CHAPTER 25

BUSINESS RISK MEASUREMENT AND MANAGEMENT IN THE CARGO CARRYING SECTOR OF THE SHIPPING INDUSTRY – AN UPDATE

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1. INTRODUCTION

Risk management in an industry which is riddled with cyclicalities in its rates and prices and which has made and destroyed millionaires over the years is extremely important. The issue has been discussed in Gray,[1, 2] comparing traditional methods of hedging, as he calls the choice of contract during ship operation,[3] with the "new" instruments that appeared in the market at the time. The latter were the futures contracts, which were launched by the Baltic Exchange in London and the International Futures Exchange in Bermuda, trading BIFFEX (Baltic International Freight Futures Exchange) and INTEX contracts for the dry bulk and tanker sectors, respectively.

In the meantime a number of developments have occurred, including the restructuring, renaming and the eventual abandonment of the Baltic Freight Index (BFI) in 2002 – the underlying commodity upon which BIFFEX contracts have been trading. The development of Over the Counter (OTC) Freight Forward Agreements (FFA) since 1992, the introduction of clearing of these OTC contracts and the appearance of options and swaps can be added to these developments, all of which have major implications for the way risk is managed in the industry today. A comprehensive description of these developments is provided in Kavussanos and Visvikis.[4, 5]

At the same time research has been published which has established formally a number of relationships not fully worked out previously empirically, and has uncovered new results on a number of important issues in the topic of risk measurement and management in the shipping industry. For instance, Kavussanos,[6–10] measures for the first time the (time varying) volatility of ship prices and freight rates by sector and type of contract, thus allowing for a formal comparison of risk levels between sectors and freight contracts at each point in time. The later work by Kavussanos and Nomikos[11–15] on the now-abandoned BIFFEX, of Kavussanos *et al.*[16, 17] and Kavussanos and Visvikiss (see endnotes 4–5)[18, 19] on FFAs and of Kavussanos and Dimitrakopoulos[20] on Value at Risk

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(VaR) and extreme value methods has looked at significant issues underlying the freight derivative instruments and their use for risk management purposes. This chapter aims to provide a review of the issues in order to help the reader see where we currently stand.

Broadly speaking, the owner of the assets, ships, is faced with a number of commercial decisions. They include decisions on:

(1) Whether to enter the shipping industry by buying or leasing ships?
(2) What kind of ships to purchase?
(3) When to buy the ships and when to sell them?
(4) How to finance the purchase of the assets – debt, equity, shareholding, etc.
(5) Once owning the vessels, where to operate them and what kind of contract to seek for them?
(6) Whether to use financial instruments, such as futures and forward contracts, to manage the risk in such markets as the freight, bunker, foreign exchange and interest rate market?

These are all real decisions that the shipowner is faced with in everyday decision making. They all amount to viewing ships as investments – as assets in portfolios, which generate a stream of cash flows by operating the ships and a possible capital gain if selling the assets at prices higher than they are bought for. Given that commercial investments have risks attached, one can immediately see that the above issues are highly relevant for decision making. See Kavussanos and Visvikis (see endnote 4) for a detailed discussion of these.

The issues raised become more evident when examining the shipowner's balance sheet, in Table 1. The shipowner's cash flow problem is outlined in the table, where:

Cash Flow = Operating Revenue – Operating Costs (Fixed) – Voyage Costs (Variable)
– Capital Costs (Fixed or Variable) + Capital Gain

Table 1: Shipowner's cash flow in spot (voyage) and T/C markets

Spot(voyage) market	**Time-charter market**
Voyage Hire (in US$) Less: Operating costs (in domestic currency, e.g. euro) Less: Voyage Costs **=Operating Earnings**	T/C Hire (in US$) Less: operating costs (in domestic currency, e.g. euro) **=Operating Earnings**
Less: Capital costs (from loans) **Plus: Capital gain/loss** from buying and selling the vessel **=Overall Cash Flow**	Less: Capital costs (from loans) **Plus: Capital gain/loss** from buying and selling the vessel **=Overall Cash Flow**

Notes:
(1) Operating costs include manning, repairs and maintenance, stores and lubes, insurance, administration.
(2) *Voyage costs* include broking commission, fuel costs, port charges, tugs, canal dues, etc. Fuel costs form the largest part of these, and are subject to the highest fluctuations.
(3) *Capital costs* refer to debt servicing through capital repayment.

Fluctuations in revenue or costs can cause fluctuations in operating earnings. This may be due to changes in revenue, which is affected by changes in demand for freight services and by changes in freight rates, or because of changes in voyage or operating costs (e.g. changes in bunker prices, wage rates, exchange rates, etc). Operating costs include manning, repairs and maintenance, stores and lubes, insurance, administration, and are thought to be relatively constant, rising in line with inflation. In contrast to time charter markets, operations in the spot market involve voyage cost payments by the shipowner. Thus, apart from fluctuations in the freight market, owners are exposed to fluctuations in voyage costs, the main part of which are bunker prices. This is one of the reasons why spot markets are deemed riskier than time charter markets. The others relate to the nature of the relationship of spot and time charter rates, which leads us to expect that spot rates trade at a premium to time charters to compensate for the higher risk involved when operating the ships spot. The relationship is that, say, one-year time charter rates must be the sum of a series of expected (monthly) spot rates plus a risk premium. This is discussed fully in Kavussanos and Alizadeh.[21]

The volatility in freight rates, examined later in the chapter, and in Kavussanos (see endnotes 6–10), could be a source of risk. From the above table though it is apparent that voyage costs – in particular bunker prices – are the source of a certain volatility apparent when operating in the spot market, which does not affect the owner when operating in the time charter market. Alizadeh, Kavussanos and Menachof[22] examine ways of mitigating bunker price risks through derivatives trading. They are discussed later in the chapter. Gray (see endnote 1) and Kavussanos and Visvikis (see endnote 4) discuss how selection of contract type can reduce freight risks, and Kavussanos (see endnotes 6–10) examines the same and other issues at the empirical level. The use of freight futures contracts (BIFFEX) for freight risk management has been examined in the past by Cullinane,[23] Haralambides[24, 25] and Kavussanos and Nomikos (see endnotes 11–15).Finally, with the decline of interest in BIFFEX, Freight Forward Agreements (FFAs) and other financial instruments have provided the alternative for freight risk management. The issue is examined in Kavussanos and Visvikis (see endnotes 4,18) and in Kavussanos *et al.* (see endnotes 16,17) These are discussed later in the chapter.

The other source of risk for the owner apparent in the table is the interest rate risk. This relates to the capital charges, associated with debt finance. They fluctuate with interest rates. The higher the debt-equity ratio in the financing of a ship, the greater the financial leverage, and the more the residual cash flow is at risk. Thus, financial leverage compounds the risks created by operating leverage.

A further source of risk comes from the fluctuation in the value of the asset – the ship. Often, owners are involved in asset play, see Stopford[26.] They see ships as assets whose prices fluctuate, and offer the possibility of a capital gain or loss. This is shown in the last part of Table 1. Fluctuations in ship prices then influence the risk level involved in the investment. A major part of this chapter is concerned with this issue, which has been analysed in papers such as Kavussanos (see endnotes 6–10).

Credit risk, or counterparty risk, is yet another source of risk that shipowners face and it refers to the possibility that the counterparty in a private contract does not fulfil its obligations. This risk is more prevalent under bad market conditions and when the other party is losing money from the agreement. Such risk is prevalent, amongst others, in freight (voyage or time charter) contracts, in FFAs in bond issues, in interest swaps, etc.

In all the above, one has to add exchange rate risk, which is present in such an international industry. It affects the owner's cash flow through a number of routes, including freight rates, voyage expenses, purchasing of the asset, etc. Interest rate and exchange rate risks fall outside the scope of this chapter. Sophisticated derivative instruments exist in the finance profession, which enable interested parties to deal with these risks – see Kavussanos and Visvikis (see endnote 4) for a description.

2. RISK/RETURN TRADE-OFFS IN SHIPPING

In making commercial decisions the owner has in mind that greater rewards are usually achieved by undertaking higher risks. Usually such risks are measured by the volatility of the variable a decision has to be made for. For example, because freight rates fluctuate widely, say from month to month, taking a position in the market in a particular month can produce substantial gains or losses depending on what happens in subsequent months. Fluctuations in freight rates around their average values over a period of time may be used typically as measures of freight risk; technically, by their variance or by its square root, the standard deviation. High (low) standard deviations reflect high (low) volatility in rates and of the risks involved.[27]

Considering shipowners as asset holders, who wish to maximise return and minimise risk on their portfolio of shipping assets. Can they do anything to mitigate the risk involved in their shipping investments and in operations resulting from freight rate fluctuations? Say the shipowner is a specialist in the tanker sector. He is faced with two important decisions which can affect the risk/return position of his portfolio; (1) what size ships to invest-on? and (2) For a given investment, whether to operate the vessels in the spot or in the period (time charter) market? The issue of what size ships to invest-on, if approached from the pure asset-play point of view, may be answered by considering the risk-return profiles of different size vessels.

Vessel size considerations are important as the markets for each size are distinct in terms of the rewards and risks they carry, and so is positioning in the spot or time-charter market. From a different point of view, Glen[28] has shown that the industry is divided into sub-markets. Kavussanos (see endnotes 6–10), shows that these markets are distinct in terms of their risk return profiles. As a result, investments in different size vessels can be thought of as having the same portfolio diversifying effects as different stocks included in an investor's portfolio. To see that consider the possible disaggregation of the cargo carrying shipping industry discussed next.

3. MARKET SEGMENTATION OF THE SHIPPING INDUSTRY

3.1 General cargo and bulk cargo movements

The *parcel size distribution* (PSD) of each commodity determines the shipping consignment of the cargo, see Stopford (see endnote 26). Some commodities are typically moved in larger sizes than others. For example, iron ore and grain consignments are much larger than phosphate rock or bauxite and alumna. Furthermore, the consignment size or PSD of each commodity changes over time and may be different on different routes. The PSD depends on: (1) Commodity demand and shipping supply economics (e.g. low value goods move in large consignments); (2) Transport distances (consignment is directly proportional to distance) and transport system restrictions (e.g. limited draft in ports, regulations); (3)Vessel availability. Consignments of over 2,000–3,000 tonnes can fill a whole ship (or hold) rather than part of a ship, and are typically transported in bulk. Smaller consignments, which fill only part of the ship (or hold), move as general cargo.

Bulk cargoes refer mainly to raw materials and are transported on a one -ship, one-cargo basis. They are further sub-divided into liquid cargo and dry cargo. Liquid cargo includes crude oil, oil products, chemicals (e.g. caustic soda), vegetable oils and wine. Dry Cargo is broadly divided in three categories: (a) Majors (i.e. iron ore, coal, grain, bauxite and phosphates), (b) Minors (i.e. steel, steel products, cement, sugar, gypsum, non ferrous metal ores, salt, sulphur, forest products, wood chips and chemicals; (c)Specialist bulk cargoes requiring specific handling or storage requirements such as heavy lift, cars, timber and refrigerated cargo. The ships involved in bulk cargo transportation are tankers, bulk carriers, combined carriers (they carry either dry or liquid bulk) and specialist bulk vessels. Bulk cargoes constitute two thirds of seaborne trade movements, and are carried mainly by tramp ships, which constitute three quarters of the world's merchant fleet. These are vessels which move around the world seeking employment in any place/route of the globe. Bulk ships usually carry one cargo in one ship at rates negotiated individually for the service provided.

General cargo, is also dry cargo, but is not transported in bulk. A large part of general cargo is transported in containers, multipurpose and other specialised ships (Ro-Ro, car carriers, etc.). General cargo (one third of seaborne trade) is transported in either tramp ships or liners; the latter provide a regular, scheduled service, transporting small cargo consignments at fixed tariff levels between areas of the world.

The economics of each type of transport service are different. For example, oligopolistic conditions prevail in liner markets, while conditions of perfect competition guide tramp markets.

3.2 Bulk-cargo segmentation

For analysis, dry and liquid bulk cargoes may be further subdivided according to the PSD functions of the products carried. The PSD function depends on the maximum size delivery an industry is able or willing to accept at any one time. In some industries stockpiles are around 10–15K tonnes, so a delivery of 50K tonnes is too large. Physical limitations on ship size draw a line between groups. For instance, Suezmax, Panamax, etc. This is because size determines the type of trade the ship will be involved in, in terms of type of cargo and route; this is a result of the different PSD's of commodities and the port and seaway restrictions for certain size ships. Design features are important. For example, cargo handling gear (cranes), pumping capacity and segregation of cargo tanks in tankers; certain ports in developing countries cannot be used (e.g. ships which do not have cargo handling gear). Also, coating of tanks and ballast spaces are distinguishing factors. Tables 2 and 3 present the submarkets that are distinguished for dry and liquid bulk.

Very Large Ore Carriers (VROC) vessels (200,000+ dead-weight tonnes (dwt)) transport only iron ore from Brazil to West Europe (Rotterdam). They are VLCCs converted into dry-bulk carriers. Capesize vessels (100,000–199,999dwt) transport iron ore mainly from South America and Australia and coal from North America and Australia. Panamax vessels (around 60,000–99,999dwt) are used primarily to carry grains and

Table 2: Dry bulk market segmentation by vessel size

Vessel type/market	**Vessel size**	**Cargo type**
VROC	200,000+ dwt	Iron ore
Capesize	100,000–199,999dwt	Iron ore, coal
Panamax	60,000–99,999dwt	Coal, grain, bauxite and larger minor bulk parcels
Supramax	54,000–59,999dwt	Minor bulks and smaller parcels of major bulks such as grains, coal and bauxite.
Handymax	34,000–53,999dwt	>>
Handysize	10,000–33,999dwt	>>

Minor bulks: Steel, steel products, cement, sugar, gypsum, non ferrous metal ores, salt, sugar, sulphur, forest products, wood chips and chemicals.

Table 3: Liquid bulk market segmentation by vessel size

Vessel type/market	**Vessel size**	**Cargo type**
Ultra-large crude carriers (ULCCs)	320,000 + dwt	Crude oil
Very-large crude carriers (VLCCs)	200,000–319,999 dwt	Crude oil
Suezmax	120,000–199,999 dwt	Crude oil
Aframax tankers	75,000–119,999 dwt	Crude oil
Large product tankers	50,000–74,999 dwt	Oil products, sometimes crude oil
Small product tankers (coasters)	10,000–49,999 dwt	Oil products, sometimes crude oil

coal from North America and Australia. Handy vessels (around 10,000–59,999dwt) transport grains, mainly from North America, Argentina and Australia, and minor bulk products – such as sugar, fertilisers, steel and scrap, forest products, non-ferrous metals and salt – virtually from all over the world. Over time, in the category of Handy vessels, Handysize (10,000–33,999dwt) vessels have gradually become Handymax (34,000–53,999dwt), while Supramax (54,000–59,999dwt) vessels have appeared over the last years, as a consequence of vessel sizes becoming larger to satisfy the demand for larger PSDs for dry bulk commodities.

Smaller vessels such as Handy and Handymax in the dry bulk sector are, in general, geared so that they can load and unload cargo in ports without sophisticated handling facilities. They can avail of more ports compared to larger vessels. As ports

Table 4: Container market segmentation by vessel size

Vessel type/market	Ship size, TEU	Speed in knots
Feeder	0–499	16.5
Feedermax	500–999	19.0
Handy	1,000–1,999	20.3
Sub-Panamax	2,000–2,999	21.0
Panamax	3,000–4,999	24.3
Post-Panamax	>5,000	25.9

of the world have been developed the new generation of Handymax and Supramax vessels are carrying more and more of the trade the Handys carry. The same is also true in the liquid bulk sector; the very large vessels trade in only four-fifths of routes as the draught restrictions in ports and the storage facilities required ashore are very large to accommodate them and their cargoes. The smaller vessels are more flexible in terms of the routes and trades they are involved in. See Kavussanos and Visvikis (see endnote 4) for more details.

3.3 General (dry) cargo segmentation

When general dry cargo is not moved by dry-bulk ships it is transported by liners. The following distinctions are common. Container ships, Ro-Ro, Multi Purpose MPP (Single-deck, multi-deck, Semi-containers), Barge Carrying vessels (BCV). Other specialised vessels include Refrigerated (Reefers), Car-carriers, Cement carriers, Heavy lift, Ore carriers, Vehicle carriers, LPG tankers, etc. Within the liner trades there is a move towards containerisation at the expense of non-unitised cargo which used to be transported in MPP ships. Containerships themselves have sub-markets according to size. These are shown in Table 4.

Just as with dry-bulk, each of these sub-markets has its own economic characteristics, and the risks and rewards involved for the shipowner and the charterers are different.

4. COMPARISON OF VOLATILITIES OF SECOND HAND SHIP PRICES

Since smaller vessels can approach more ports (due to their smaller size and the existence of cargo handling gear on board) and can switch between different trades/routes they are more flexible for employment. As a consequence, they are less risky than the larger vessels. This is established in the market by the volatilities of both their prices and of their freight rates being lower than those of the larger vessels. This was first shown formally in Kavussanos (see endnotes 6–10), who compares freight rate and ship price volatilities between different vessel sizes. This is discussed next.

Having obtained data for freight rates and second-hand Handysize, Panamax and Capesize vessel prices, monthly returns and volatilities are calculated. These volatilities are compared between vessel sizes. Investments in vessels with higher volatilities are

Table 5: F-statistics for equality of unconditional variances in dry bulk ship prices

	Cape vs Panamax	Cape vs Handy	Panamax vs Handy
F-statistic	1.635	1.842	1.127

Notes:
(1) These statistics, which are defined as $F=SD_1^2/SD_2^2 \sim F(n-1, m-1)$, where SD_1^2 and SD_2^2 are the sample variances and follow the F distribution with (n-1, m-1) degrees of freedom; in this case (195,195) degrees of freedom.
(2) Critical values of the statistics at the 5% and 1% levels are 1.26 and 1.36 respectively.
(3) Sample period 1979: 5–1995:8.
Source: Kavussanos (see endnote 8)

Table 6: F-statistics for equality of unconditional variances in tanker ship prices

	VLCC vs Suezmax	VLCC vs Aframax	Suezmax vs Aframax
F-statistic	1.84	2.71	1.47

Notes:
(1) F distribution degrees of freedom (166,166), with critical values at the 5% and 1% levels 1.29 and 1.44, respectively.
(2) Sample period 1980: 2–1993:12.4.
Source: Kavussanos (see endnote 7)

deemed riskier compared to those with lower ones. Tables 5 and 6 show the results for the dry bulk and the tanker sectors, respectively.

Broadly speaking, for asset players who choose to have ships in their portfolio of assets they can reduce risk by investing in smaller vessels, compared to larger ones. Moreover, the results make sense as explained earlier. The smaller vessels are more flexible as assets. They have a lower risk of unemployment in adverse market conditions, as they can be switched more easily between routes and trades to secure employment. In addition, the cargo sizes that larger vessels carry makes them less useful for charterers requiring transportation of smaller quantities. This makes the demand for these vessels less flexible, and vessels cannot switch between sea-lanes and charterers as easily as their smaller counterparts. For instance, if anything happens (e.g. a political or economic change) in one of the routes the VLCC's operate in this will have a significant impact in rates in the market, which is translated into high volatility in rates. As a consequence, the income stream from operations of smaller vessels, and their prices, as present values of the expected future income, are subject to less fluctuations in comparison to the larger vessels.

4.1 Dynamically adjusting volatilities

The studies by Kavussanos, (see endnotes 6, 7) mentioned above, have gone a step further in the analysis of ship price volatilities. They introduce, for the first time in shipping, the class of Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models of Engle[29] and Bolerslev,[30] to estimate time varying volatilities of ship prices. Thus, price volatilities are explained in terms of their past values, values of squared shocks to long-run equilibrium in each market, and allow for the possibly of introducing a set of exogenous factors. The general form of the augmented GARCH-X(p,q) model of Bollerslev (see endnote 30) can be represented by the following equations:

$$\Delta \ln P_t = \mu_{t-1} + \varepsilon_t \,;\, \varepsilon_t \sim IN(0, h_t)$$

$$ht = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{q} \beta_j h_{t-j} + \delta Z_t \tag{1}$$

$$LL = -(T/2)\ln h_t - (1/2h_t)\sum_{i=1}^{p} \alpha_i \varepsilon^2{}_{t-1}$$

where, μ_{t-1} is the specification of the conditional mean, that is, of the change in the log of ship prices, $\Delta \ln P_t$, ε_t is a white noise error term with the usual classical properties and a time-varying variance h_t, which may include a set of exogenous factors, Z_t, and *LL is* the corresponding log-likelihood function after omitting the irrelevant constant. The parameters of interest are those included in μ_{t-1}, say $\phi(L)$, and the GARCH parameters $\alpha_0, \alpha_i, \beta_j$ and δ and can be estimated by maximum likelihood methods.

The estimated time varying volatilities allow the measurement and comparison of volatilities at each point in time, rather than relying on the averages over the period examined in Tables 5 and 6. Considering average volatilities(standard deviations) of ship prices (or freight rates) over a period of time as indicators of risk levels provides a partial picture of the risk/return situation. This is because uncertainty in prices, is not constant over time. The patterns and relative levels of volatilities, at each point in time (market situation) can now be measured, and compared between different ship sizes. Such estimates of time varying variances are also deemed important in the financial literature, as they may be used in the construction of dynamic portfolios of assets. These time varying volatilities of ship prices for the tanker and dry bulk sub-sectors are shown in Figures 1 and 2, respectively.

This method of analysing volatilities and examining them graphically has allowed further inferences for the dry bulk sector, such as that: Volatilities, and thus risks, vary over time and across sizes; in particular, volatilities are high during and just after periods of large imbalances and shocks to the industry. These include the period of the oil crisis of the early 1980s, the recovery period of 1986–1989 and the Gulf crisis of the early 1990s. Panamax volatilities are driven by old "news", while new shocks

Figure 1: Vessel price volatilites in segments of the tanker sector

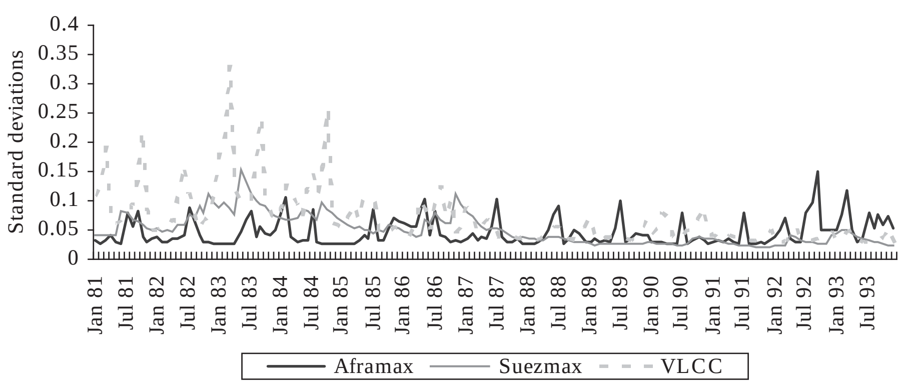
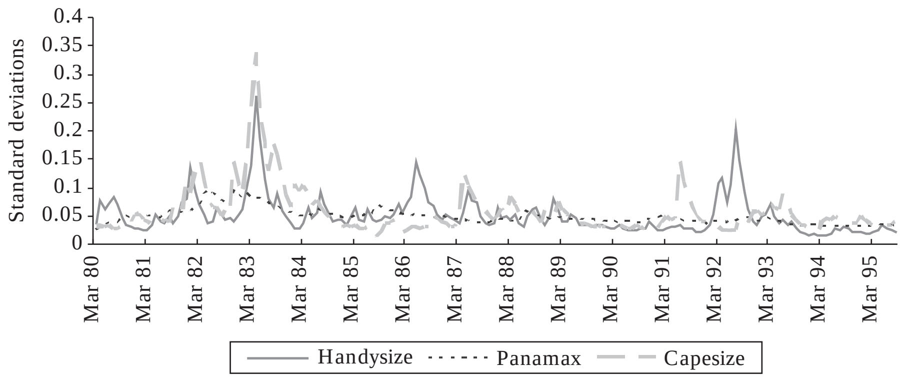


Figure 2: Vessel price volatilities in segments of the duty bulk sector



are more important in the Handy and Capesize markets. Also, conditional volatilities of Handysize and Panamax vessel prices are positively related to interest rates and Capesize volatilities to time-charter rates.

The three markets tend to respond together to external shocks, and yet quite differently, implying market segregation between different size ships. (i.e. there are some common driving forces of volatilities in different size markets, and yet there are idiosyncratic factors to each market that make each size-ship volatility move in its own way). These idiosyncratic factors relate to the type of trade each size ship is engaged in. Thus, volatility for Handysize and Capesize vessels has several hikes, while that for Panamax is smoother. This differing nature of volatilities over ship sizes is manifested in the GARCH alpha(news) coefficients being higher than the beta (persistence) coefficients for Capesize and Handysize vessels, while the opposite is true for Panamax.[31]

Regarding volatility levels, Capesize volatility generally lies above the volatilities of the other two sizes, except for two–three years in the mid-1980s. Similarly, the Panamax volatility is, in general, at a level above Handysize, which, however, is exceeded at times by the hikes in the Handy volatility.

Similar results are reached by considering the time varying volatilities for the tanker sector. In addition, volatilities in the tanker sector and thus risks levels seem to be positively related to oil prices. The downward trends in volatilities observed in the dry bulk and tanker industry sub-sectors seem to indicate that risks in the shipping industry have decreased over time. It should also be mentioned that the availability of time varying volatility estimates for vessel prices, as with other assets in the financial literature, may be used as inputs in pricing derivative instruments such as options prices, etc.

5. COMPARISON OF VOLATILITIES OF SPOT AND TIME CHARTER RATES

Theoretically, ship prices are the present value of the expected stream of cash flows (profits) from their operation. The relationship has been investigated formally in

Table 7: Pairwise sample variances of time-charter (upper triangle) and spot (lower triangle) rates in tanker sub-markets

	Handymax (H)	**Aframax (A)**	**Suezmax (S)**	**VLCC (V)**
Handymax (H)		8.23*(H<A)	1.14 (H<S)	8.68*(H<V)
Aframax (A)	1.30*(H<A)		7.24*(A>S)	1.06(A<V)
Suezmax (S)	1.27*(H<S)	1.03(A>S)		7.64*(S<V)
VLCC (V)	2.68*(H<V)	2.05*(A<V)	2.11*(S<V)	

Notes:
(1) 5% and 10% critical values for F(166,166) are 1.29 and 1.22, respectively.
(2) *Indicate significance at the 10% level.
(3) The symbol < indicates less than, while the symbol > indicates greater than.
Source: Kavussanos (see endnote 10)

Kavussanos and Alizadeh.[32] As a result of this theoretical relationship, comparison of freight rate volatilities by vessel size should reveal a similar relationship to that uncovered by examining the second hand prices. This is indeed the case; Kavussanos (see endnotes 6, 9) shows that volatilities of spot rates and of time charter rates are smaller for smaller size vessels, compared to those of larger ones. Table 7 compares these volatilities in the tanker sector.

In both the spot and time charter markets the VLCC sector exhibits the highest volatility compared to smaller sizes over the period examined. The Handymax volatilities are the lowest in both markets compared to other sizes. The Aframax and the Suezmax sectors show significantly larger volatilities in comparison to the Handymax sector and smaller ones compared to the VLCC in both the spot and the time-charter markets. However, the volatilities between the Aframax and Suezmax sectors are not statistically different between them. Overall, within the dry bulk and tanker sectors, risk levels, as expressed by freight rate volatilities, are different between vessel sizes. Coupled with the different levels of return each vessel size yields, different size vessels can be viewed as distinct asset classes in a portfolio of ships. This has implications for investors.

The above findings then, of the possible diversification effects that may be achieved by holding different size ships in a portfolio of assets have not been discussed in the literature previously. The studies by Kavussanos (see endnotes 4,7–11), have provided a formal justification of pursuing such strategies. In addition, these studies have also investigated, for the first time, empirically some well-known propositions regarding the possibility of operational risk reduction by choice of contract. Gray (see endnote 1) discusses the gradual risk reduction effects that are achieved by shipowners selecting to employ their vessels in markets such as voyage charter(spot), trip time charter, period time charter and in contracts of affreightment,[33] consecutively.

Table 8 compares, statistically, pair-wise volatilities between the spot and the time-charter market for each size ship in the tanker sector. In all vessel sizes, but the Aframax, the spot rates are significantly more volatile compared to time-charters. In the Aframax size there is no significant difference between spot and time-charter volatilities. Once again the evidence seems to be consistent with *a priori* expectations, in that the spot rates are much more exposed to the day-to-day market conditions in determining rates compared to time-charter rates. The latter, being theoretically the discounted stream of

Table 8: Pairwise comparison of volatilities in Spot(FR) vs Time-Charter(TC) rates of the tanker industry

Size	Handymax	Aframax	Suezmax	VLCC
Result	FR > TC*	FR < TC	FR > TC*	FR > TC*

Notes: (1). * indicates statistical significance.
(2). Also, see notes in Table 7 for definitions.
Source: Kavussanos (see endnote 10)

12-months expected spot rates, are smoother, and this is reflected in the smaller volatilities in comparison to the one-month spot rates, see Kavussanos and Alizadeh (see endnote 33) for an empirical formulation of this relationship.

It seems that the risk involved in operating tankers in the spot markets is greater than in the time-charter markets and this seems to hold irrespective of size.

5.1 Comparison of time varying freight volatilities over vessel sizes

Risks in the spot and time-charter tanker markets are a combination of industry-market risk and "idiosyncratic" risk (e.g. relating to individual vessel size). As long as one is faced with more than one option over choices, then idiosyncratic risk may be diversified. The shipowner, for instance, may choose to use the spot instead of the time-charter market, or may decide to invest in alternative size ships. Decisions about this process take place on a continual basis. This is not possible by considering the averages of volatilities over a 10–15 year period. Monthly estimates of these volatilities though, resolves the problem. The results in Kavussanos (see endnotes 6–10) enable this.

Consider first how the industry has been affected across markets by examining time-varying risks in the spot and time charter tanker and dry bulk sectors, as observed in Figures 3–6. A tendency for volatility clustering is observed. Volatility is high during and just after periods of large shocks and imbalances in the industry; such as during the 1980–1981 oil crises and the decline in demand for shipping services as the world economy slowed down following the second oil shock; the supply of oil restrictions imposed by the OPEC production ceiling in 1982–1983, the targeting of ships in the Gulf in 1984, the sharp decline in oil prices in 1986 and the 1990–1991 period of the Gulf-war are particularly visible.

The above incidents affected all markets and are manifested in patterns of risk, which are specific to vessel sizes. In tanker markets for instance, the VLCC sector seems to have the highest volatility and fluctuations are a lot sharper than in any of the other sizes. The sector involves vessels trading in four routes, all lifting oil from the Gulf, which were severely disrupted in periods of crises. The Handymax volatility is the lowest in both the spot and time charter markets reflecting the steady trades this type of ship is involved in. The Suezmax and Aframax volatilities fluctuate between those of the Handymax and the VLCC. In the spot market, the levels of volatilities are interchanged with neither being significantly above the other.

Figures 5 and 6 compare time varying volatilities of spot and of time charter freight rates between Handysize, Panamax and Capesize vessels in the dry bulk sector. Once more, risk, as manifested by volatility estimates, is in general higher in larger vessels. The reasons for the lower volatility levels in Handysize vessels as compared to the other

Figure 3: Time charter volatilities by vessel size

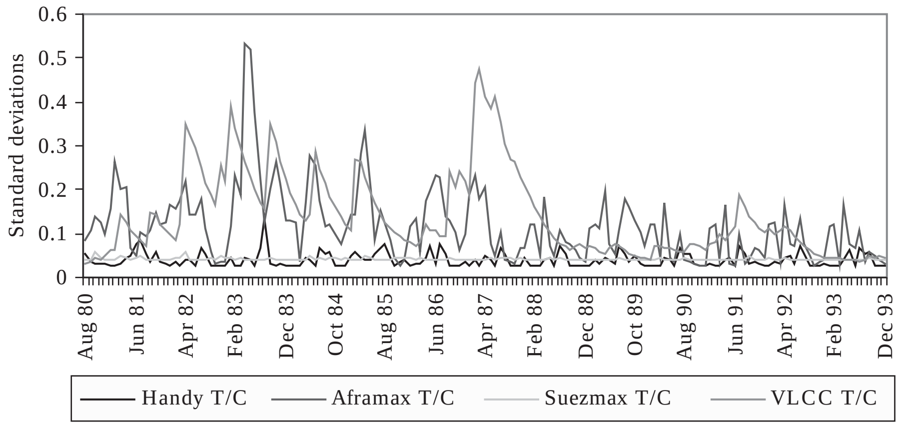
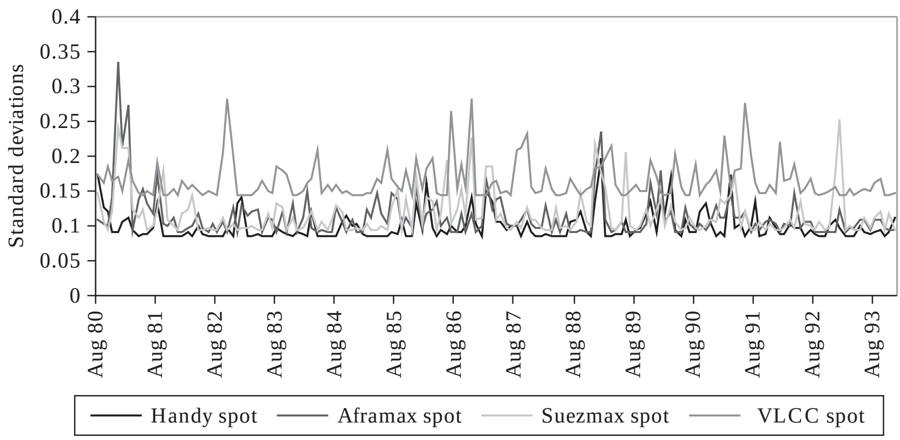


Figure 4: Spot freight rate volatilities by vessel size



sizes and of Panamax in comparison to Capesize have been explained before. Smaller ships serve many more different trades than larger ones, with less draft restrictions on certain ports because of size, and are not therefore subject to so many ups and downs in the market. On the contrary, larger size vessels may be thought of as operating in narrower markets, serving only a few major commodities and being restricted to approaching specific ports only. This has its toll on volatility levels.

Overall, it may be said that the shipping markets tend to respond together to external shocks, and yet quite differently implying market segregation between different size ships. That is, there are some common driving forces of volatilities in different size vessels, and yet there are idiosyncratic factors to each market that make each size-ship

Figure 5: Spot freight rate volatilities by vessel size; dry-bulk sector

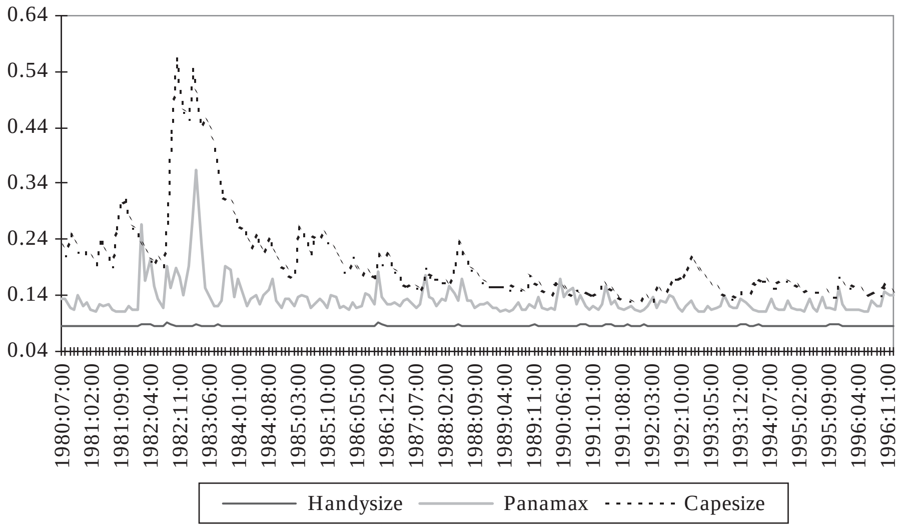
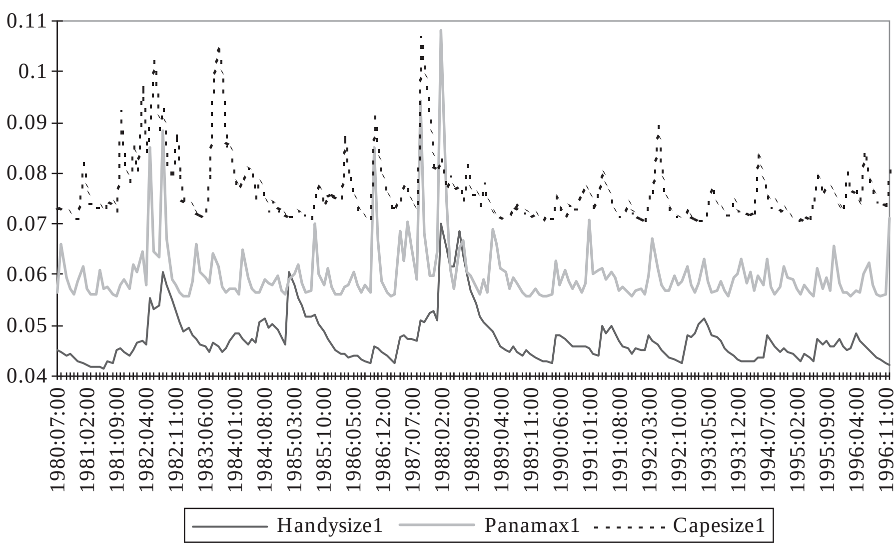


Figure 6: Time charter rate volatilities by vessel size; dry-bulk sector



volatility move at its own level and in its own way. These idiosyncratic factors relate to the type and number of routes each size ship is engaged in.

The results suggest that operational risks in the larger sub-sectors of the tanker and dry bulk sectors of the shipping industry may be mitigated by holding smaller vessels. Hence, risk averse investors in shipping can diversify risks in their portfolios by heavier weighting towards smaller size vessels.

Figure 7: Spot vs time charter volatilities: Handymax sector

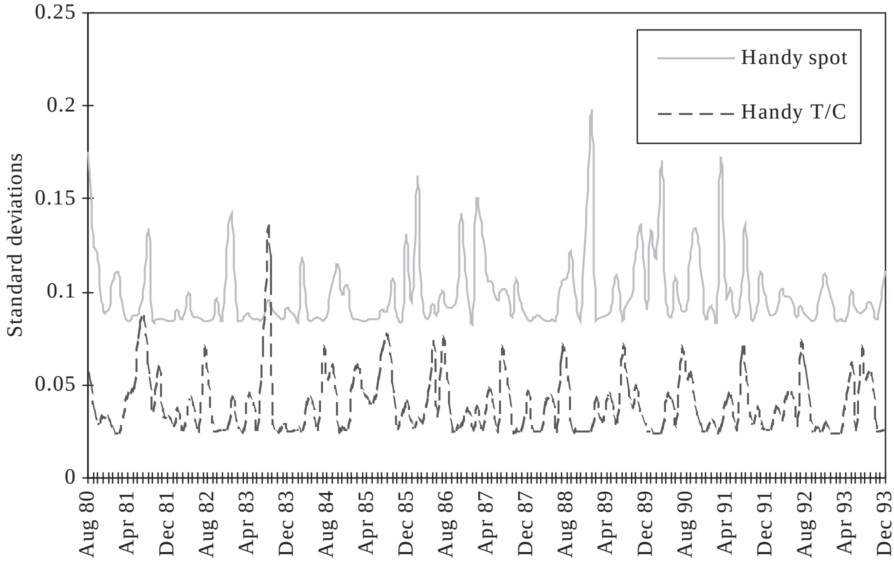
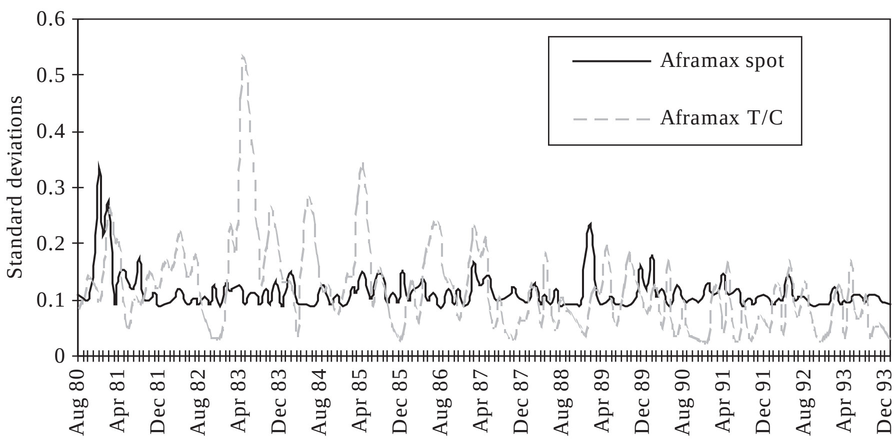


Figure 8: Spot vs time-charter volatilities: Aframax sector



5.2 Comparison of time varying freight volatilities over type of contract, spot vs time-charter

With respect to the choice between spot and time-charter markets, volatilities are compared in Figures 7–10, between time-charter and spot freight rates for each size vessel in the tanker sector. See Kavussanos (see endnote 10) for full details of this exercise. Figures 7 and 9 reveal that the volatility of spot-freight rates in the Handymax and

Figure 9: Spot vs time-charter volatilities: Suezmax sector

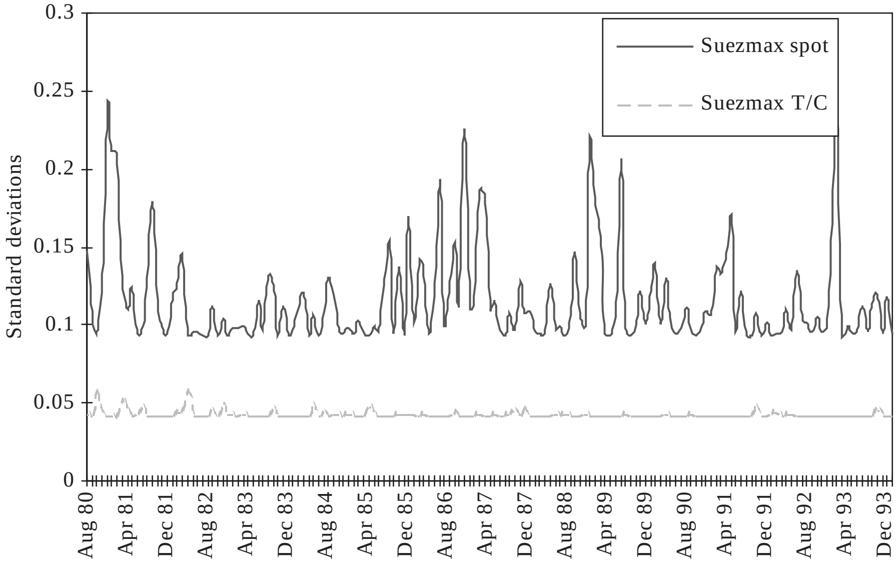


Figure 10: Spot vs time-charter volatilities: VLCC sector

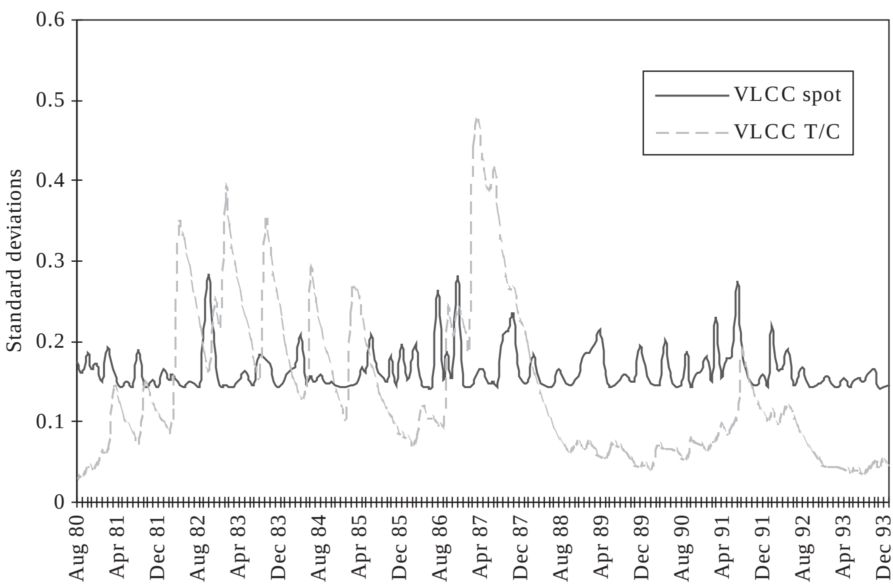
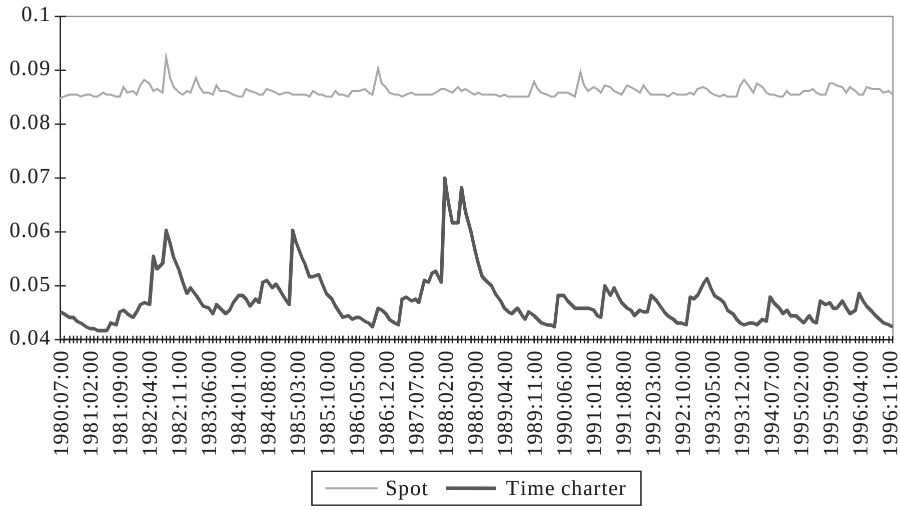


Figure 11: Handysize sector: Spot vs time charter rate volatilities (SD's)



Suezmax sectors are clearly above the corresponding time charter rates over the whole period. The results are not so neat for the Aframax and VLCC markets. Figure 8 shows that before 1987, the Aframax time charter volatility was mostly at a higher level than the spot one, with the reverse occurring once the market recovered. The fluctuations in the volatility of time charter rates in the early period are sharp and in wider bands as compared to the post-1987 period, forcing the average in Table 8 to be, though insignificantly so, above the spot rate. The story is similar in the VLCC sector. The downward trend in time charter risk, lying constantly below the spot rate level of risk from 1988 onwards, is particularly noticeable.

Kavussanos (see endnote 6) compares aggregated (over vessel sizes) spot with time-charter volatilities for the dry-bulk sector. The results there are somewhat in line with the findings in the Aframax and VLCC sectors discussed above. That is, when the market is low, time-charters are more volatile than spot rates, probably because time-charter rates reflect expectations of future events, which makes them more sensitive to changing perceptions of the future market. When the market is at the bottom and there is a feeling for a market upturn, charterers rush to fix vessels on time charter. This results in time-charter rates moving more steeply upwards than spot rates. The opposite happens when the market is at its peak, where charterers fix in the spot market and the lack of demand for time charters results in an abrupt drop in their values.

As the data used in this last comparison of spot-with time-charter rates on the dry bulk sector were at the aggregate level, and did not refer to time charter rates of individual vessels, it was felt that more information could be obtained if the results were refined by vessel size. Thus, time varying volatilities of spot and of time charter rates in dry bulk have been estimated and presented for the first time in this chapter for each vessel size using GARCH models. Their plots are shown in Figures 11–13. Spot volatilities seem to be above the one-year time charter ones for each vessel size. This takes us back to the traditional belief that spot rates are more volatile and hence riskier than time charters.

Figure 12: Panamax sector: Spot vs time charter rate volatilities (SD's)

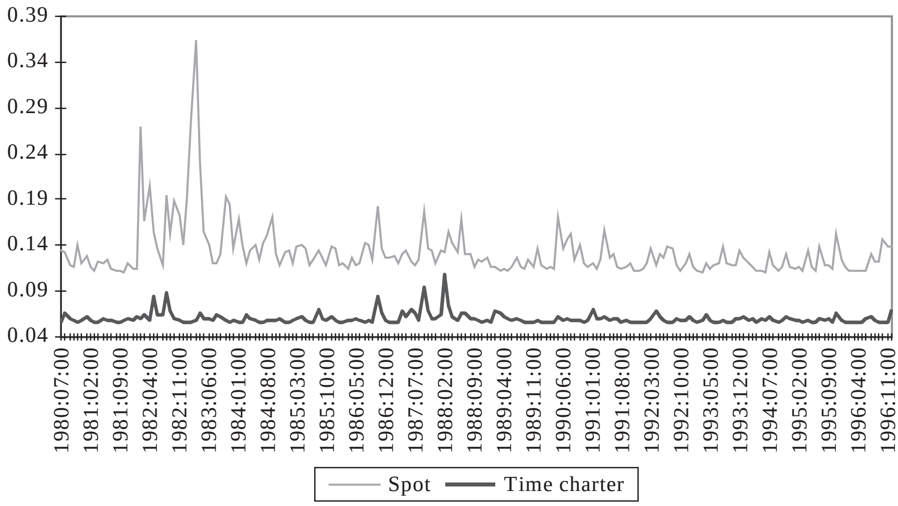
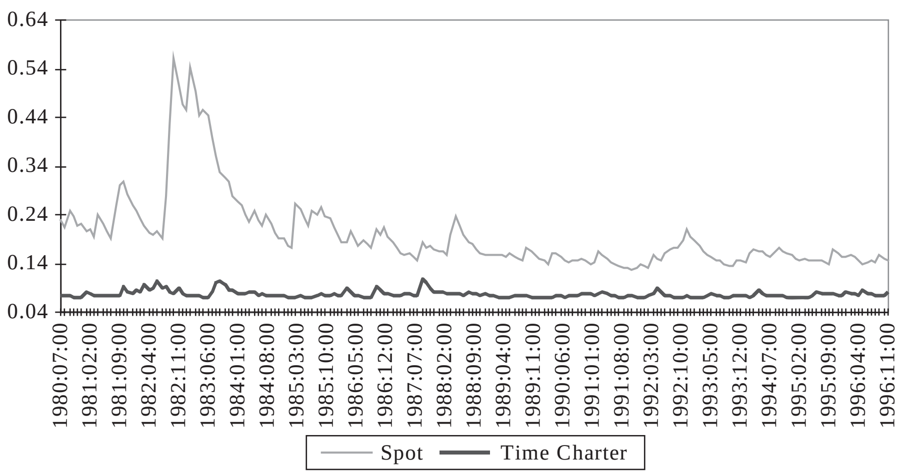


Figure 13: Capesize sector: Spot vs time charter rate volatilities (SDs)



The result is justified in Kavussanos and Alizadeh (see endnote 21), and identify four types of risk which the owner is faced with when employing the vessel in the spot as opposed to the time-charter market. In a time charter the vessel is fixed, say, over a year. Expenses are being paid by the charterer, making income from operations quite predictable. The alternative to the one-year time charter would be, say, 12-monthly spot fixtures, with expenses on the owner's side. The owner would thus be faced with the risk of not finding employment every month on the vessel; even if employment is secured, the risk of having to relocate the vessel to a nearby port, thereby increasing his costs; the risk of the freight market decreasing by the time the next voyage contract is secured, thereby decreasing his revenues; bunker prices may move adversely for him, thereby increasing his costs. Of course, seasonal factors may also be contributing to such risks. See for example, Kavussanos and Alizadeh[34, 35] for their measurement and comparison in the dry bulk and tanker sectors under different market conditions. Moreover, it can be argued that, administratively, a time charter contract is simpler to implement over the course of 12 months, in comparison to a series of voyage contracts, and is hence a cheaper option for the shipping company. Finally, it is well known that a long period time charter contract on a ship is viewed favourably by banks seeking collateral to finance the vessel, thereby making it a “safer” option for the shipping company in comparison to a series of voyage contracts.

On balance, one could say that policy implications for risk averse shipowners with a choice of employing ships between the spot and time charter markets, point to preferring the lower risk time charter market over the spot market, in general. However, in prolonged “bad” periods for the industry, time charter risk in some sectors, such as in the Aframax and VLCC sectors, may rise above the corresponding spot market risk.

5.3 Correlation coefficients amongst shipping and other asset classes

To reinforce the case made above about different size vessels being distinct asset classes, which if included in the same portfolio can have significant diversification effects, correlation coefficients amongst segments of shipping markets and some other potential investments – such as shares and commodities – are considered next. In finance portfolio theory it is well known that pairs of assets with low or negative correlation coefficients of returns provide substantial risk reductions, if combined in the same portfolio of investments. In that spirit, Table 9 displays correlation coefficients of daily logarithmic returns of freight rates in dry bulk Capesize, Panamax and Supramax sectors, and tanker dirty and clean sectors of shipping, as well as share price (S&P500) and commodity prices (wheat, corn and Brent crude oil) to represent alternative classes of investments that the international investor – the shipowner – might consider to include in his portfolio of assets.

Consider first the three correlation coefficients between the three subsectors of the dry bulk shipping industry. Their values range from a low of 0.384 to a high of 0.517. Given their relatively low values, around 50% and lower, there is scope for diversification between subsectors of dry bulk shipping by investing in different size ships. The correlation coefficients between freight rates in the dry bulk and the tanker subsectors are even lower and very close to zero, the reason being that the drybulk and tanker shipping cycles, particularly in the short run are distinct. The S&P500, wheat and corn can provide good alternative investment assets for shipowners, for diversification purposes, as seen by the very low – almost zero – correlation coefficients that they display with freight rates. As expected, Brent crude oil prices has some positive but low correlations with the dirty and clean tanker freight indices, again making a case of a potential diversifying asset.

The contribution of the analysis so far, is to point to real possibilities of risk reduction by choice of sub-sector within the dry bulk and tanker sectors of the shipping industry. In addition, the use of GARCH models to estimate time-varying volatilities points to a strategy of dynamic revisions of assets to include in a portfolio of vessels. No empirical analysis has yet been carried in the literature for the container sector, but one

Table 9: Correlation coefficients of sectoral freight rate indices, S&P500 share price index and commodity prices of Wheat, Corn and Brent crude oil

	BCI	**BPI**	**BSI**	**BDTI**	**BCTI**	**S&p 500**	**WHEAT**	**CORN**	**BRENT**
BCI	1								
BPI	0.517	1							
BSI	0.384	0.513	1						
BDTI	–0.032	–0.004	0.123	1					
BCTI	0.058	0.127	0.195	0.488	1				
S&P 500	0.102	0.143	0.086	0.066	0.091	1			
WHEAT	0.023	0.022	0.062	–0.063	–0.046	–0.122	1		
CORN	0.026	0.032	0.074	–0.037	–0.024	–0.047	0.586	1	
BRENT	0.017	0.068	0.147	0.213	0.308	0.297	–0.086	–0.115	1

Notes: BCI, BPI, BSI, BDTI and BCTI refer to the Baltic Capesize, Panamax, Supramax, Dirty Tanker and Clean Tanker Indices, respectively. S&P500 is the stock exchange index covering large publicly held companies that trade on either NYSE Euronext or NASDAQ OMX. Wheat, Corn and Brent refer to prices of these commodities. Variables are in logarithmic first differences. Sample period September 2006–January 2009.

would expect similar conclusions regarding volatilities in rates of different vessel sizes. Once the investments (ships) have been acquired, shipowners have to make similar decisions on how to maximise their return from operations, subject to the operational business risks that they face. The second contribution of the analysis so far is to point to the possibility of using period contracts as ways of reducing risks in a portfolio of "long" positions on tonnage. Caution needs to be exercised though, say in a dynamic portfolio setting, to ensure that the relationship holds true in adverse market conditions, as time charter volatility may rise above the spot one.

The strategies that the above possibilities point to are useful, but may prove to be expensive, non-existent or inflexible, if not planned properly. For example, it costs to buy and sell ships and to go in or out of freight contracts. This reduces their flexibility. Long-term charters may be hard for owners to find when the market is in decline. The opposite is true when the market is improving. In addition, when the conditions turn too much against one of the parties (owner or charterer) it may be that they decide to abandon the agreement. The introduction of derivatives contracts, such as freight futures, in 1985, and of Over the Counter (OTC) freight-forward contracts, options and swaps, since 1992 has helped to alleviate these problems with respect to operational risk management. They have made operational risk management cheaper, more flexible and readily available to parties exposed to adverse movements in freight rates.

6. THE USE OF DERIVATIVES FOR OPERATIONAL RISK MANAGEMENT IN SHIPPING

Many other industries have used derivative contracts to manage risks. To see for instance how futures/forward contracts work, consider a "party" which is "long" in a "commodity". For the shipowner this would be the freight service, for the charterer it would be the cargo he wants to transport. If freight rates are expected to decrease by the time the owner secures the next contract with a charterer, he may want to avoid taking the risk of reducing his revenue. Apart from the traditional methods of managing this risk, discussed earlier, such as entering a time charter contract, he may decide to use, amongst others, freight futures, forwards, options or swap contracts to hedge these risks.

For these to function, a market price of the underlying physical commodity is needed. For instance, if a "party" is long in coffee, a spot market price for coffee is needed – which is available in the market – and based on that, futures contracts could be issued, say one month ahead. The party that owns coffee and expects its price to be lower next month will sell futures contracts to buy them back in a month's time at the lower price prevailing in the market(provided his expectations materialise). He will thus, make a profit from the selling and buying of the futures contracts at different periods, which will offset the loss which will occur in the physical market because of the reduction in the price of the commodity.

In a forward agreement, the two parties (owner of coffee and potential buyer of coffee) will come "directly" together. They will agree on a forward price for coffee and the producer will deliver that quantity at the agreed price. This is a practice which has been used as a hedging mechanism for years in a number of industries. Gray (see endnote 2) claims that the problem with this is inflexibility and unreliability; if either party wanted to change any part of the contract (e.g. quantity delivered or price), they will not be able to do so without renegotiating the whole contract. If there is a futures market operating for the commodity both parties are flexible in terms of being allowed to change the details of the original contract. Thus, delivery date, quantity, price and other characteristics may be altered at will.

7. THE BALTIC FREIGHT INDEX

The shipping industry did not have an underlying "commodity", which could be used to trade futures contracts. In 1985 the Baltic Freight Index (BFI) produced by the Baltic Exchange in London and the International Futures Exchange in Bermuda was established. The latter was abandoned early. Until 2002 the BFI was used as the underlying "commodity" for futures BIFFEX (Baltic International Freight Futures Exchange) contracts trading for the dry bulk sector of shipping. Unlike physical goods, such as coffee, which could be delivered physically at the expiry of the futures contract, the trade of freight services amounted to delivering the cash value of the commodity. This cash settlement procedure has enabled the introduction of BIFFEX contracts, based on the BFI (Gray (see endnotes 1, 2)). The underlying asset, which is delivered at the settlement date, is the cash value of a freight rate index, the BFI. This makes the whole process a paper transaction with no ship or cargoes being involved.

The BFI–previously called the BDI (Baltic Dry Index) – is a weighted average index of dry cargo freight rates (see e.g. Kavussanos and Visvikis) (see endnote 4). The index is revised every year from a panel of brokers appointed by the Baltic exchange, namely the panellists. The revisions are such so as to take into account the changing conditions in the industry and keep the index up to date. For instance, separate indices have been introduced for the Capesize, Panamax and Handy sectors in recognition of the distinctiveness of the sectors, while the weightings of the constituent routes of each of these indices (and of the BDI) have changed over time, to reflect the relative importance of seaborne trades in these routes.

8. THE PRICE DISCOVERY ROLE OF FREIGHT DERIVATIVE CONTRACTS

In the theory of futures and forward markets it is claimed that there are two main economic benefits that these markets provide to market agents. These are price discovery (of future spot prices) and risk management through hedging (see e.g. Garbade and Silber[36]). Price discovery is the process of revealing information about current and expected spot prices through the futures or forward markets.

Kavussanos and Nomikos (see endnote 11),using BIFFEX contracts of one and two months to maturity show that these contracts are unbiased predictors of the spot price, (i.e. of the BFI). The evidence on the three-months contract is marginal. Kavussanos *et al.* (see endnote 16) show that FFA prices one and two months prior to maturity are unbiased predictors of the realised spot prices in routes 1, 1A, 2 and 2A. However, the efficiency of the FFA prices three months prior to maturity provide mixed evidence, with routes 2 and 2A being unbiased estimators, while routes 1 and 1A being seemingly biased estimators of the realised spot prices. Thus, it seems that “unbiasedness” depends on the market and type of contract under investigation.

The evidence uncovered by these studies is important for market agents in that they can rely on the free information provided by the futures/forward markets as to the level the spot market will be, say two months ahead. Therefore, through the FFA contracts, market agents can get an indication of the expected level of freight rates in the future. Moreover, Kavussanos and Nomikos (see endnote 11) show that, BIFFEX prices provide more accurate forecasts of the realised spot prices than forecasts generated from forecasting models, such as the random walk, ARIMA and the Holt-Winters exponential smoothing models.

In addition to providing a mechanism for market agents to form expectations regarding spot prices that will prevail in the future, trading in futures/forward markets also provides information regarding current spot prices. Kavussanos and Nomikos (see endnote 15) show that futures prices tend to discover new information more rapidly than spot prices. Subperiod results, corresponding to revisions in the composition of the underlying index, show that the price discovery role of futures prices has strengthened as a result of the more homogeneous composition of the index in recent years. Moreover, futures prices, when formulated as a VECM, are found to produce more accurate forecasts of spot prices than VAR, ARIMA and random-walk models, over several steps ahead.

Kavussanos and Visvikis (see endnote 19) investigate the lead-lag relationships between forward and spot markets, both in terms of returns and volatility. Causality tests and impulse response analysis indicate that there is a bi-directional causal relationship between spot and futures returns in all routes. The latter imply that FFA prices can be equally important as a source of information as spot prices are. A closer examination of the results suggests that causality from FFA to spot returns runs stronger than the other way in all routes. These results are in line with those for futures contracts presented in Kavussanos and Nomikos (see endnote 11).

Volatility spillovers between the spot and FFA markets are also investigated in the Kavussanos and Visvikis study (see endnote 19). Results from a bivariate

VECM-GARCH-X model, indicate that the FFA volatility spills over to the spot market volatility in route 1. In route 1A the results indicate no volatility spillover in either market. In routes 2 and 2A there is a bi-directional relationship, as each market transmits volatility to the other.

Thus, FFA prices seem to contain useful information about subsequent spot prices, beyond that already embedded in the current spot price, and therefore can be used as price discovery vehicles. Furthermore, the FFA contracts in routes 1, 2, and 2A contribute in the volatility of the relevant spot rate, and therefore, further support the notion of price discovery. In the absence of futures contracts, following the de-listing of BIFFEX in April 2002, FFAs seem to do an equally important job as vehicles of price discovery of spot prices.

Even if market agents are not aware of the valuable information that FFA contracts incorporate for them as a source of information regarding the likely developments of the spot market, they would be keen to know how successful the use of these contracts are in mitigating their risks in freight markets. This is important as it relates to direct monetary benefits from the use of the contracts. If these are perceived important and the service offered by the existence of FFA contracts is used enough by the industry it will survive to serve the players in the industry.

9. THE HEDGING EFFECTIVENESS OF FREIGHT DERIVATIVE CONTRACTS

Risk management refers to hedgers using futures contracts to control their spot price risk. The issue of the effectiveness of BIFFEX contracts in hedging freight risk has been investigated in Thuong and Vischer,[37] in Haralambides (see endnotes 24, 25), and in Kavussanos and Nomikos (see endnotes 12–14). Kavussanos *et al.*(see endnote 17) and Kavussanos and Visvikis (see endnote 19) investigate the risk management function of the FFA markets. As explained earlier, hedging involves taking a position in the futures market that is opposite to the position that one already has in the spot market. The shipowner is “long” on tonnage and sells BIFFEX/FFA contracts to protect him against a decline in freight rates. The charterer is ‘short’ on tonnage, thus buying BIFFEX/FFA contracts to protect him against a rise in freight rates. Of course, for a trade to occur the views of these two “parties” to the trade must be opposite. Futures/forward markets simply transfer risks from one willing party to another.

In hedging, the “party” interested in mitigating risks has to determine a hedge ratio, which will make the hedge as “effective” as possible (i.e. he has to decide on the number of futures/forward contracts to buy or sell for each unit of spot commodity on which he bears price risk). Johnson,[38] Stein,[39] and Ederington,[40] apply the principles of portfolio theory to solve the problem. They show that the hedge ratio, which minimises the spot market risk equals the covariance between spot and futures/forward price changes over the variance of futures/forward price changes.

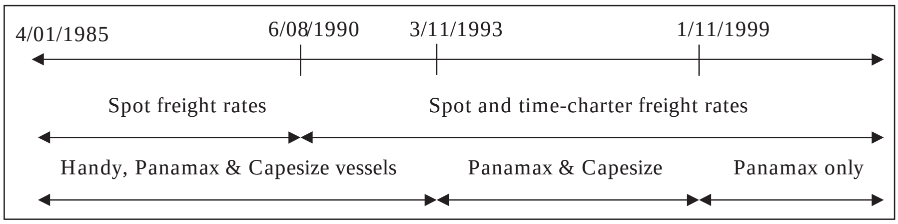
The effectiveness of the hedge is determined by the degree of variance reduction it achieves in the hedged portfolio. Alternatively, effectiveness is determined by the proportion of risk in the spot market that is eliminated through the futures/forward position (hedging). Alternative strategies in calculating hedge ratios involve a naïve one-to-one hedge, under which for each $ exposition in the spot market a $ position is opened in the futures market. This may be sub-optimal. Other strategies involve using constant or time varying optimal hedge ratios. The latter would be justified if the distributions of the covariance and/or the variance entering the calculation of the optimal hedge ratio are time varying. In this case, at each point in time, a different hedge ratio would be appropriate. To make this point evident, Figure 15 plots the estimated constant and time varying hedge ratios for spot and FFA contracts for route 1 of the BDI. It is obvious that using the constant hedge ratio, instead of the time varying one, in observation 30 on the graph would have provided estimates, which are way off the most efficient hedge.

The "technology" to calculate time varying hedge ratios for BIFFEX contracts has been introduced by Kavussanos and Nomikos (see endnotes 12–14) to individual routes of the BFI and in FFA contracts by Kavussanos *et al.* (see endnote 17) and Kavussanos and Visvikis (see endnote 19). These time varying hedge ratios, have been calculated by extracting time varying variances and covariances of spot and futures prices from the estimation of multivariate GARCH models, with a VECM specification of the mean of the variables. Alternative hedging strategies are evaluated by comparing the portfolio variance reduction from the use of a particular hedge ratio (strategy) to a benchmark portfolio – that of the unhedged position. The larger the reduction in the unhedged variance, the higher the degree of hedging effectiveness. Whether time varying or constant ratios for BIFFEX or FFA contracts are appropriate for each individual route cannot be determined *a priori*. It is a matter of empirical evidence.

Kavussanos and Nomikos (see endnotes 12–14) examined the issue of hedging effectiveness for BIFFEX contracts. Two cases are distinguished: in-sample and the more pragmatic out-of-sample hedge ratios. In the former case time-varying hedge ratios are superior in routes 1, 1A, 3A, 7 and 10. Out-of-sample results indicate that time-varying hedge ratios perform better in routes 1, 1A, 3A and 8. In route 3, the constant hedge ratio seems superior. The naive hedge is the worst hedging strategy in all in sample results. For out of sample, in routes 7 and 10, hedging increases the portfolio variance compared to the unhedged position, suggesting that market participants should leave their positions unhedged. Also the naive hedge in route 9 seems superior. Overall, the average variance reduction for the Panamax routes is higher than that for the capesize routes across all the estimated models. This is not surprising as the Panamax routes represent 70% of the total BFI composition. Ultimately, the user of the futures contracts is interested in the variance reduction that may be achieved with the best method of hedging available. The above study shows that the highest variance reduction possible is in route 1A (23.25%) and the lowest is in route 7 (–14.86%). It seems then that for all routes a large proportion of the variability of the unhedged portfolio is not eliminated. It explains the decreasing interest in the use of BIFFEX by market participants, which lead to its eventual abandonment.

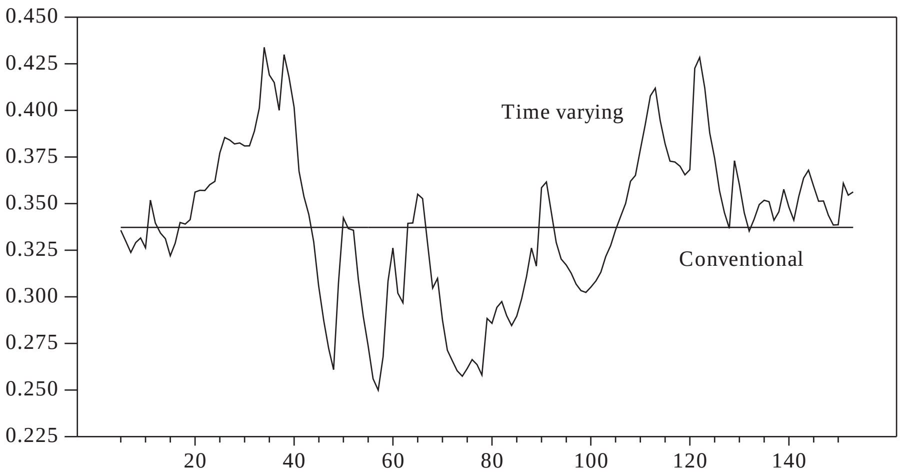
During its history, the composition of the BFI has been restructured several times (see Figure 14) to make it more representative of the industry, and to improve the hedging performance of BIFFEX contracts. Kavussanos and Nomikos (see endnotes 11,15) show that the restructuring of the BFI has helped improve the price discovery function of the futures market. Kavussanos and Nomikos (see endnote 13) also investigate whether the other function of futures markets, that of hedging performance, has changed as a result of changes in the composition of the BFI. There seems to be no evidence of statistical change in the hedging performance of BIFFEX on any route, following the inclusion of time-charter routes in the BFI. However, performance improves in route 1 following the exclusion of the handysize routes. The exclusion of the capesize routes from the index, in November 1999, making the index more homogeneous increases the

Figure 14: Major revisions of the BFI



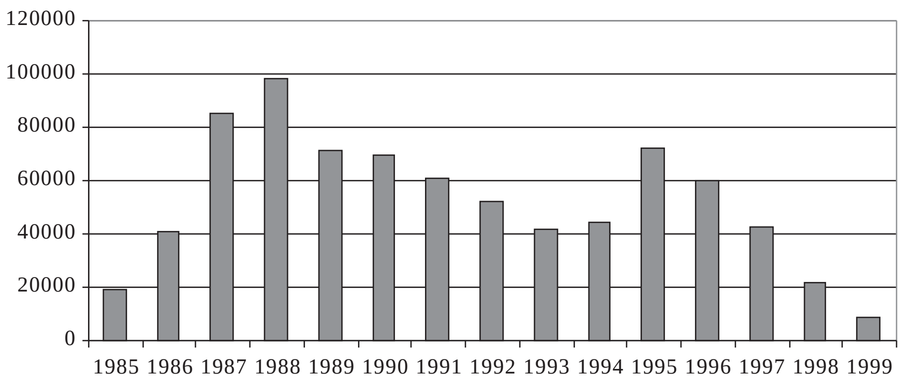
Source: Kavussanos and Nomikos (2000b)

Figure 15: Constant vs. time-varying hedge ratios for spot and FFA in route 1



Source: Batchelor, Kavussanos and Visvikis (2002b)

Figure 16: Yearly Volumes of the BIFFEX Contract (May 1985–June 1999)



Source: LIFFE, 1999

in-sample hedging effectiveness for every route (except route 1) in comparison to the pre-November 1999 period. This improved variance reduction is as high as 23.03% in route 3A, with an overall average improvement (over routes) of 14.36%. For the BPI then the highest hedging effectiveness achieved through the use of BIFFEX was in route 3A, reaching a figure of 39.95%.

It seems that the increased homogeneity of the index has had a positive impact on hedging effectiveness, despite leaving the variance reduction achieved well below that evidenced in other markets in the literature. At the time of writing, Kavussanos and Nomikos (see endnote 13) argued that: “the magnitude of the observed increases in hedging effectiveness is still small, and may not be sufficient to induce market agents in actively using the market for hedging purposes. This also seems to be in line with the trading preferences of participants in the shipping markets who are now increasingly using over-the-counter (OTC) forward contracts which are cash settled against the underlying shipping routes of the BPI. Because these contracts are traded against specific routes, rather than a general index, they also avoid the problem of basis risk, which is evidenced in the BIFFEX market.”

Unfortunately trading volumes, seen in Figure 16, have not turned around sufficiently to justify the BIFFEX contract’s existence for LIFFE. Over the period September 1992 to October 1997 the average daily trading volume has been 210 contracts per day, the equivalent of the average freight cost of transporting 220,000 tons of grain from the US Gulf to Rotterdam (i.e. four voyages in Route 1 of the BFI). This had become minimal for the later years of the history of BIFFEX. As a consequence, LIFFE stopped trading BIFFEX in April 2002.

Currently, in order to hedge freight rate risk, one has to turn to OTC financial products. Their performance is examined in a series of seminal papers by Kavussanos *et al.* (see endnotes 16,17) and Kavussanos and Visvikis (see endnotes 18,19). Kavussanos and Visvikis (see endnote 18) investigate the risk-management function in the FFA markets. In sample, the time-varying hedge ratios perform better, in increasing hedging effectiveness, in capsize route C4 (59.96%) and in the panamax PTC (62.69%), capesize CTC (64.02%) and supramax STC (42.18%) time-charter baskets. In contrast, in route P2A, the simple conventional model (63.96%) outperforms other specifications. Out-of-sample, specifically, for the period March to October 2008 investigated in routes P2A and C4, and in the PTC, CTC and STC time-charter baskets for June to October 2008, results show that-in routes P2A (76.59%) and C4 (85.69%) and in the CTC basket (65.73%), naïve (one-to-one) hedge ratios produce the highest variance reductions. In contrast, in the STC basket, the constant hedge ratio produced by the VECM model provides the greatest variance reduction (52.17%). In the PTC basket, the time-varying VECM-GARCH-X model seems to outperform the alternative hedging strategies (75.76%). The hedging performance results in this paper, with the greatest variance reduction of 86%, compares favourably with results, achieved through the use of futures contracts, in other markets – (57.06% for the Canadian Interest rate futures (Gagnon and Lypny[41]), 69.61% and 85.69% for the corn and soybean futures (Bera *et al.*[42]) and 97.91% and 77.47% for the SP500 and the Canadian Stock Index futures contract, respectively (Park and Switzer[43]).

Finally, Kavussanos and Dimitrakopoulos (see endnote 20), consider appropriate Value at Risk (VaR) and extreme value methods of determining the maximum loss that may be sustained from long positions on freight, and which can drive decisions on whether to hedge freight exposures through the use of freight derivatives – see also Kavussanos and Visvikis (see endnote 4).

10. FORWARD FREIGHT AGREEMENTS (FFAS)

As mentioned earlier, FFAs are principal-to-principal contracts, between a seller and a buyer to settle a freight or hire rate, for a specified quantity of cargo or type of vessel, for usually one, or a combination of the major trade routes of the dry-bulk and tanker industries. Settlement is made on the difference between the contracted price and the average price for the route selected in an index over the last seven working days. The indices published by the Baltic exchange on routes of the tanker and dry bulk industry are used as the "underlying commodity" on which to base the FFAs.

In OTC derivative agreements there is credit risk involved. For the agreement to go ahead, the parties have to approve each other–i.e. each party accepts the credit risk from the other party. Over the past years, clearing houses, such as those of the London Clearing House (LCH Clearnet) in 2005, the Norwegian Options and Futures Clearing House (NOS) in 2002 and Singapore Asia Clear in 2006, have provided the facility of clearing FFAs for a fee, if one counterparty was not prepared to accept the credit risk of the other counterparty in an FFA agreement – see Kavussanos and Visvikis (see endnote 4) for full details of this issue.

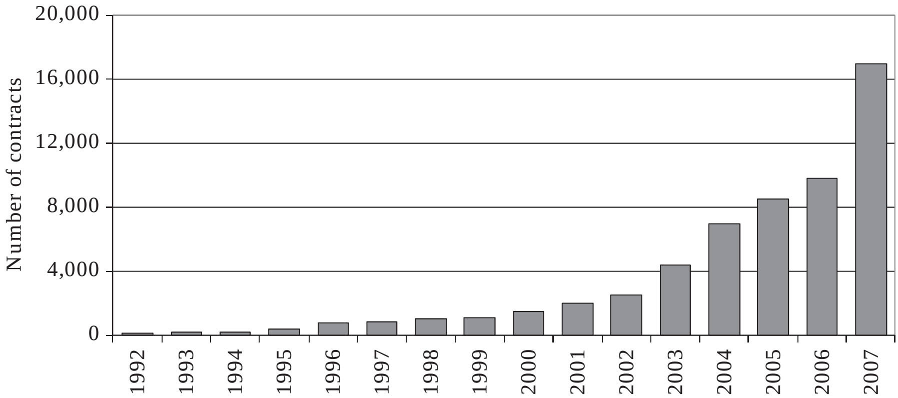
Institutions, which facilitate FFA markets are major shipbrokers, investment banks, and other financial intermediates in the fund management industry. The International Maritime Exchange (IMAREX) has also been established in Oslo and since 2002 trades and clears (through the NOS) FFAs, in what resembles futures contracts on freight. The New York Merchantile Exchange (NYMEX) made a similar move and has provided futures contracts for the tanker industry since 2005.

The primary advantage of an OTC market is that the terms and conditions are tailored to the specific needs of the two parties. It is a private market in which the general public does not know that the transaction was done. It is considered to be flexible in the sense that the "parties" can introduce their own contract specifications to cover their specific needs, saves money by not normally requiring initial, maintenance, and variation margins (common in the futures organised exchanges), and allows the market to quickly respond to changing needs and circumstances by developing new variations of old contracts.

In the dry-bulk sector, FFAs are available to match the Capesize, Panamax, Supramax and Handymax routes. For those wishing to hedge long-term freight risk, time-charter based FFAs, typically "baskets" of routes of the indices are tradeable with settlement based on the difference between the contract price and the daily average of the spot "basket". It is customary to divide the period into monthly settlements to establish cash-flow. These routes are regularly reviewed to ensure their relevance to the underlying physical market. The combination of time-charter routes can create the equivalent of a period time-charter trade (Clarkson Securities[44]).

Figure 17 shows the tremendous growth in FFA contracts, which, according to Clarkson's, have grown to an estimated 17,000 contracts in 2007. In value terms, they have surpassed the value of the physical trading of freight. Figures 18–21 present the near-month FFA prices against the spot prices (underlying asset) in Panamax routes 1 (US Gulf/Antwerp-Rotterdam-Amsterdam), 1A (Transatlantic round to Skaw-Gibraltar range), 2 (US Gulf/Japan) and 2A (Skaw Passero–Gibraltar/Taiwan–Japan), respectively. In every route the FFA and spot prices move closely together. This is verified by the values of the correlation coefficients of logarithmic differences of FFA prices with spot prices in routes 1, 1A, 2 and 2A. They are, respectively, 0.965, 0.972, 0.986, and 0.985.

Figure 17: Yearly volumes of dry bulk FFA contracts (Jan 1992–Dec 2007)



Source: Clarksons Securities

Figure 18: FFA and spot prices in route 1; Daily data (16/01/97–31/07/00)

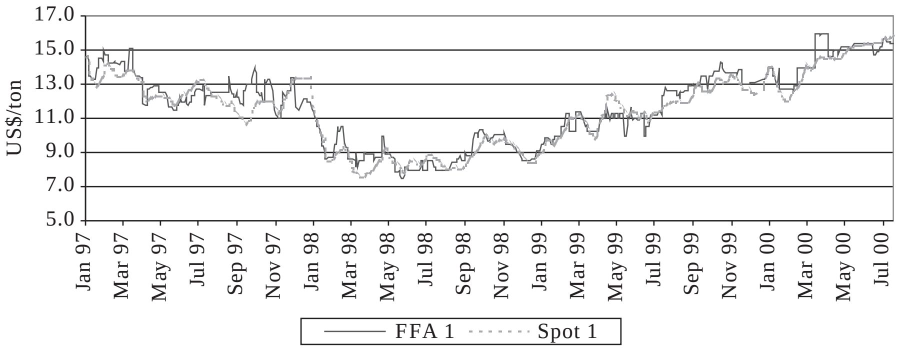


Figure 19: FFA and spot prices in route 1A; Daily data (16/01/97–31/07/00)

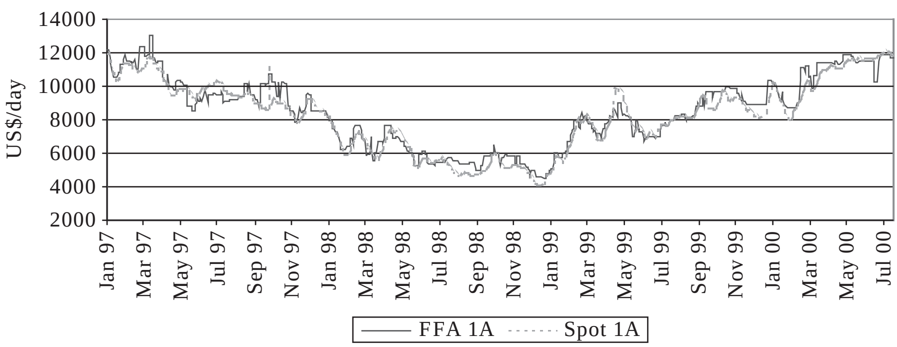


Figure 20: FFA and spot prices in route 2; Daily data (16/01/97–10/08/01)

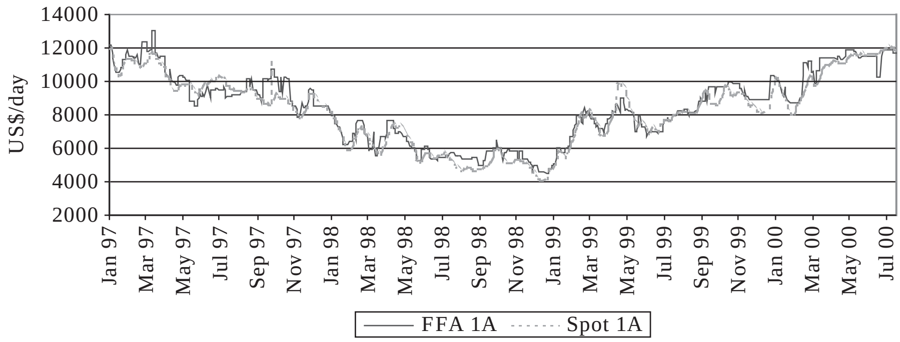
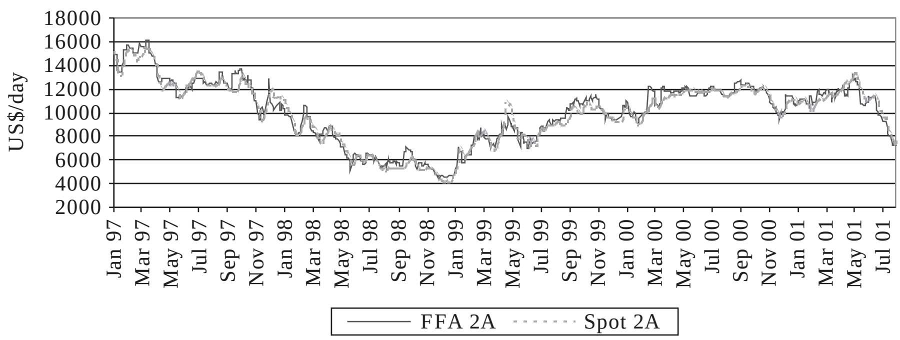


Figure 21: FFA and spot prices in route 2A; Daily data (16/01/97–10/08/01)



11. THE EFFECT OF FFA TRADING ON SPOT PRICE VOLATILITY

It is often claimed that the advent of futures or forward prices can have an adverse impact on spot price volatility. Kavussanos *et al.* (see endnote 17) investigate the issue in the FFA market. The results suggest that the onset of FFA trading has had (i) a stabilising impact on the spot price volatility in routes 1 and 2; (ii) an impact on the asymmetry of volatility (market dynamics) in routes 2 and 2A; and (iii) substantially improved the quality and speed of information flow in routes 1, 1A and 2. Overall, the results indicate that the introduction of FFA contracts has not had a detrimental effect on the underlying spot market. On the contrary, it appears that there has been an improvement in the way that news is transmitted into prices following the onset of FFA trading. By attracting more, and possibly better informed, participants into the market, FFA trading has assisted in the incorporation of information into spot prices more quickly. Thus, even those market agents that do not directly use the FFA market have benefited from the introduction of FFA trading.

12. STABILISING VOYAGE COSTS: HEDGING BUNKER PRICE RISK

Returning to the cash flow position of shipowners, as mentioned in section 1 and shown schematically in Table 1, the major and most volatile part of their voyage costs comes from bunker price fluctuations (amounting to 50% of voyage costs, according to Stopford (see endnote 26)). Yet, with the exception of some financial institutions,[45] offering tailor-made OTC derivatives products such as forwards, swaps and options, there were no tradable futures contract for the bunker fuel[46] until a few years ago. In the absence of bunker futures contracts, hedging against bunker price fluctuations using other similar futures contracts, such as energy futures, involves a cross-hedge. In order to offer market participants the possibility to eliminate credit risk involved in OTC bunker fuel contracts, in 2006 SGX AsiaClear introduced clearing of bunker forward contracts, with cash settlement against a monthly average of the Platts daily quotations. Since December 2005, IMAREX introduced bunker fuel futures contracts for the most popular bunker fuel grades, and for contract durations up to two calendar years ahead. The settlement prices used are those of Platts and Bunkerworld and the settlement period is the average of the month.

Although marine bunkers are bought and sold in almost every port in the world, the world bunker market can be broadly divided into three major regional markets in which the bulk of physical bunkering activities takes place. These are: Singapore, Rotterdam and Houston. Singapore has long flourished as a transhipment centre due to its strategic geographical location. The Singapore bunker market is by far the largest marine fuels market in the world, and is duly considered to be a prime benchmark for the industry. Singapore's turnover in marine fuel oil in 2000 was 18.7 million tonnes. In Europe, the Amsterdam–Rotterdam–Antwerp (ARA) region sells as much as 16 million tonnes of bunker fuel annually. The heart of the ARA region is Rotterdam, which sells about 8 to 9 million tonnes of bunker oil and lubes annually, helped by a hub of oil refining and storage facilities sited in its Europort complex, which handles around 100 million tonnes of crude annually. Bunkering on the US Gulf coast is dominated by Houston, recording an annual sales volume of 3 million tonnes in 2000.

Before the introduction of bunker futures contracts, Alizadeh, Kavussanos, and Menachof (see endnote 22), explored the possibility of using a number of traded petroleum futures contracts as instruments for risk reduction in relation to this major operating expense for the shipowner. They examined the effectiveness of hedging marine bunker price fluctuations in Rotterdam, Singapore and Houston using different crude oil and petroleum future contracts traded at the New York Mercantile Exchange (NYMEX) and the International Petroleum Exchange (IPE) – now Intercontinetal exchange – in London.

Using both constant and dynamic hedge ratios, it is found that in and out-of-sample hedging effectiveness is different across regional bunker markets. The most effective futures instruments for out-of-sample hedging of spot bunker prices in Rotterdam and Singapore are the IPE crude oil futures, while for Houston it is the gas oil futures. However, they achieve only up to 43% variance reduction when using IPE crude oil to hedge bunker prices in Rotterdam. Hedging effectiveness varies from one bunker market to the other. For agents determined to use futures contracts to hedge bunker price risk, policy action points to using IPE crude oil contracts to hedge bunker price fluctuations when loading in Rotterdam, NYMEX gas oil contracts when loading in Singapore, and IPE gas oil futures contracts when using Houston for refuelling vessels. The maximum hedging effectiveness are 43%, 15.9% and 14% in each case. This compares unfavourably with other futures contracts. However, as discussed earlier, the availability of bunker fuel futures contracts at IMAREX, and the existence of an active OTC bunker fuels market in association with the market clearing of these products serves the market in a much better way – see Kavussanos and Visvikis (see endnote 4) for further discussion of these issues.

13. SUMMARY–CONCLUSION

Shipowners are faced with substantial business risks in the international environment that they operate. Risks emanate from fluctuations in freight rates, bunker prices, the price of the investment ship, interest rates, exchange rates, etc. This chapter has put forward a framework for identifying and measuring these risks, and has proposed solutions on how to handle the question of risk management. In the process, a review of the literature and some new ideas about how risks can be managed in the shipping industry have been put together. At the same time the chapter provides the state of the art of where we stand now technically in calculating instruments that can be used to hedge risks, such as the calculation of time varying hedge ratios. It offers a review of where we stand research-wise in the area, and can provide a stepping-stone for further research and innovations in the area. Naturally, a lot of the details underlying the research have not been reproduced here, due to lack of space. However, these details can be found in the original papers, referenced here.

The ideas put forward in this chapter include: The sectoral disaggregation of the dry bulk, tanker and container sector of the cargo carrying shipping industry, based on distinct risk-return characteristics. As a consequence, it is suggested that shipowners can mitigate risks by holding portfolios of assets–ships– of different size; The possible risk diversification effects in ship operation by switching between contracts of different duration; The use of freight derivatives, such as futures and forward contracts to manage freight rate risks; The economic functions of price discovery and risk management of these financial instruments are discussed critically. The review looks back at BIFFEX and their role in serving the industry as hedging instruments for freight rates. It compares their performance with other financial instruments and finds it somewhat lacking. In a way, it identifies why the industry has turned gradually to OTC products and explains the withdrawal of freight futures contracts after 17 years of existence. Naturally it is impossible to cover all aspects involved in one chapter. The book by Kavussanos and Visvikis (see endnote 4) aims to close this gap and provide interested readers with all the relevant information in the area of risk analysis and management in shipping, particularly on the use of derivative instruments.

ACKNOWLEDGEMENT

The origins of the ongoing research underlining the work in this chapter go back to 1991 when the author decided to get involved and develop the area of risk analysis and management in the shipping industry. Six PhD and a large number of MSc students have been introduced and undertaken research under the author’s supervision in the subject area. Special thanks are due to them for valuable assistance and feedback on various parts of the research underlying this chapter. Thanks are also due to colleagues in the industry who have offered their comments on parts of this work, while presented in conferences and professional meetings around the world. Naturally, all remaining errors or omissions are the sole responsibility of the author.

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