.12%	62.33	7.89
10%	30%	60%	-8.15%	66.79	8.17
10%	40%	50%	-10.18%	75.33	8.68
10%	50%	40%	-12.21%	87.97	9.38
10%	60%	30%	-14.24%	104.69	10.23
10%	70%	20%	-16.26%	125.50	11.20
10%	80%	10%	-18.29%	150.39	12.26
10%	90%	0%	-20.32%	179.38	13.39
20%	0%	80%	-2.53%	82.66	9.09
20%	10%	70%	-4.56%	87.45	9.35
20%	20%	60%	-6.59%	96.34	9.82
20%	30%	50%	-8.62%	109.31	10.46
20%	40%	40%	-10.64%	126.37	11.24
20%	50%	30%	-12.67%	147.52	12.15
20%	60%	20%	-14.70%	172.75	13.14
20%	70%	10%	-16.73%	202.08	14.22
20%	80%	0%	-18.76%	235.48	15.35
30%	0%	70%	-3.00%	122.66	11.08
30%	10%	60%	-5.02%	135.97	11.66
30%	20%	50%	-7.05%	153.37	12.38
30%	30%	40%	-9.08%	174.86	13.22
30%	40%	30%	-11.11%	200.43	14.16
30%	50%	20%	-13.14%	230.09	15.17
30%	60%	10%	-15.16%	263.83	16.24

Portfolio Holdings					
Voyage Charters	Time Charters	Freight Futures	Expected Return	Variance	Standard Deviation
30%	70%	0%	-17.19%	301.67	17.37
40%	0%	60%	-3.46%	185.68	13.63
40%	10%	50%	-5.49%	207.51	14.41
40%	20%	40%	-7.52%	233.42	15.28
40%	30%	30%	-9.55%	263.41	16.23
40%	40%	20%	-11.57%	297.50	17.25
40%	50%	10%	-13.60%	335.67	18.32
40%	60%	0%	-15.63%	377.93	19.44
50%	0%	50%	-3.93%	271.72	16.48
50%	10%	40%	-5.95%	302.06	17.38
50%	20%	30%	-7.98%	336.48	18.34
50%	30%	20%	-10.01%	374.99	19.36
50%	40%	10%	-12.04%	417.59	20.44
50%	50%	0%	-14.07%	464.27	21.55
60%	0%	40%	-4.39%	380.78	19.51
60%	10%	30%	-6.42%	419.62	20.48
60%	20%	20%	-8.45%	462.56	21.51
60%	30%	10%	-10.47%	509.58	22.57
60%	40%	0%	-12.50%	560.70	23.68
70%	0%	30%	-4.85%	512.85	22.65
70%	10%	20%	-6.88%	560.21	23.67
70%	20%	10%	-8.91%	611.66	24.73
70%	30%	0%	-10.94%	667.20	25.83
80%	0%	20%	-5.32%	667.94	25.84
80%	10%	10%	-7.35%	723.81	26.90
80%	20%	0%	-9.38%	783.77	28.00
90%	0%	10%	-5.78%	846.04	29.09
90%	10%	0%	-7.81%	910.43	30.17
100%	0%	0%	-6.25%	1047.17	32.36

K.2 HR-JAP 55,000 Dwt. Coal

Portfolio Holdings			Expected Return	Variance	Standard Deviation
Voyage Charters	Time Charters	Freight Futures			
0%	0%	100%	2.15%	43.65	6.61
0%	10%	90%	0.27%	37.16	6.10
0%	20%	80%	-1.60%	38.68	6.22
0%	30%	70%	-3.47%	48.20	6.94
0%	40%	60%	-5.34%	65.72	8.11
0%	50%	50%	-7.21%	91.24	9.55
0%	60%	40%	-9.08%	124.77	11.17
0%	70%	30%	-10.95%	166.31	12.90
0%	80%	20%	-12.82%	215.84	14.69
0%	90%	10%	-14.69%	273.38	16.53
0%	100%	0%	-16.56%	338.92	18.41
10%	0%	90%	4.87%	56.35	7.51
10%	10%	80%	3.00%	67.27	8.20
10%	20%	70%	1.13%	86.19	9.28
10%	30%	60%	-0.74%	113.11	10.64
10%	40%	50%	-2.61%	148.04	12.17
10%	50%	40%	-4.48%	190.98	13.82
10%	60%	30%	-6.35%	241.91	15.55
10%	70%	20%	-8.22%	300.85	17.35
10%	80%	10%	-10.09%	367.79	19.18
10%	90%	0%	-11.96%	442.74	21.04
20%	0%	80%	7.60%	112.34	10.60
20%	10%	70%	5.73%	140.66	11.86
20%	20%	60%	3.86%	176.99	13.30
20%	30%	50%	1.99%	221.32	14.88
20%	40%	40%	0.12%	273.66	16.54
20%	50%	30%	-1.75%	334.00	18.28
20%	60%	20%	-3.62%	402.34	20.06
20%	70%	10%	-5.49%	478.69	21.88
20%	80%	0%	-7.36%	563.03	23.73
30%	0%	70%	10.33%	211.62	14.55
30%	10%	60%	8.46%	257.35	16.04
30%	20%	50%	6.59%	311.09	17.64
30%	30%	40%	4.72%	372.83	19.31
30%	40%	30%	2.85%	442.57	21.04
30%	50%	20%	0.98%	520.31	22.81
30%	60%	10%	-0.89%	606.06	24.62

Portfolio Holdings					
Voyage Charters	Time Charters	Freight Futures	Expected Return	Variance	Standard Deviation
30%	70%	0%	-2.77%	699.81	26.45
40%	0%	60%	13.06%	354.20	18.92
40%	10%	50%	11.19%	417.33	20.43
40%	20%	40%	9.32%	488.48	22.10
40%	30%	30%	7.45%	567.62	23.82
40%	40%	20%	5.58%	654.77	25.59
40%	50%	10%	3.70%	749.92	27.38
40%	60%	0%	1.83%	853.07	29.21
50%	0%	50%	15.79%	540.06	23.24
50%	10%	40%	13.92%	620.61	24.91
50%	20%	30%	12.05%	709.16	26.63
50%	30%	20%	10.17%	805.71	28.38
50%	40%	10%	8.30%	910.26	30.17
50%	50%	0%	6.43%	1022.82	31.98
60%	0%	40%	18.52%	769.22	27.73
60%	10%	30%	16.64%	867.17	29.45
60%	20%	20%	14.77%	973.13	31.19
60%	30%	10%	12.90%	1087.08	32.97
60%	40%	0%	11.03%	1209.04	34.77
70%	0%	30%	21.24%	1041.67	32.27
70%	10%	20%	19.37%	1157.03	24.02
70%	20%	10%	17.50%	1280.39	35.78
70%	30%	0%	15.63%	1411.75	37.57
80%	0%	20%	23.97%	1357.42	36.84
80%	10%	10%	22.10%	1490.18	38.60
80%	20%	0%	20.23%	1630.94	40.38
90%	0%	10%	26.70%	1716.45	41.43
90%	10%	0%	24.83%	1866.62	43.20
100%	0%	0%	29.43%	2118.77	46.03

K.3 BRZ-NWE 120,000 Dwt. Iron Ore

Portfolio Holdings					
Voyage Charters	Time Charters	Freight Futures	Expected Return	Variance	Standard Deviation
0%	0%	100%	-1.17%	23.57	4.85
0%	10%	90%	-2.42%	19.23	4.39
0%	20%	80%	-3.66%	19.73	4.44
0%	30%	70%	-4.90%	25.06	5.01
0%	40%	60%	-6.14%	35.25	5.94
0%	50%	50%	-7.38%	50.27	7.09
0%	60%	40%	-8.62%	70.13	8.37
0%	70%	30%	-9.86%	94.84	9.74
0%	80%	20%	-11.10%	124.39	11.15
0%	90%	10%	-12.35%	158.77	12.60
0%	100%	0%	-13.59%	198.01	14.07
10%	0%	90%	0.85%	31.22	5.59
10%	10%	80%	-0.39%	36.51	6.04
10%	20%	70%	-1.63%	46.64	6.83
10%	30%	60%	-2.87%	61.61	7.85
10%	40%	50%	-4.11%	81.42	9.02
10%	50%	40%	-5.35%	106.08	10.30
10%	60%	30%	-6.59%	135.57	11.64
10%	70%	20%	-7.84%	169.91	13.03
10%	80%	10%	-9.08%	209.09	14.46
10%	90%	0%	-10.32%	253.11	15.91
20%	0%	80%	2.88%	64.42	8.03
20%	10%	70%	1.64%	79.34	8.91
20%	20%	60%	0.40%	99.10	9.95
20%	30%	50%	-0.84%	123.70	11.12
20%	40%	40%	-2.08%	153.15	12.38
20%	50%	30%	-3.33%	187.43	13.69
20%	60%	20%	-4.57%	226.56	15.05
20%	70%	10%	-5.81%	270.53	16.45
20%	80%	0%	-7.05%	319.34	17.87
30%	0%	70%	4.91%	123.17	11.10
30%	10%	60%	3.67%	147.72	12.15
30%	20%	50%	2.43%	177.11	13.31
30%	30%	40%	1.19%	211.34	14.54
30%	40%	30%	-0.06%	250.42	15.82
30%	50%	20%	-1.30%	294.33	17.16
30%	60%	10%	-2.54%	343.09	18.52

Portfolio Holdings			Expected Return	Variance	Standard Deviation
Voyage Charters	Time Charters	Freight Futures			
30%	70%	0%	-3.78%	396.69	19.92
40%	0%	60%	6.94%	207.46	14.40
40%	10%	50%	5.70%	241.64	15.54
40%	20%	40%	4.45%	280.66	16.75
40%	30%	30%	3.21%	324.53	18.01
40%	40%	20%	1.97%	373.23	19.32
40%	50%	10%	0.73%	426.78	20.66
40%	60%	0%	-0.51%	485.17	22.03
50%	0%	50%	8.96%	317.30	17.81
50%	10%	40%	7.72%	361.11	19.00
50%	20%	30%	6.48%	409.76	20.24
50%	30%	20%	5.24%	463.26	21.52
50%	40%	10%	4.00%	521.60	22.84
50%	50%	0%	2.76%	584.78	24.18
60%	0%	40%	10.99%	452.68	21.28
60%	10%	30%	9.75%	506.13	22.50
60%	20%	20%	8.51%	564.41	23.76
60%	30%	10%	7.27%	627.54	25.05
60%	40%	0%	6.03%	695.51	26.37
70%	0%	30%	13.02%	613.61	24.77
70%	10%	20%	11.78%	676.69	26.01
70%	20%	10%	10.54%	744.61	27.29
70%	30%	0%	9.30%	817.37	28.59
80%	0%	20%	15.05%	800.09	28.29
80%	10%	10%	13.81%	872.80	29.54
80%	20%	0%	12.36%	950.35	30.83
90%	0%	10%	17.08%	1012.12	31.81
90%	10%	0%	15.83%	1094.46	33.08
100%	0%	0%	19.10%	1249.69	35.35

Appendix L

Expected Return, Interquartile Range and Minimum Return Results for Portfolios with a 10% Chunk-size

L.1 USGC-JAP 30,000 Dwt. Grain

Portfolio Holdings					
Voyage Charters	Time Charters	Freight Futures	Expected Return	Interquartile Range	Minimum Return
0%	0%	100%	-16.86%	7.28	-16.86
0%	10%	90%	-18.72%	8.34	-18.72
0%	20%	80%	-20.58%	9.50	-20.58
0%	30%	70%	-22.43%	9.44	-22.43
0%	40%	60%	-24.29%	9.83	-24.29
0%	50%	50%	-26.15%	10.72	-26.15
0%	60%	40%	-28.01%	12.26	-28.01
0%	70%	30%	-29.87%	13.94	-29.87
0%	80%	20%	-32.09%	16.33	-32.09
0%	90%	10%	-35.64%	19.21	-35.64
0%	100%	0%	-39.19%	21.22	-39.19
10%	0%	90%	-17.43%	9.96	-17.43
10%	10%	80%	-19.28%	10.76	-19.28
10%	20%	70%	-21.14%	11.40	-21.14
10%	30%	60%	-23.00%	13.09	-23.00
10%	40%	50%	-24.86%	14.76	-24.86
10%	50%	40%	-26.72%	16.64	-26.72
10%	60%	30%	-29.07%	18.32	-29.07
10%	70%	20%	-32.34%	20.36	-32.34
10%	80%	10%	-35.90%	22.30	-35.90
10%	90%	0%	-39.47%	24.36	-39.47
20%	0%	80%	-18.83%	13.57	-18.83
20%	10%	70%	-20.54%	15.81	-20.54
20%	20%	60%	-22.24%	16.94	-22.24
20%	30%	50%	-23.95%	19.40	-23.95
20%	40%	40%	-26.29%	20.11	-26.29
20%	50%	30%	-29.59%	21.92	-29.59
20%	60%	20%	-33.16%	24.37	-33.16
20%	70%	10%	-36.73%	26.77	-36.73
20%	80%	0%	-40.29%	28.46	-40.29
30%	0%	70%	-20.27%	18.20	-20.27
30%	10%	60%	-21.98%	19.73	-21.98
30%	20%	50%	-23.69%	21.42	-23.69
30%	30%	40%	-26.85%	23.45	-26.85
30%	40%	30%	-30.41%	24.90	-30.41
30%	50%	20%	-33.98%	27.36	-33.98
30%	60%	10%	-37.55%	29.52	-37.55

Portfolio Holdings			Expected Return	Interquartile Range	Minimum Return
Voyage Charters	Time Charters	Freight Futures			
30%	70%	0%	-41.12%	31.49	-41.12
40%	0%	60%	-22.24%	23.97	-22.24
40%	10%	50%	-24.10%	25.06	-24.10
40%	20%	40%	-27.67%	26.14	-27.67
40%	30%	30%	-31.24%	27.79	-31.24
40%	40%	20%	-34.81%	30.38	-34.81
40%	50%	10%	-38.38%	32.84	-38.38
40%	60%	0%	-41.95%	34.52	-41.95
50%	0%	50%	-25.59%	28.62	-25.59
50%	10%	40%	-28.50%	29.88	-28.50
50%	20%	30%	-32.07%	31.20	-32.07
50%	30%	20%	-35.64%	33.64	-35.64
50%	40%	10%	-39.21%	35.57	-39.21
50%	50%	0%	-42.78%	38.02	-42.78
60%	0%	40%	-29.33%	33.13	-29.33
60%	10%	30%	-32.90%	34.42	-32.90
60%	20%	20%	-36.46%	36.84	-36.46
60%	30%	10%	-40.03%	39.01	-40.03
60%	40%	0%	-43.60%	41.38	-43.60
70%	0%	30%	-33.72%	37.98	-33.72
70%	10%	20%	-37.29%	40.51	-37.29
70%	20%	10%	-40.86%	42.79	-40.86
70%	30%	0%	-44.43%	44.33	-44.43
80%	0%	20%	-38.19%	44.18	-38.19
80%	10%	10%	-41.69%	46.32	-41.69
80%	20%	0%	-42.26%	48.04	-42.26
90%	0%	10%	-42.51%	49.75	-42.51
90%	10%	0%	-46.08%	51.81	-46.08
100%	0%	0%	-46.91%	55.47	-46.91

L.2 HR-JAP 55,000 Dwt. Coal

Portfolio Holdings			Expected Return	Interquartile Range	Minimum Return
Voyage Charters	Time Charters	Freight Futures			
0%	0%	100%	2.15%	7.57	-10.51
0%	10%	90%	0.27%	7.65	-12.36
0%	20%	80%	-1.60%	8.35	-14.22
0%	30%	70%	-3.47%	10.45	-16.07
0%	40%	60%	-5.34%	13.38	-17.92
0%	50%	50%	-7.21%	15.96	-19.78
0%	60%	40%	-9.08%	19.27	-22.38
0%	70%	30%	-10.95%	22.27	-26.11
0%	80%	20%	-12.82%	25.83	-30.09
0%	90%	10%	-14.69%	28.91	-34.08
0%	100%	0%	-16.56%	32.01	-38.07
10%	0%	90%	4.87%	10.08	-10.40
10%	10%	80%	3.00%	11.19	-12.25
10%	20%	70%	1.13%	13.65	-14.11
10%	30%	60%	-0.74%	17.30	-15.96
10%	40%	50%	-2.61%	19.88	-17.81
10%	50%	40%	-4.48%	24.47	-21.38
10%	60%	30%	-6.35%	27.95	-25.37
10%	70%	20%	-8.22%	31.21	-29.36
10%	80%	10%	-10.09%	34.45	-33.35
10%	90%	0%	-11.96%	37.49	-37.33
20%	0%	80%	7.60%	15.71	-10.29
20%	10%	70%	5.73%	17.70	-12.15
20%	20%	60%	3.86%	20.65	-14.00
20%	30%	50%	1.99%	24.04	-16.66
20%	40%	40%	0.12%	27.95	-20.65
20%	50%	30%	-1.75%	32.75	-24.63
20%	60%	20%	-3.62%	36.07	-28.62
20%	70%	10%	-5.49%	39.14	-32.61
20%	80%	0%	-7.36%	41.94	-36.60
30%	0%	70%	10.33%	23.08	-10.18
30%	10%	60%	8.46%	24.41	-12.04
30%	20%	50%	6.59%	28.17	-15.92
30%	30%	40%	4.72%	32.33	-19.91
30%	40%	30%	2.85%	36.73	-23.90
30%	50%	20%	0.98%	40.73	-27.89
30%	60%	10%	-0.89%	43.98	-31.87

Portfolio Holdings			Expected Return	Interquartile Range	Minimum Return
Voyage Charters	Time Charters	Freight Futures			
30%	70%	0%	-2.77%	46.50	-35.86
40%	0%	60%	13.06%	28.96	-11.20
40%	10%	50%	11.19%	32.26	-15.19
40%	20%	40%	9.32%	36.55	-19.17
40%	30%	30%	7.45%	40.71	-23.16
40%	40%	20%	5.58%	44.64	-27.15
40%	50%	10%	3.70%	48.50	-31.14
40%	60%	0%	1.83%	51.82	-35.13
50%	0%	50%	15.79%	36.08	-14.45
50%	10%	40%	13.92%	40.43	-18.44
50%	20%	30%	12.05%	44.62	-22.43
50%	30%	20%	10.17%	49.40	-26.41
50%	40%	10%	8.30%	52.82	-30.40
50%	50%	0%	6.43%	56.53	-34.39
60%	0%	40%	18.52%	43.88	-17.70
60%	10%	30%	16.64%	48.55	-21.69
60%	20%	20%	14.77%	53.32	-25.68
60%	30%	10%	12.90%	57.93	-29.67
60%	40%	0%	11.03%	61.17	-33.65
70%	0%	30%	21.24%	52.23	-20.95
70%	10%	20%	19.37%	57.34	-24.94
70%	20%	10%	17.50%	62.09	-28.93
70%	30%	0%	15.63%	66.18	-32.92
80%	0%	20%	23.97%	61.07	-24.21
80%	10%	10%	22.10%	66.11	-28.19
80%	20%	0%	20.23%	70.43	-32.22
90%	0%	10%	26.70%	69.91	-27.46
90%	10%	0%	24.83%	74.36	-31.54
100%	0%	0%	29.43%	78.28	-30.86

L.3 BRZ-NWE 120,000 Dwt. Iron Ore

Portfolio Holdings			Expected	Interquartile	Minimum
Voyage Charters	Time Charters	Freight Futures	Return	Range	Return
0%	0%	100%	-1.17%	5.70	-14.02
0%	10%	90%	-2.42%	6.15	-13.20
0%	20%	80%	-3.66%	6.92	-14.17
0%	30%	70%	-4.90%	7.57	-15.14
0%	40%	60%	-6.14%	10.07	-16.11
0%	50%	50%	-7.38%	12.81	-18.75
0%	60%	40%	-8.62%	15.64	-21.47
0%	70%	30%	-9.86%	18.82	-24.20
0%	80%	20%	-11.10%	22.37	-26.93
0%	90%	10%	-12.35%	24.85	-29.94
0%	100%	0%	-13.59%	28.00	-32.94
10%	0%	90%	0.85%	8.63	-14.62
10%	10%	80%	-0.39%	9.02	-15.59
10%	20%	70%	-1.63%	10.15	-16.56
10%	30%	60%	-2.87%	12.36	-17.53
10%	40%	50%	-4.11%	15.07	-18.50
10%	50%	40%	-5.35%	17.49	-20.17
10%	60%	30%	-6.59%	20.44	-23.18
10%	70%	20%	-7.84%	24.62	-26.18
10%	80%	10%	-9.08%	28.33	-29.19
10%	90%	0%	-10.32%	31.37	-32.19
20%	0%	80%	2.88%	10.29	-17.00
20%	10%	70%	1.64%	11.66	-17.98
20%	20%	60%	0.40%	14.05	-18.95
20%	30%	50%	-0.84%	16.53	-19.92
20%	40%	40%	-2.08%	20.74	-20.89
20%	50%	30%	-3.33%	24.25	-22.43
20%	60%	20%	-4.57%	27.58	-25.44
20%	70%	10%	-5.81%	31.15	-28.44
20%	80%	0%	-7.05%	34.72	-31.45
30%	0%	70%	4.91%	14.19	-19.39
30%	10%	60%	3.67%	17.12	-20.36
30%	20%	50%	2.43%	18.90	-21.33
30%	30%	40%	1.19%	23.26	-22.30
30%	40%	30%	-0.06%	27.72	-23.28
30%	50%	20%	-1.30%	30.15	-24.69
30%	60%	10%	-2.54%	33.71	-27.70

Portfolio Holdings					
Voyage Charters	Time Charters	Freight Futures	Expected Return	Interquartile Range	Minimum Return
30%	70%	0%	-3.78%	37.54	-30.70
40%	0%	60%	6.94%	19.85	-21.78
40%	10%	50%	5.70%	22.50	-22.75
40%	20%	40%	4.45%	26.38	-23.72
40%	30%	30%	3.21%	30.27	-24.69
40%	40%	20%	1.97%	33.89	-25.87
40%	50%	10%	0.73%	36.74	-27.64
40%	60%	0%	-0.51%	39.64	-29.96
50%	0%	50%	8.96%	25.22	-24.17
50%	10%	40%	7.72%	28.26	-25.14
50%	20%	30%	6.48%	32.49	-26.11
50%	30%	20%	5.24%	36.28	-27.17
50%	40%	10%	4.00%	39.57	-28.94
50%	50%	0%	2.76%	43.33	-30.71
60%	0%	40%	10.99%	30.79	-26.55
60%	10%	30%	9.75%	34.72	-27.52
60%	20%	20%	8.51%	38.55	-28.49
60%	30%	10%	7.27%	42.40	-30.23
60%	40%	0%	6.03%	45.96	-32.00
70%	0%	30%	13.02%	37.10	-28.94
70%	10%	20%	11.78%	40.68	-29.91
70%	20%	10%	10.54%	44.87	-31.53
70%	30%	0%	9.30%	48.47	-33.30
80%	0%	20%	15.05%	43.17	-31.33
80%	10%	10%	13.81%	47.05	-32.83
80%	20%	0%	12.36%	51.12	-34.60
90%	0%	10%	17.08%	49.41	-34.12
90%	10%	0%	15.83%	53.08	-35.89
100%	0%	0%	19.10%	55.00	-37.19

Appendix M

A Program for Determining the Roots of Polynomials

```
C     |------------------------------------------------------------|
C     |This is a program for deriving the roots of a polynomial using  |
C     |Newton's Divided Difference algorithm. To run the program, it is|
C     |necessary to input an initial guess at a root. This guess should|
C     |relate to an interval of interest. It is also necessary to       |
C     |adjust the f(x) and fd(x) variables in line with the form of the|
C     |polynomial and its derivative.                                   |
C     |------------------------------------------------------------|
C
      implicit real*8(a-h,o-z)
      f(x)=.0000335241*x**3+.00383043*x**2+.1158109*x-90.842647
      fd(x)=3*.0000335241*x**2+2*.00383043*x+.1158109
      print*,'what is your initial approximation'
      read*,x0
      print*,'what is the required accuracy'
      read*,tol
      print*,'what is the maximum no. of iterations allowed'
      read*,nmax
      do 1,i=1,nmax
      x1=x0-(f(x0)/fd(x0))
      if(abs((x1-x0)/x1).lt.tol.and.abs(f(x1)).lt.tol) then
```

```
      print*,'the root is',x1,'took',i,'iterations'
      stop
      endif
      print*,'iteration',i,'approximation',x1
      x0=x1
    1 continue
      print*,'sorry have not converged'
      stop
      end
```