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Investigating the effectiveness of hedging bunker price fluctuation

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INVESTIGATING THE EFFECTIVENESS OF HEDGING BUNKER PRICE FLUCTUATION

By

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2007

DECLARATION

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

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

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ABSTRACT

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Title of Dissertation: **Investigating the effectiveness of hedging bunker price fluctuation**

Degree: Master of Science in Maritime Affairs (Shipping Management)

The dissertation investigates the effectiveness of hedging bunker price fluctuation in three main bunker markets: Singapore, Rotterdam and Houston.

To begin with, a deep literature review on the topic is carried out. A brief development of the bunker market from 1990 to 2007 is examined. The influential factors of bunker supply and demand are identified, from which the most determinant factors are discovered by correlation methods. Moreover, methodologies for estimating the hedging effectiveness and hedge ratio are taken into consideration.

The application of such financial derivatives into shipping as futures contract, forward contract, options and swaps agreements are carefully examined with some practical examples. Special attention is paid to futures and forward contracts.

Finally, the effectiveness of hedging bunker price fluctuation in Singapore, Rotterdam and Houston is investigated using (1): a direct-hedge with bunker forward contracts traded at the International Maritime Exchange (IMAREX) and (2): a cross-hedge using different energy futures contracts traded at New York Mercantile Exchange (NYMEX). Using the OLS regression model, it is found that the hedging effectiveness is different in Singapore, Rotterdam and Houston. The most effective futures instruments for a direct-hedge in Rotterdam and Singapore is the 1-month bunker forward contracts. Meanwhile, for a cross-hedge, WTI futures contracts prove the highest effectiveness of performance in a hedging bunker spot price fluctuation at Rotterdam and Singapore.

KEY WORDS: Bunker, bunker price, spot market, futures market, fluctuation, hedging, hedging effectiveness, hedge ratio, OLS regression.

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LIST OF ABBREVIATIONS

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ARCH	Autoregressive Conditional Heteroscedasticity
BFI	Baltic Freight Index
BIFFEX	Baltic international Freight Futures Exchange
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
IMAREX	International Maritime Exchange
IPE	Internacional Petroleum Exchange
MGARCH	Multivariate GARCH
NYMEX	New York Mercantile Exchange
OLS	Ordinary Least Squares
OTC	Over-the-Counter
VAR	Vector Autoregression
VECM	Vector Error Correction Model

CHAPTER 1 INTRODUCTION

"All life is the management of risk, not its elimination"

Walter Wriston

Former Chairman of Citibank Group

Shipping markets carry high risks. The players operating in such markets such as shipowners, ship operators and other related parties have to manage these risks which emanate from the fluctuations in freight rates, bunker prices, interest rates, foreign exchange rates and vessel prices (Kavussanos & Visvikis, 2006, p. 233); such fluctuations then affect the cash flows of shipowners and ship operators.

Bunker costs, before 2003, were just a "*minor consideration*" but now they have turned into a "*major headache*" for shipowners (Corbett, 2006, p. 2). According to Stopford, bunker costs now become one of the major operating expenses of any shipowner and account for 47% (Stopford, 1997, p. 166) or even 50% (Corbett, 2006, p. 2) of voyage costs and this portion tends to become bigger and bigger. Thus, the fluctuation (increase or decrease) of bunker price could lead to a decrease or increase in the shipowners' cash flows and profit margins. For example, A.P. Moller-Maersk states that the change of +/- US$1/ton in bunker price could lead to change of -/+ US$12 million in their revenue (Hansen, 2007, p. 15). Moreover, in May 2006, NYK (Japanese shipping company) reported that high fuel costs shaved $242 million off their profit (Roberts, 2006).

There are many ways to reduce bunker costs[1] such as reducing risk arising from bunker price fluctuations, reducing speed, improving the efficiency of engines as

[1] Bunker costs = bunker amount * bunker price

well as shortening the shipping routes. However, with the pre-fixed shipping routes at an agreed speed and for a certain kind of ship, thus the requirement of managing bunker costs is mainly to control and reduce the risk arising from the fluctuations of bunker prices which reflect the balance of supply and demand of bunker level. Such a job is especially important for the tramp shipping company which fixes a time charter party (short time or long term) and particularly a Contract of Affreightment[2].

In liner shipping companies, it is now under debate that whether the increase in bunker price can be fully covered by the Bunker Surcharge (Bunker Adjustment Factor –BAF) or not. A recent study carried out by Cariou and Wolf found that BAF follows the main trend of the average bunker price (2006, p. 193). However, a study of Menachof and Dicer suggests that liner shipping companies should use hedging instruments in the future market to better reduce risk exposure rather than depend on the Bunker Surcharge (2001, p. 141).

As a result, managing the bunker cost fluctuation is one of the most important activities in any shipping company in order to make a profit. It attracts much more attention from shipowners and ship operators because the bunker price is becoming less predictable and fluctuates very much even in a very short period of time. In a statement to *Bunkerworld*, A.P. Moller-Maersk uttered that “The price rise in bunkers over the past 18 months is a serous concern as it has added significantly to our cost base both for ship bunker fuel and for all inter-modal costs” (Roberts, 2006).

The fluctuations of bunker price will then affect the cash flows, profit margins of shipowners and ship operators. For example, in 2005 from July 21 to September 22, the bunker price jumped from USD 275/ton to USD 358/ton (Hand, 2005, p. 3). For a vessel consuming about 8,000 tons bunker/voyage, the loss arising from bunker price fluctuation of one voyage is tremendous (8000*(358-275) = USD 664,000 loses just within only two months).

[2] In a Contract of Affreightment, the freight rates and shipping route is pre-fixed by the owner and charterer

However, the question is that how can we effectively manage and reduce such a risk? Hedging against bunker price fluctuation is one way to solve this question and is the focus of this dissertation.

Hedging, the taking of a future position to reduce price risk or a risk-shifting activity, is said to be effective if the price risks are offsetting (Marshall, 1989, p. 195). However, "hedging is rarely perfectly effective because even after a hedge is established, some risks still remain" (Marshall, 1989, p. 195). Thus, hedging or finding a certain level of effectiveness of hedging in particular now becomes a fascinating topic for researchers.

1.1 Objectives

The overriding objective of this dissertation is to suggest an appropriate market place (where to hedge) and the suitable hedging instruments (tool to hedge) for shipowners and ship operators in hedging their bunker spot price fluctuation so that it could bring optimal hedge ratio and hedging effectiveness. In doing so, a number of hedging instruments are then carefully examined in order to find out which instrument is best suitable for bunker hedging.

Hedging bunker price requires a deep understanding of bunker price behavior, not only the spot price but also the futures price as well. As a result, the first aim of this dissertation is to provide a brief account of the development of bunker market to date as well as an economic analysis of the determinants of the supply and demand of bunker.

Using different hedging instruments deploying different investigating methods could result in different levels of hedging effectiveness. Thus, the dissertation also offers a review of the literature on applications of hedging methods to shipping and particularly in hedging bunker price.

Moreover, investigating the effectiveness of hedging requires large data sets of market variables such as world economy, international seaborne trade, oil price, freight rates, world tonnage, speeds and fuel consumption of ships as well as bunker prices (spot and future). Thus, careful attention will be given to obtaining appropriate data for the purpose of this paper in order to offer an empirical analysis that will be carried out to investigate the hedging effectiveness of future hedging contracts based on the available data (1990-2007).

1.2 Methodology

Quantitative methods are extensively used in carrying out studies on hedging and can be found in two areas: secondary research and primary research.

Secondary research comprises the acquisition of knowledge of hedging in general and hedging in shipping industry in particular. In this area, Kavussanos & Visvikis' (2005) *Derivatives and Risk Management in Shipping*, Brooks' (2002) *Introductory Econometrics for Finance*, Marshall's (1989) *Futures and Option contracting: Theory and Practice*, Hull's (2006) *Options, Futures, and Other Derivatives* and Ederington' (1979) *The Hedging Performance of the New Futures markets* provided very deep knowledge as well as analyses of previous works on the topic.

Moreover, excellent articles from *Financial Review*, *Applied Economics*, *Journal of Future Market*, *Journal of Finance, Journal of Banking and Finance, International Journal of Logistics: Research and Application, Maritime Policy and Management, Journal of Applied Corporate Finance, Review of Economics and Statistics,* and *Review of Economics Studies* also provided an update on the current issue related to the topic as well as an insight into the subject matters.

Primary research includes data collecting and analyzing. Shipping related data (freight rates, bunker prices, seaborne trade, world GDP, world tonnage, fuel consumption, speed, oil prices) as well as the ideas of shipping professionals have been systematically collected from various issues of shipping newspapers, shipping magazines, and research institutes such as Fairplay, Drewry, Lloyd's list, U.S. Department for Energy. In addition, the dissertation also includes the professional points of view of the shipping industry including professors at WMU, shipowners, shipping companies, shipping agents that author obtained during Field Studies in Germany, Greece, Denmark, Sweden and Norway.

1.3 Structure of the dissertation

The dissertation is organized as follows.

In the next Chapter –Chapter 2, after briefly triggering some basic understandings of the spot market, future markets and hedging such as hedge ratio, direct-hedge versus cross-hedge, hedging versus speculation; a deep literature review on hedging studies in general and more particularly in shipping industry such as hedging freight rates and hedging bunker price is provided.

Chapter 3 firstly presents the behavior of the bunker market from 1990 to 2007 by using the *mean* and *standard deviation* methods to investigate the fluctuation of such a market. Secondly, it analyzes the influential factors of the bunker market including supply and demand factors. Moreover, it also uses the *correlation* method to examine the relationship between these influential factors and the bunker prices.

In Chapter 4, concentrates on presenting the available hedging instruments for hedging bunker price such as the Energy Futures Contract, the Forward Bunker Contract, the Bunker Swaps Agreement and the Bunker Options Agreement. Moreover, some practical examples are also provided for an easier understanding of the hedging function of such instruments.

Chapter 5 firstly provides the reviews on the different methods used for estimating the hedge ratio and hedging effectiveness. Secondly, it carefully analyzes the Ordinary Least Square (OLS) *regression* model that the author uses for estimating the hedge ratio and hedging effectiveness in this dissertation. Thirdly, it then applies the OLS regression model into estimating the hedge ratio and hedging effectiveness of (1): a direct-hedge with bunker forward contracts traded at IMAREX (data available from December 2005 to May 2007, 399 observations) and (2): a cross-hedge with crude oil and heating oil futures contracts traded at NYMEX (data available from January 1990 to July 2007, 909 observations). The evaluation of the results obtained from the estimations is also done to know which futures contracts, and which hedging instruments are good for hedging bunker.

Finally, Chapter 6, after concluding the work, identifies the main limitations and offers elements for further research on this topic.

CHAPTER 2 LITERATURE REVIEWS ON HEDGING IN THE SHIPPING INDUSTRY

2.1 Literature reviews

This chapter first provides some basic understandings of the spot market, futures market and hedging, and will then give a deep review of the application of hedging instruments both in general and in hedging in shipping industries in particular.

2.1.1 General notes on the spot market, futures market and hedging

2.1.1.1 Spot market, future market and hedging

The **spot market** for a commodity is a market where goods are sold for cash and delivered immediately (Woelfel & Garcia & Munn, 1994, p. 509). Consequently, contracts on spot markets are immediately effective. The spot market is also called the "*cash market*" or "*physical market*" because prices are settled in cash on the spot at current market price. As a result, **spot price** is the price of goods for immediate delivery (Kolb, 1991, p. 76).

The **future market** is a market that enables the participants (buyer/seller) to exchange contracts for the future delivery of commodities or financial instruments. The advent of the future market has come about because of the need to reduce price risk in commodity trading (Woelfel, Garcia and Munn, 1994, p. 506). Contracts on the futures market are standardized and effective at a specified future date. The **future price** is the price for delivery at a specified future date (Kolb, 1991, p. 76), for example, the future price for delivering bunker in two moths or three months.

In an early study, Johnson stated that the organized futures market facilitates two kinds of activities: hedging and speculation (1960, p. 139). Kavussanos and Nomikos (2000b, p. 776) also confirmed that one benefit of the future market is to provide the ability to control the risk associated with the price fluctuation in the spot market through hedging. **Hedging** can be defined as "the taking of a futures position to reduce price risk" –this futures position is opposite to the one that the hedger has had on the spot market, or "a risk-shifting activity". The hedge is effective only when the price risks are offset (Marshall, 1989, p.195).

2.1.1.2 Hedging versus speculation

As mentioned above, hedging mostly represents the commercial interests that the hedger will take a future position for the purpose of offsetting the losses associated with the price risk that he could face in the physical market. Whereas speculation is an activity in which the speculator, usually without any physical positions, takes a position in the future for the purpose of earning possible speculative profits (Marshall, 1989, p. 69). From this connection, it can be understood that a speculator is the one who does thing in his own expectation, if he expects that the price will increase in the future he will then buy the contract to earn the price difference. However, if his expectation is wrong, he will face the losses arising from such a price risk because he usually does not have any physical positions to offset his loses arising from the futures contract (Marshall, 1989, p. 69).

If we forget the transaction costs or the commission/premium (the price of a hedge), a future trading or an activity of speculating can be seen as a *Zero-Sum game* in the sense that the profits that the winner has will be exactly equal to the losses of the loser (Marshall, 1989, p. 70). The position of hedger and speculator is shown in *Figure 2.1* in which h is the hedge ratio, Vs represents the total variation in the hedged item and Vc represents the variation in the combined hedged position.

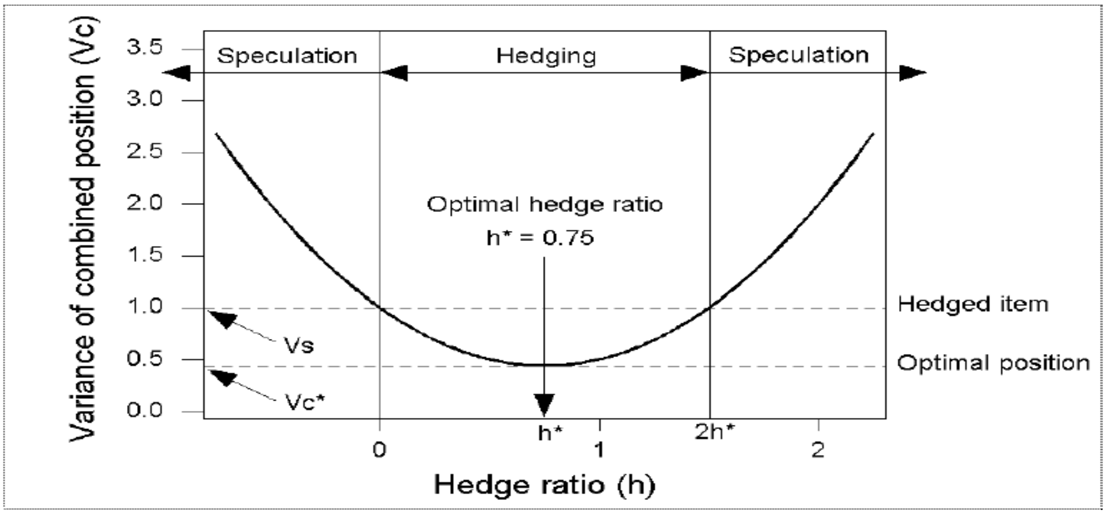

Figure 2.1 Comparison between a hedge position and a speculated position

Source: Charnes, J. & Koch, P. & Berkman, H. (2003). Measuring hedge effectiveness for FAS 133 compliance. *Journal of Applied Corporate Finance, 54* (4), 1-11.

2.1.1.3 Direct-hedge versus cross-hedge

A hedge can be a direct-hedge or a cross-hedge. A **direct-hedge** is a hedge in which the hedger uses the same commodity as the commodity that he has in a physical position to hedge against such commodity's spot price change (Marshall, 1989, p. 199). In other words, in a direct-hedge, the underlying commodities in the spot and futures markets are similar. For example, a shipowner uses the futures price of bunker to hedge against the fluctuation of the spot price of bunker on the spot market.

In contrast, a **cross-hedge** is a hedge in which the hedger uses the futures price of a different but typically related commodity to hedge against his physical position (Marshall, 1989, p 199). "Typically related commodity" is understood in the sense that the futures price of the typically related commodity must behave the same way as the commodity the hedger has in the physical market. For instance, using the future price of crude oil to hedge against the bunker spot price fluctuation, bunker price and crude oil price is said to be typically/closely related (this will be presented in *part 3.3*, chapter 3).

According to Marshall, a direct-hedge is usually more effective than a cross-hedge. However, a cross-hedge can prove high effectiveness if such a hedge uses the prices of several closely-related commodities (Marshall, 1989, p. 200).

2.1.1.4 Hedge ratio

To obtain the effectiveness of hedging, the hedger has to define a hedge ratio or an optimal hedge ratio that could minimize the price risk. **A hedge ratio** can be described as a ratio of the asset needed to hedge in the future to the asset the hedger has in physical position. In other words, hedge ratio is the number of future contracts that the hedger has to buy/sell (Kolb, 1991, p. 177).

A hedge ratio is calculated as $h = \dfrac{Future\ position}{Physycal\ position}$

Naturally, "hedging is rarely perfectly effective because even after a hedge is established, some risks still remain" (Marshall, 1989, p. 195). As a result, estimating a hedge ratio and the hedging effectiveness of futures hedging has been the topics of much research in the literature.

2.1.2 Review on general hedging studies

A number of works have been published on hedging in general. For example, Johnson (1960) studied the theory of hedging in commodity futures while Holthausen (1979) investigates the possibility of hedging under price uncertainty. Ederington (1979) focuses on "the hedging performance of the new futures market", a paper that will be carefully reviewed in the later part of this chapter.

In 1988, Cecchetti, Cumby and Figlewski, in their study, used the Autoregressive Conditional Heteroskedasticity (ARCH) model to estimate the optimal future hedge. Francis, Wolf and Castelino (1991) discussed the matter of cross-hedge and the choice of the optimal hedging vehicle, and focus on the cost-tradeoff between the hedging effectiveness and the costs of the alternative hedges.

In 1997, Broll and Wahl investigated the hedging problem of a firm which sells their products either on domestic or foreign markets. Pennings and Meulenberg (1997) studied the hedging effectiveness as a futures exchange management approach. In 1998, a study of Ferguson and Leistikow tested the regression technique in future hedging and stated that such a technique is stationary in future hedging. In the same year, Daigler and Copper examined the hedging effectiveness by deploying the duration-convexity hedging method. Satyanarayan (1998) gave a note on the return measure of hedging effectiveness. After that Roon, Nijman & Veld (2000) confirmed again the hedging pressure in the futures markets. Frechette (2000) found out the demand for hedging and the value of hedging opportunities.

In their study, Larcher and Leobacher (2003) searched for an optimal strategy of hedging with short-term futures contracts. Yang and Awokuse, in an effort to seek for the difference in the risk minimization hedging effectiveness between the non-storable and the storable commodity futures markets, stress that hedging effectiveness is strong for all storable commodities and weak for all non-storable commodities (2003, p. 490).

Also in 2003, Charnes, Koch and Berkman contributed to the literature development of hedging studies by publishing their paper on measuring the effectiveness of hedging for FAS133 (Financial Accounting Standard). Applying different methods in estimating the hedging effectiveness, their main conclusion is that hedging effectiveness depends on the choice of the hedge instruments and the number of hedge instruments (2003, p. 8).

In 2004, Yang and Allen, investigating the hedging effectiveness in Australian futures markets, deployed four alternative modeling frameworks: an OLS-based model, a VAR model, a VECM model and a multivariate GARCH model, and then compared the hedging effectiveness obtained. Their comparison suggested that the VECM hedge ratio performs better than the VAR hedge ratio in terms of risk reduction (2004, p. 320).

2.1.3 Review of hedging studies in the shipping industry

Considering the high volatility in shipping markets, especially for freight rates and bunker prices, many authors have applied the financial tools to shipping in order to reduce the risk associated with such volatility.

2.1.3.1 Review of hedging freight rates studies

In 2000, Kavussanos and Nomikos took the case of freight futures (BIFFEX) to investigate the hedging effectiveness of futures contracts. Using both the constant and time-varying hedge ratio to test eleven component shipping routes[3] of Baltic Freight Index (BFI), they found that the hedging effectiveness of BIFFEX futures contract has improved over recent years. This is, according to them, due to the increasing homogeneity of the index (2000b, pp. 776, 798).

Following this topic, Haigh & Holt also studied the hedging effectiveness of BIFFEX futures contract, by comparing the results obtained from an Ordinary Least Square (OLS) regression model and a time-series technique, particularly the Multivariate Generalized Autoregressive Heteroscedasticity (MGARCH) model, they concluded that the hedging effectiveness of BIFFEX futures contract depends on the weighting of each shipping route: the higher the weighting of the route the higher the hedging effectiveness and vice versa (2000, p. 895).

Another study of Kavussanos and Nomikos investigated the hedging effectiveness of freight futures contract traded at BIFFEX but only tested route 1 and route 1A of BFI, also using the constant and time-varying hedge ratio, and they concluded that the hedging effectiveness of the BIFFEX contracts varies from 19.2% to 4.0% across different shipping routes of the BFI (2000b, p. 798).

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[3] It is noted that the numbers of shipping routes of BFI changed over time: 13 routes (1/1/1985-11/3/1988), 12 routes (11/4/1988-8/3/1990), 14 routes (8/6/1990-2/4/1991), 15 routes (2/5/1991-11/2/1993), 11 routes (11/3/1993-5/5/1998), 11 routes (5/6/1998-10/29/1999), and 7 routes from 1/11/1999 to now, see more in **Appendix H**.

In 2002, Haigh & Holt applied the portfolio theory in investigating the hedging effectiveness of freight rates, commodity prices and foreign exchange rates. Also using the OLS regression, the MGARCH model and the Seemingly Unrelated Regression (SUR) model to estimate the hedging effectiveness and compare their results. Their main conclusions are, *firstly*, the BIFFEX freight contract is not an effective hedging instrument as the risk reduction of such contracts could only reach up to 6.0%. This result explains the decision by London International Futures Freight Exchange (LIFFE) to cease trading BIFFEX contract in April 2002 due to the poor volume of trading (2002, p. 1207). *Secondly*, foreign exchange rates hedging plays an important role in reducing the price risk for traders (Haigh & Holt, 2002, p. 1205).

In 2004, using the VECM (Vector Error Correction Model) model in the ARCH family, Kavussanos and Visvikis examined the hedging performance of Over-the-Counter Forward shipping freight market. The authors concluded that hedging effectiveness (both in-sample and out-of-sample test) for time-charter rates varies from route to route (from 29.10% to 32.16%) and the level of effectiveness varies from one market to the other (2004a, pp. 932-933).

2.1.3.2 Review on hedging bunker price studies

Until today, only a limited number of authors have studied the hedging effectiveness of fuel prices fluctuation. Typically, Swan & Morrell (2006) studied the hedge effectiveness of airline jet fuel; Alizadeh & Nomikos (2004) investigated the efficiency of the Forward bunker market; Alizadeh *et al* (2004) investigated the hedging effectiveness of hedging bunker using cross-hedge with energy futures contract; and Menachof and Dicer (2001) studied the hedge effectiveness of bunker price at Rotterdam through cross-hedge with London Gas-oil futures contract. For the purpose of this dissertation, the latter two studies will be carefully reviewed.

In their study, Menachof and Dicer applied the time-varying moving average hedge ratios and used London Gas-oil futures contracts to hedge against the Rotterdam bunker price in the Trans-Atlantic liner trade. Their estimation from the data range

1986-1990 proved that while a direct-hedge is not available, a cross-hedge using Gas-oil futures contracts to reduce the risk of bunker price fluctuation was highly effective and they concluded that up to 28% of the risks associated with bunker price fluctuations could be eliminated through hedging (2001, pp.152-153).

Also using the time-varying hedge ratio to estimate the effectiveness of hedging bunker, Alizadeh *et al* (2004, p. 1340), however, employed the VECM model in ARCH family with a GARCH error structure. In their study, the effectiveness of hedging bunker price fluctuations in Rotterdam, Singapore and Houston is examined using cross-hedge with different crude oil and petroleum futures contracts traded at the New York Mercantile Exchange (NYMEX) and the International Petroleum Exchange (IPE) based in London. After using both constant and time-varying hedge ratios to test a rather large number of observations (642 observations, weekly based from 30/06/1988-9/11/2000), they found that the hedging effectiveness is different among the three bunker markets (2004, p.1337).

Their main conclusions are that: in Rotterdam, for out-of-sample results, the IPE crude oil (the best contract) offers a 43% risks reduction while the best contract of NYMEX (gas oil) only provides 27% reduction. In Houston, the IPE gas oil offers a 14% risk reduction while NYMEX gas oil gives 12% reduction of risks. In Singapore, gas oil contract traded at NYMEX provides the greatest out-of-sample risk reduction (15.9%) while gas oil contract traded at IPE could only have a 10.97% reduction of risk (2004, p.1351).

2.2 Chapter conclusion

To sum up from the above reviews, it is learned that, until today, there is no paper studying the problem of investigating the effectiveness of hedging bunker price using a bunker forwards contract traded at IMAREX and comparing the results obtained with a cross-hedge using different energy futures contracts traded at NYMEX. This is the reason why the topic for this dissertation was triggered.

CHAPTER 3 INFLUENTIAL FACTORS OF THE BUNKER MARKET

> "*The price rise in bunkers over the past 18 months is a serious concern as it has added significantly to our cost base both for ship bunker fuel and for all inter-modal costs*"
>
> A statement of **A.P. Moller-Maersk** to *Bunkerworld* (Roberts, 2006)

Bunker is the oil-based marine fuel. It is the final product in the refining process after taking out all the higher components such as Gasoline, Aviation spirit, Kerosene and Butane. There are three basic kinds of bunker: the Intermediate Fuel Oil (IFO), the Heavy Fuel Oil (HFO) and the Marine Diesel Oil (MDO). The IFO and HFO bunkers are used for the main engine and are more popular than the MDO bunker which is specially used for auxiliary engine.

For IFO bunker, there are two basic grades: IFO380cst (centistokes) and IFO180cst. The distinction between these two grades is the distillate content. The higher the distillate content, the higher energy the fuel has. For example, grade IFO180 has 7-15% distillate content while IFO380 only has 2-5%. The shipping industry widely uses IFO380 (60% in demand), IFO180 (30% in demand) and the remaining 10% is for MDO (Alizadeh *et al*, 2004, p. 1338).

The bunker price is governed by the laws of supply and demand. However, as vessels only take bunker at a limited number of ports around the world (let's say Singapore, Rotterdam, Houston, Fujairah), the bunker price, as a result, reflects the certain situation of bunker supply and demand at a certain port or in a certain region. This sometimes leads to differences in bunker prices of up to 50% (Ma, 2006, p. 96).

The demand for bunker originates from the demand for shipping. Consequently, any factors affecting the demand for shipping such as the world's economy, international seaborne trade, seasonality factor, political disturbance, and transport costs will also affect the demand for bunker. Unlike demand factors, the supply of bunker is mainly comes from the supply of crude oil and is then affected by the crude oil market, local demand, refining capacity, oversea and local competition as well as bunkering methods.

This chapter, after analyzing the bunker market in general and the bunker price in particular from 1990 to 2007, concentrates on analyzing the determinant factors of the bunker market by examining the supply and demand factors to explore the reasons why bunker price behaves in such ways. Considering the word limitation and, for the demand factors, this chapter firstly focuses on factors that directly impact the bunker price such as the world's economy, international seaborne trade, freight rates, fuel consumption, world tonnage and vessel speed.

For supply factors, the factors directly affecting bunker price are examined such as the world oil price, the local demand, the refining capacity, the degree of competition among suppliers and the bunkering methods. Finally, the correlation between bunker price and some of the most determining factors are calculated.

3.1 The bunker market

Following the laws of supply and demand, a rise in the demand of bunker will cause an increase in bunker price. The extent of this rise is captured by the price elasticity of demand (Ma, 2006, pp. 98-99). According to Beenstock & Vergottis (1993), the demand of bunker is quite inelastic as bunker is an essential energy for ship propulsion.

This finding is confirmed by a high correlation coefficient (0.98[4]) between bunker price and bunker demand from 2004 to 2007. *Table 3.1* stresses that from 2004 to

[4] Calculated from data in **Table 3.1**.

2005, the demand only increased by 11.76% while the price increased by 46.02% (four times).

Table 3.1 Forecast of bunker demand and bunker price from 2004-2020

Demand	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2015**	**2020**
(Million tons)**	170	190	210	220	230	240	250	280	340
Price (US$/ton)*	186	217.6	321.3	338	350	363	376.9	389.9	402.9
% Demand change		11.76	10.53	4.76	4.54	4.35	4.2	(*6.68*)	
% Price change		46.02	18.28	5.22	3.55	3.72	3.45	(*13.37*)	

Source: ** **Bunker demand**: compiled from Meech, R. (April 17, 2006). Study on shortage of low Sulphur fuel oil. In *Proceeding of 27th International Bunker Conference.* Gothenburg: Marine and Energy Consulting Limited. * **Bunker prices**: price from 2004-2006 are compiled average monthly price in *Appendix A*, prices from 2007-2020 are forecasted by author using time-series moving average.

Moreover, in 2004–2010, the average % change of demand is about 6.68%/year while average bunker price changes as twice as demand at 13.37%/year. *Figure 3.1* shows the behavior of bunker price and bunker demand from 2004 to 2020.

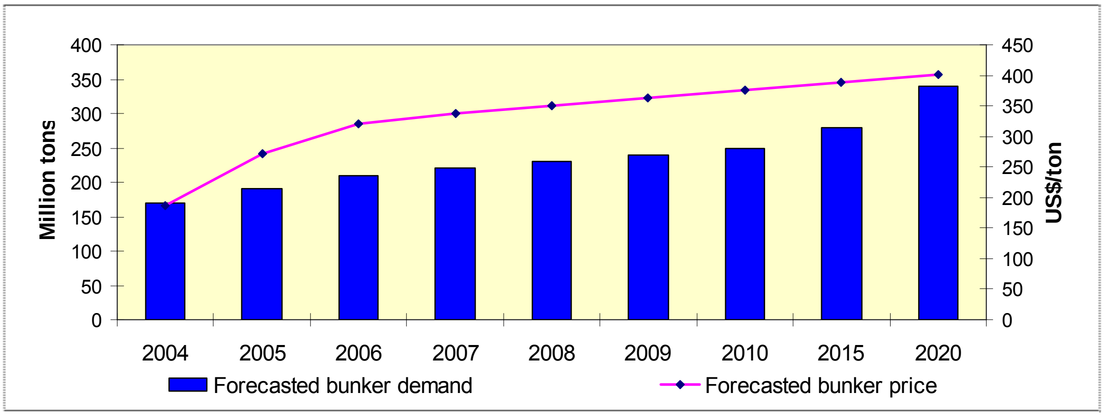

Figure 3.1 Forecast of bunker demand and bunker price from 2004-2020

Source: compiled from *Table 3.1*

On the supply side, bunkers depend on the supply of fuel oil, thus the world oil market. The correlation coefficient between bunker price and crude oil price is over 0.95 (discussed in *part 3.2.2*) and contradicts the findings from Beenstock &

Vergottis (1993) who estimate an elasticity of supply with respect to fuel price is around 0.23. This could be explained by the current situation in the bunker market affected by the cut-off in supply by OPEC, by the huge demand from China as well as a colder winter in the US. *Figure 3.2* shows the behavior of bunker price and fuel oil supply from 1990 to 2006. It can be seen from *Figure 3.2* that supply of fuel oil decreased from 2,201 million barrels/day in 1990 to only 1,694 million barrels/day in 2006 (see *Appendix F*). At the same time, bunker price jumped up from $112/ton in 1990 to $321/ton in 2006 (nearly tripling or 187% increase).

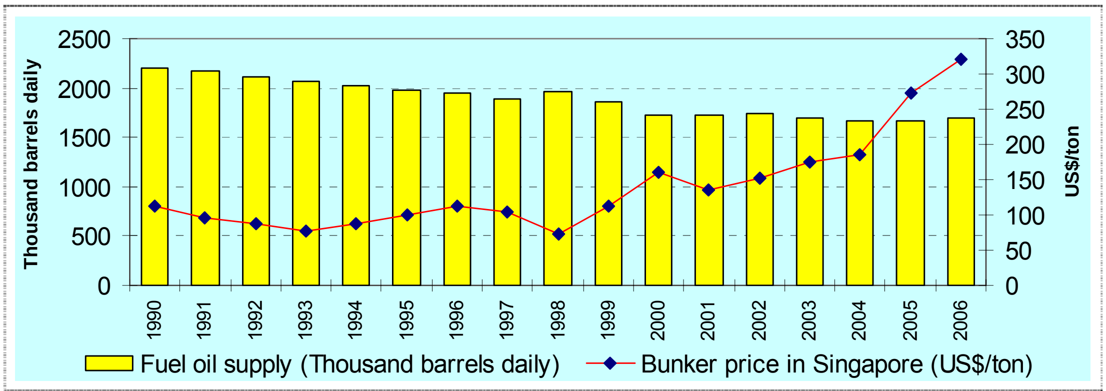

Figure 3.2 Behavior of fuel oil supply and bunker price from 1990 to 2006

Source: **Bunker price in Singapore**: compiled from various issues of Drewry Monthly from 1990 to 2007 (see *Appendix A*). **Fuel oil supply**: compiled from BP Plc. (2007b). *BP statistical review of world energy, June 2007: quantifying energy*. London: BP Plc.

3.1.1 Development of bunker market 1990-2007

From 1990 to 2007, the bunker market is dotted by two main trends: quite stable development with a low level from 1990 to 1999 and a boom in level with high fluctuation from 2000 to 2007.

3.1.1.1 1990-1999 period: low bunker price and stable development

The calculation of mean, standard deviation, Min and Max of bunker price on the weekly based data (see *Appendix B*) in *Table 3.2* suggests that, in the period 1990-

1999, the average bunker price was quite low. The mean is in the range of $84–$89/ton at four main ports: Houston, Rotterdam, Los Angeles and Singapore.

Table 3.2 Behavior of bunker price from 1990 to 1999 (weekly base)

Market	Rotterdam	Singapore	Houston	Los Angeles
1990-1999 (US$/ton)				
Mean	85	89	84	88
Standard deviation	20.86	23.56	20.44	21.57
Max	189	153	143	171
Min	60	58	55	61

Source: Complied from various issues of Fairplay Weekly from 1990 to 1999 (see **Appendix B**)

In addition, the standard deviation of bunker price at four main ports in this period is in the range of $20.44-$23.56. Two notable exceptions exist from July 1990 to March 1991 and late 1998.

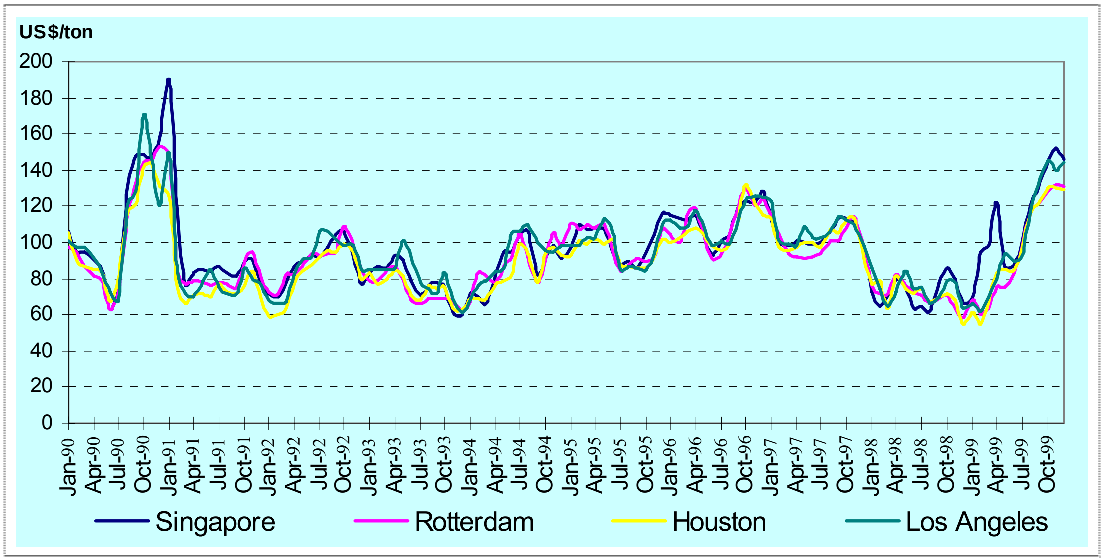

Figure 3.3 Bunker prices (IFO380) in four main markets (Jan 1990 –Dec 1999)

Source: Compiled from various issues of Drewry Monthly from 1990 to 1999 (see **Appendix A**)

The sudden sky-high bunker price in late 1990 and early 1991 is explained by the fact that Iraq invaded Kuwait (the two leading oil producers in the world) in this period (Stopford, 1997, p. 58). This invasion tied up the crude oil supply and resulted in the shortage of bunker supply thus sending the bunker price up. Moreover, bunker price was at its bottom in late 1998 and early 1999 (only $55-$60/ton). The reason for such a decline was the impact of the Asian financial crisis that broke down the financial system in some Asian countries (BP Plc, 2007b, p. 16). These are also supported by the trend shown in *Figure 3.3*.

3.1.1.2 2000-2007 period: high bunker price and fluctuation

This period of high bunker price was triggered by the invasion of the USA of Iraq in early 2000. The invasion led to a shortage in supply of crude oil. Consequently, bunker price in early 2000 was nearly twice that of late 1998, 1999 as shown in *Table 3.3* in all four main ports ($155-$173 versus $84-$89).

Table 3.3 Behavior of bunker price from 2000 to 2007 (weekly base)

Market	**Rotterdam**	**Singapore**	**Houston**	**Los Angeles**
2000-2007 (US$/ton)				
Mean	155	173	158.5	167
Standard deviation	66.48	69.29	69.5	74.8
Max	355	344	349	382
Min	108	107	100	103
2005-2007				
Mean	263.75	296.25	275	308
Standard deviation	43.64	42.84	41.79	43.52

Source: Complied from various issues of Fairplay Weekly from 2000 to 2007 (see **Appendix B**)

The maximum bunker price in 2000-2007 is almost six times higher than the minimum price in 1990-1999. For instance, the maximum bunker price in 2000-2007 was $384/ton (in May 2007 at Los Angeles) while the minimum price in 1990-1999 was only $55/ton (in December 1998 at Houston). Such trends are clearly detected in *Figure 3.4* in which bunker price tends to continuously increase from 2000 to 2007.

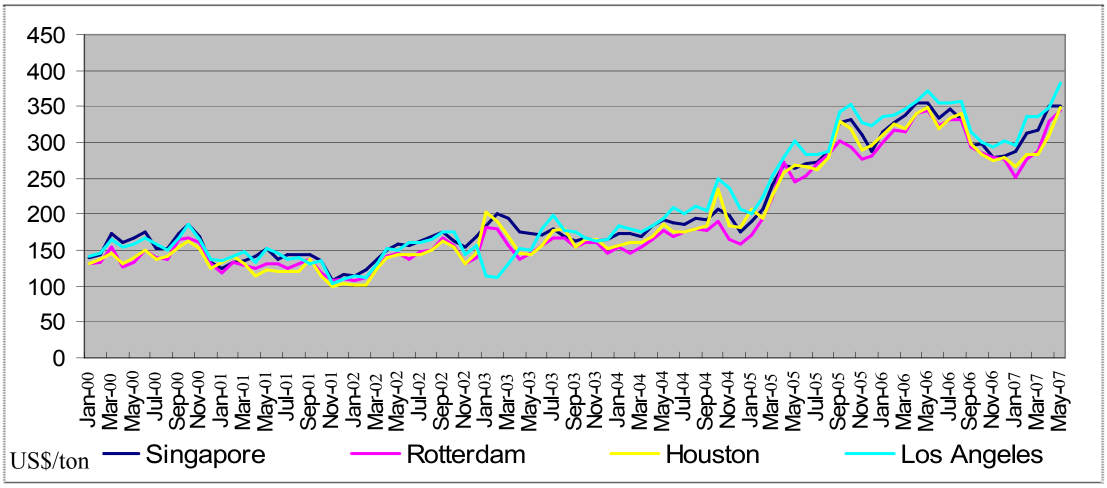

Figure 3.4 Bunker prices (IFO) at four major markets (Jan 2000 –May 2007)

Source: Compiled from various issues of Drewry Monthly from 2000 to 2007 (see **Appendix A**)

In addition, the standard deviation of bunker price nearly tripled in this period (from \$66.48 to \$74.8) compared with 1990-1999 (from \$20.86 to \$23.56). Such fluctuation was extremely high from early 2005 to early 2006. For example, in Singapore and in December 2004, the bunker price was at \$175/tons and jumped to \$269/tons in April-2005 (almost 60% increase) and reached \$332/ton in October-2005 (almost 90% increase) (*Appendix A*).

During this period, shipowners' revenue and profit margins were negatively affected by this rise. For instance, in May 2006, NYK (Japanese shipping company) reported that high fuel costs did shave \$242 million off its profit (Roberts, 2006). Moreover, during the first half of 2006, due to the increasing fuel costs, A.P. Moller-Maersk reported a \$607 million loss in its container arm alone (Roberts, 2006).

3.1.2 Singapore –Rotterdam –Houston: three major bunker markets

Normally, bunker is sold and bought at every port where ships call for cargo operation or other purposes, all over the world. However, as pointed out by Kavussanos & Visvikis, the world bunker market can be divided into three major regional markets: Singapore (Asia), Rotterdam (Europe) and Houston (U.S). For each individual market, differences in technical requirements (refining capacity, infrastructure and storage capacity) and commercial requirement (sales volume, competitive bunker price) for physical bunkering activities exist (2006b, p. 288).

3.1.2.1 Singapore

With container traffic ranked at the third place (23,192,200TEU, after China – 88,548,473TEU and the USA –38,519,037TEU) and being the world's biggest port in terms of throughput (23,192,200TEU) in 2005 (Jane, 2007, p. 8), Singapore is a leading hub port in Asia and meets the conditions for a highly developed bunker market. Supported by a highly developed fuel oil cargo and a most dense shipping traffic area, Singapore is considered as an Asian benchmark for bunker price (Lee, 2007). *Figure 3.5* shows the forecasted demand of bunker in Singapore and other areas from 2004 to 2020.

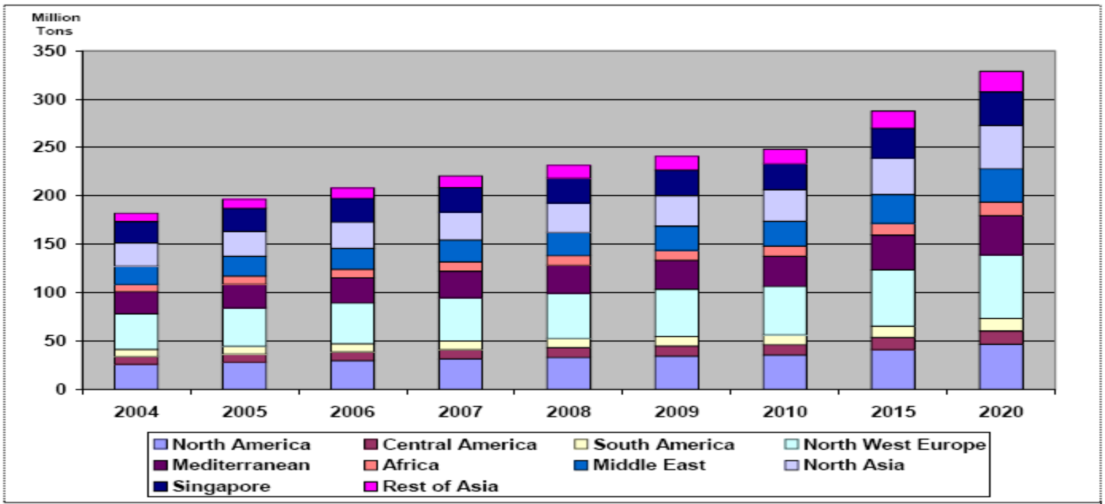

Figure 3.5 Forecast of bunker demand in Singapore and other areas

Source: Meech, R. (April 17, 2006). Study on shortage of low sulphur fuel oil. In *Proceeding of 27th International Bunker Conference.* Gothenburg: Marine and Energy Consulting Limited.

It can be seen from *Figure 3.5* that from 2005 to 2007, Singapore demands a volume of bunker of about 26-30 million tons/year. The figure will reach about 50 million tons in 2020. Bunker sales in Singapore is the highest in the world, reaching 28.5 million tons in 2006 (Lee, 2007).

In addition, bunker supply in Singapore is supported by a high and stable refining industry as well as by impressive storage capacity (*Table 3.4*).

Table 3.4 Refining capacity of Singapore and other countries in the world

1000 barrels/day	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	%/Total
USA	15452	15711	16261	16512	16595	16785	16757	16894	17125	17335	**17455**	20.0%
Canada	1807	1811	1844	1861	1861	1917	1923	1959	1915	1927	**1968**	2.3%
N.America	**18703**	**18971**	**19554**	**19822**	**19937**	**20183**	**20143**	**20316**	**20503**	**20725**	**20886**	**23.9%**
S&C. America	**6026**	**6324**	**6265**	**6417**	**6523**	**6468**	**6547**	**6612**	**6625**	**6644**	**6680**	**7.7%**
Germany	2098	2170	2206	2240	2262	2274	2286	2304	2320	2322	**2390**	2.7%
Netherlands	1239	1266	1266	1282	1282	1283	1287	1287	1289	1279	**1282**	1.5%
Russian	6098	5933	5577	5443	5395	5363	5451	5486	5491	5491	**5491**	6.3%
UK	1873	1823	1848	1777	1778	1769	1785	1813	1848	1819	**1819**	2.1%
Europe	**25454**	**25468**	**25240**	**24886**	**24837**	**24808**	**24980**	**25036**	**25170**	**25154**	**25171**	**28.9%**
Middle East	**5820**	**5983**	**6143**	**6374**	**6307**	**6603**	**6747**	**6906**	**7101**	**7126**	**7221**	**8.3%**
Africa	**2987**	**2928**	**2881**	**2983**	**3034**	**3217**	**3294**	**3313**	**3311**	**3332**	**3336**	**3.8%**
China	4226	4559	4592	5401	5407	5643	5479	5487	6289	6587	**7029**	8.1%
Japan	5006	5056	5144	5087	5010	4705	4721	4683	4567	4529	**4542**	5.2%
Singapore	1245	1246	1246	1246	1255	1255	1255	1255	1255	1255	**1255**	1.4%
Asia Pacific	**18039**	**19265**	**19713**	**21445**	**21627**	**21828**	**21939**	**21774**	**22640**	**22948**	**23944**	**27.4%**
WORLD	**77029**	**78939**	**79796**	**81927**	**82265**	**83107**	**83650**	**83956**	**85349**	**85929**	**87238**	**100.0%**

Source: Compiled by author from BP Plc. (2007a). *BP statistical review of world energy, June 2007.* Retrieved 10 July, 2007 from World Wide Web: http://www.bp.com/multipleimagesection.do?categoryId=9017892&contentId=7033503.

Table 3.4 shows that refining capacity of Singapore is stable at about 1,255 thousand barrels/day and accounts for 1.4% of the world refining capacity in the last ten years. Refining activities in Singapore are dominated by major multinational oil companies such as ExxonMobil (capacity of 605,000 bpd), Shell (500,000 bpd) and SRC with capacity of 285,000 bpd (Lee, 2007).

Moreover, the onshore storage capacity of Singapore has been expanding in recent years with major terminals such as Horizon Terminal (1.2 million cbm capacity by mid-2008), Universal Terminal (2.28 million cbm to operate by end-2007) and the Helios Terminal (450,000 cbm capacity by end-2007) (Lee, 2007).

3.1.2.2 Rotterdam

If Singapore is considered as a benchmark in the Asian bunker market, Rotterdam is said to be the Europe's biggest refining hub in the heart of the ARA (Amsterdam -Rotterdam -Antwerp) region. With the refining capacity increasing from 1996 to 2006 and accounting for about 1.5% of the world's refining capacity (*Table 3.4*), Rotterdam is the home for two oil refining giants: the BP-owned Nerefco with a refining capacity of 400,000 bpd and the Shell-owned Pernis with a capacity of 416,000 bpd (Einemo, 2007).

Bunker supply in Rotterdam is supported by bunker fuel storage capacity with a spread between the gigantic Vopak Europoort Terminal (total capacity of 2,871,100 cbm, in which 240,000 cbm is for bunker), the Argos Terminal and the newest Vitol-owned Euro Tank Terminal (capacity of 278,000 cbm only for bunker) (Einemo, 2007).

Bunker sales in Rotterdam reached 13.4 million tons in 2006 and expected to break another record in 2007 with 14 million tons. Bunker price in Rotterdam is usually quoted on an FOB export base as "*barges Free on Board (FOB)* [5] *Rotterdam*". Moreover, the port is equipped with the world's biggest and most modern bunker barges which are ideal for handling the bunker requirements of new-generation mega containerships which require large bunker stems (Einemo & Carroll, 2007).

Moreover, the positive development of the bunker market in Rotterdam is supported by the increasing throughput of the port. The total goods handled at Rotterdam in 2006 is about 392 million tons in which the strongest growth was for petroleum products (+42%), Ro/Ro cargos increased 38% and containers gained 8% increase.

3.1.2.3 Houston

Houston is the biggest bunkering market in the US Gulf Coast although smaller compared with Rotterdam and Singapore. In 2004, Singapore sold 16 million tons bunker, Rotterdam sold about 8 million tons while Houston only sold 5.5 million tons (Kavussanos & Visvikis, 2006b, p. 288). It has five refineries with the capacity of 1,344,000 bpd (for general products and fuel oil) and accounts for 26% of the fuel refining capacity of the USA (Lindemer, 2007). The bunker market in Houston is

[5] In a "*barges FOB*" quotation, the barging costs are usually included in the quoted bunker prices

fairly stable and is supported by a wide range of multinational oil companies such as Chemoil, BP Marine, ExxonMobil Marine Fuels (EMMF) and Shell (Fearnley Consultants, 2003, p. 66). It is said to be the most competitive bunker market and is consequently cheaper than other USA ports (Kavussanos & Visvikis, 2006b, p. 288).

To sum up the above discussion, bunker price was quite stable from 1990 to 1999, except for (1) the jump at the beginning of 1990s explained by the invasion of Iraq into Kuwait and (2) the decline in late 1998 and early 1999 due to the impact of the Asian financial crisis. Bunker prices existed at rather low levels (from $84 to $89/ton) and fluctuation was low (standard deviation ranges from $20.44 to $23.56). This fluctuation is said to be normal compared with the other normal price behaviors.

In 2000-2007, the invasion of Iraq by the USA in early 2000 sent the bunker price to nearly double levels compared with the period 1990-1999 (from $155 to $173/ton) and fluctuations were abnormally high (standard deviation range from $66.48 to $74.80). Especially, only from 2005 to 2007, the bunker price rocketed to nearly double from a mean range of $155-$173/ton to a sky-high range of $263.75-$308/ton.

The following sections examine the reasons why the bunker price behaved in such ways by analyzing the factors affecting the demand and supply of bunker as well as the causal relationship between the main demand/supply factors and bunker price.

3.2 Influential factors of the bunker market

The price of bunkers is determined by the laws of supply and demand. Thus the factors directly or indirectly affecting the supply and demand of bunker will then play an important role on the bunker price.

3.2.1 Supply factors

3.2.1.1 Oil market

As bunker is the final product in the refining/distillation process of crude oil, factors affecting the crude oil market have a direct impact on the bunker market. For instance, when OPEC informed a tight-up-supply plan in mid-2006, crude oil prices reached a high record level of $75.63/barrel. Although the oil price decreased below $60/barrel early in 2007, it soared again and stayed at a high level of around $70/barrel (*Appendix B*). Such high oil prices have resulted in extremely high bunker prices in the last few years as presented in *part 3.1.1*.

Sky-high oil prices are supported by the increasing demand of oil consumption from developing countries and by the effect of bad weather. At the same time, oil production (supply side) did not keep pace with the increasing pace of oil consumption demand. It is understood from *Figure 3.6* that world oil production and oil consumption almost behaved in the same ways and were almost at the same levels (*Appendix C*). This implies a potential danger of shortage of supply if an unanticipated event happens (*Figure 3.6*) when the spare production capacity is not enough.

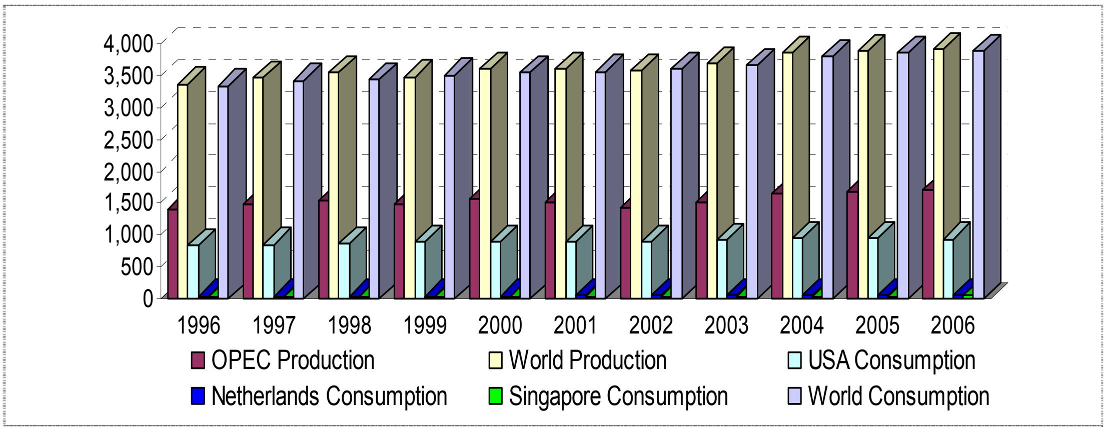

Figure 3.6 World oil production and oil consumption (1996-2006) [million tons]

Source: compiled from **Appendix C**

Historically, the oil price has engaged itself with much fluctuation. After the oil crisis in 1973 which put the bad impact on the oil market, there are other events that have badly influenced oil price, thus consequently the impact on bunker price. The invasion of Kuwait by Iraq in 1990 sent oil prices up to $40/barrel, the Asian financial crisis in late 1998 pulled oil prices down to about $10/barrel. The invasion of Iraq by the USA in 2000 brought oil price up again to $35/barrel (*Appendix B*). Other events also had an impact on oil prices such as the 9/11 event in 2001 and political conflicts in the Middle East. The fluctuation of crude oil prices from 1990 to 2007 is shown in *Figure 3.7*.

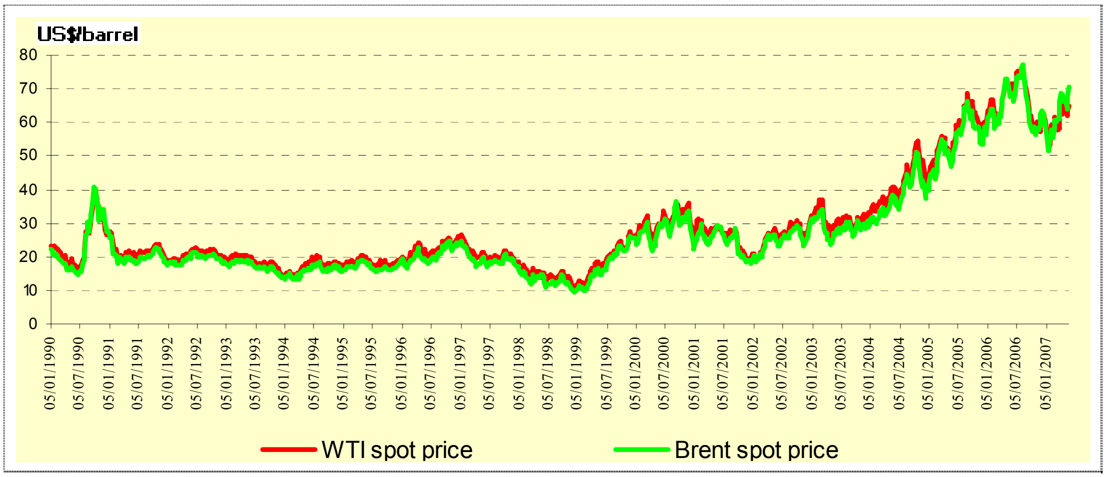

Figure 3.7 WTI and Brent crude oil spot prices from 05/01/1990 to 25/05/2007

Source: compiled from **Appendix B**.

The correlation coefficient between crude oil price and bunker price is 0.96. However, it can be seen from *Figure 3.8* that oil price did not fluctuate as much as bunker price. This is mainly explained by the fact that crude oil is sold almost everywhere while bunker transactions only take place at certain ports and are mainly controlled by multinational oil companies.

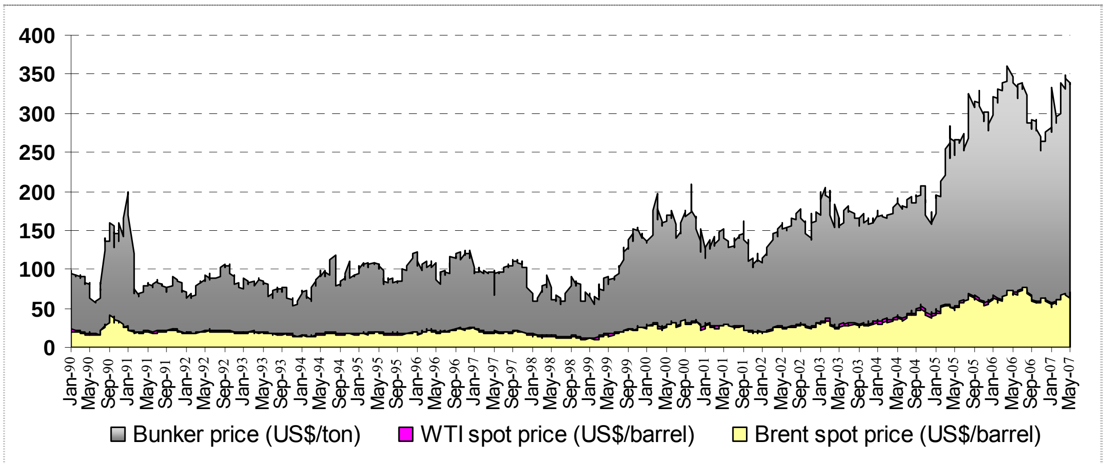

Figure 3.8 Development of bunker price and crude oil price (1990 –2007)

Source: bunker prices are compiled from various issues of Fairplay Weekly (1990-2007); crude oil prices are retrieved 15 June, 2007 and compiled from http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_d.htm. (**Appendix B**).

3.2.1.2 Changes in bunker level, refining capacities

Bunker supply levels at a certain port depend on the refining capacity of the port area and the bunker import policy of the country. *Table 3.4* and *Figure 3.9* show that refining capacities have developed quite slowly in the last ten years (1996-2006) and limit the oil products supply as well as bunker supply development.

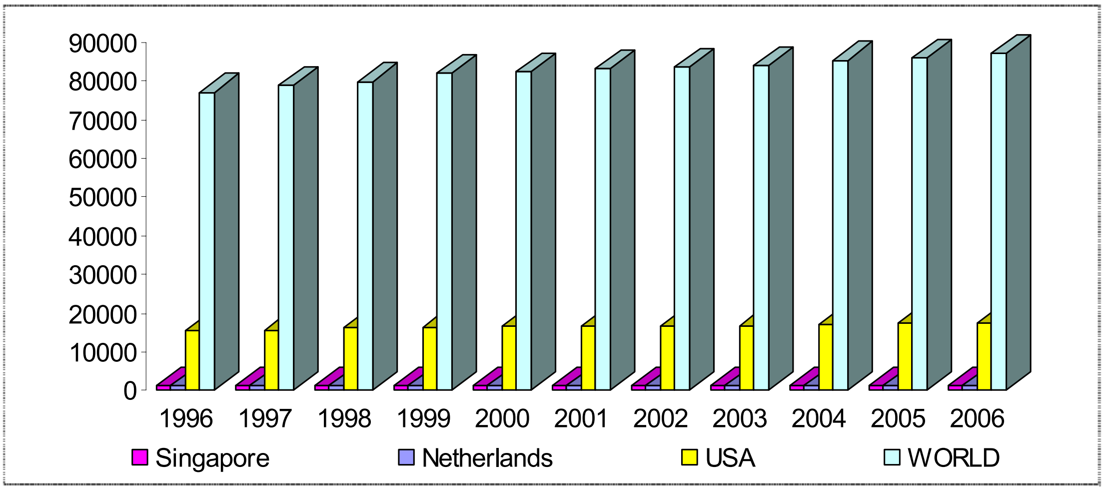

Figure 3.9 Refining capacities of countries and the world (thousand barrels/day)

Source: Retrieved 18 June, 2007 and compiled from World Wide Web:
http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/spreadsheets/statistical_review_full_report_workbook_2007.xls. (see **Table 3.4**)

Moreover, refining margins of three main regions in the world (*Table 3.5*) proves that refining marginal costs have increased. For example, in the USA Gulf Coast in 1996, to refine one more barrel of crude oil, the industry only had to pay $1.76. In 2006, it became much more expensive with a marginal cost of $12.00/barrel.

The refining marginal costs are different from the USA Gulf Coast to Rotterdam and Singapore. Refining marginal cost is the most expensive in the USA Gulf Coast, followed by Singapore and then Rotterdam. As a result, it is now more difficult for the USA Gulf Coast to improve refining capacity compared with Singapore or Rotterdam.

Table 3.5 Oil refining marginal costs of three main regions (US$/barrel)

Year	USGC West Texas Sour Coking (*)	NWE Brent Cracking (**)	Singapore Dubai Hydro-cracking
1996	1.76	2.11	3.85
1997	2.88	2.10	2.40
1998	2.40	2.11	1.11
1999	1.28	1.20	0.50
2000	3.89	3.35	2.11
2001	4.86	2.24	0.90
2002	2.37	1.04	0.57
2003	4.72	2.63	1.78
2004	7.15	4.28	4.93
2005	11.36	5.45	5.56
2006	12.00	3.92	4.23

Notes: (*) USGC = US Gulf Coast; (**) North West Europe (NWE –Rotterdam)

Source: Retrieved 18 June, 2007 and compiled from World Wide Web: http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/spreadsheets/statistical_review_full_report_workbook_2007.xls.

3.2.1.3 Other supply factors: bunkering methods, changes in oversea competition, changes in local market

As mentioned in previous parts, bunkering charges are included in the quoted prices. As a result, the methods of bunkering have a direct impact on bunker supply in the sense that if modern technology is used, the supply price will be cheaper and the operation will be safer.

Generally, there are two methods of bunkering. The first method is bunkering directly from the storage tanks when the ship is at berth. The second method is offshore bunkering using barges. At present, 90% of bunkers all over the world are delivered by barges. The first bunkering method is said to be more expensive if the ship only comes to berth for bunkering as it has to pay port dues. In contrast, the offshore bunkering method can take place when the vessel is at anchor and gives the possibility to save agency fees as well as port dues (European Commission, 2003, p.26).

Other factors affecting the bunker supply are the supply conditions in oversea competition as well as in the local market. Naturally, shipowners look for the cheapest option[6]. Consequently, if a port can attract bunkering business through low pricing, it has an impact on all bunkering ports. For instance, a fall in bunker price in Singapore influences the bunker price in Rotterdam and vice versa (Kavussanos & Visvikis, 2006b, p. 290).

Besides the discussed factors, many other factors play on the bunker supply such as competition in the local market, seasonality factor, the effect of unpredictable economic and the natural and political factors.

3.2.2 Demand factors

3.2.2.1 Development of world economy

The world economy affects the shipping demand in two ways: the economic policy and economic development (Ma, 2006, p. 19). World economic development creates demand for transferring production inputs (materials, equipment) as well as finished products from one country to another. The development of trade among big countries and organizations like the US, Japan, China, WTO, EU and ASEAN is the main element to explain the change in international seaborne trade. In addition, the movement of goods is supported by various bilateral, multilateral trade agreements among economic organizations. For instance, the mutual trade agreements between Vietnam and China, China and the US, multilateral trade agreements among WTO members, APEC members and NAFTA members remove the barriers and facilitate the development of international trade and then the demand for bunker.

In world economy development, GDP growth is the key driver for the growth of shipping demand (Hansen, 2007, p. 17). However, quantifying the impact of GDP growth on maritime demand growth is not an easy task. Volk (2002, p. 7) states for instance that a small change in the economic development might have a considerable impact on the demand for sea transport. The development of world trade is naturally

[6] Of course, he will consider the trade-off between taking bunker at current port versus taking more cargo to gain freight. If the difference in bunker price between the current port and the next port is higher than the gain from freight, he will take bunker at current port and vice versa.

faster than GDP growth (Ma, 2006, p. 19); the ratio between growth in trade and growth in GDP is defined as the elasticity of world trade. The higher the elasticity of world trade, the faster the development of world trade compared with GDP growth. Moreover, a study of IMF stated that elasticity of trade for the last 30 years has been positive at average 1.58 or world trade grew 58% faster than the GDP growth. The calculation between 2006 and 1996 shows that trade elasticity is 2.89. In other words, trade developed much faster than GDP between 2006 and 1996 (189%).

Table 3.6 World GDP growth and Merchandise Export Growth (1990-2007)

Year	World GDP Growth (%)	World Merchandise Export Growth (%)	Merchandise Export Value (million US$)
1990	2.6	5.5	3,245,000
1991	1.8	6.2	3,444,624
1992	2.7	4.2	3,588,150
1993	2.7	5.3	3,777,000
1994	4.0	14.5	4,326,000
1995	3.7	19.3	5,162,000
1996	4.3	4.4	5,391,000
1997	4.2	3.5	5,577,000
1998	2.5	-1.5	5,496,000
1999	3.4	3.9	5,708,000
2000	3.4	12.9	6,446,000
2001	2.4	-3.9	6,197,000
2002	3.0	4.6	6,481,000
2003	4.0	15.8	7,503,000
2004	5.1	22.0	8,907,000
2005	4.9	13.0	10,159,000
2006	5.4	16.0	11,786,600
2007*	4.9	13.8	13,414,200

Notes: * are estimated figures

Source: **World GDP**: compiled from various issues of IMF. *World Economic Outlook 1990-2007*. Retrieved 8 July, 2007 from World Wide Web: http://www.imf.org/external/pubs/ft/weo/2007/01/data/download.aspx. **World Merchandise Export:** compiled from various issues of WTO. *International Trade Statistics* 1990-2006. Author

Table 3.6 and *Figure 3.10* illustrate that world export always develops faster than world GDP except for in 1998 and 2001. In 1998, the whole world was affected by the impact of the Asian financial crisis, oil prices declined to their bottom line of about $10/barrel, bunker prices declined to only $55-$60/ton (*Appendix B*), world export developed at minus 1.5% compared with +3.5% in 1997, and the world economy fell into deep recession after booming like a "*bubble economy*" from 1994 to 1997.

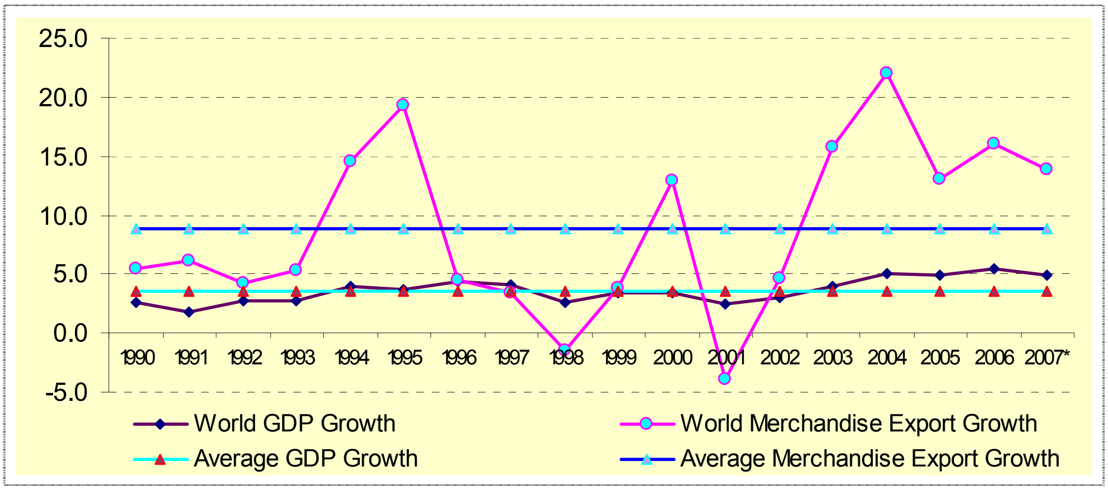

Figure 3.10 World GDP growth and world export growth (1990-2007) (%)

Notes: * are estimated

Source: compiled from **Table 3.6**

In 2001, the USA was straggled by the long uncertain war against terrorism after the 9/11 event, the price of oil jumped up to $35/barrel. The whole world economy was stagnated and finally mirrored in the recession of world trade with a growth rate of minus 3.9% compared to +12.9% in 2000 (*Figure 3.10*).

Foreign exchange policy and the policy of economic structure changes are the most influential policies on maritime demand (Ma, 2006, p. 19). A policy aiming at a weaker domestic currency encourages exports and discourages imports. For example, from 2000 to 2003, China applied a rather fixed Yuan policy versus the US dollar while the Yuan was rather devalued versus the US dollar so boosting Chinese exports to the USA in this period. Furthermore, since almost all freight rates and bunker prices are quoted in US dollars, the appreciation of the dollar relative to other currencies may increase the freight rates or bunker prices; whereas, dollar depreciation will effectively lower the freight rates and bring the bunker price down.

The change in the economic structure of a country also affects maritime demand in creating opportunities for resources moving mutually between the industrialized countries and the developing countries. For instance, the export-oriented policy of Vietnam encourages imports of machineries and equipment into Vietnam for export-processing.

The last element having an impact on the shipping industry and therefore on the bunker market is inflation. Low inflation rates prove the stability of the world‘s economic development and create more demand for shipping and bunker.

3.2.2.2 Development of international seaborne trade

Shipping is the final task in an international trade transaction to bring goods from the sellers to the buyers. Shipping does not create demand itself, its demand is derived from the development of trade in goods (Ma, 2006, p. 5). At the same time, the development of shipping can create new opportunities for international trade (Hansen, 2007). *Table 3.7* shows that world seaborne trades have developed dramatically from 1990 to 2006. Dry cargo accounts for about 65-70%, the rest being mainly tanker (liquid) cargo.

Table 3.7 Development of international seaborne trade (1990 -2007) (mil. tons)

Year	Tanker Cargo	Dry Cargo	Total
1990	1,755	2,253	4,008
1991	1,790	2,330	4,120
1992	1,860	2,360	4,220
1993	1,945	2,385	4,330
1994	2,007	2,478	4,485
1995	2,049	2,602	4,651
1996	2,127	2,631	4,758
1997	2,172	2,781	4,953
1998	2,181	2,884	5,065
1999	2,159	2,970	5,129
2000	2,163	3,709	5,872
2001	2,174	3,717	5,891
2002	2,129	3,819	5,948
2003	2,226	4,274	6,500
2004	2,318	4,528	6,846
2005	2,422	4,687	7,109
2006*	2,526	4,846	7,372
2007*	2,630	5,005	7,635

* are estimated figures

Source: Compiled from various issues of Review of Maritime Transport (1990-2006), UNCTAD

Figure 3.11 shows that seaborne trades grow at more than 4%/year. In which seaborne dry cargo grew at an average of more than 5%/year, faster than the tanker cargo (2.5%/year from 1990 to 2007).

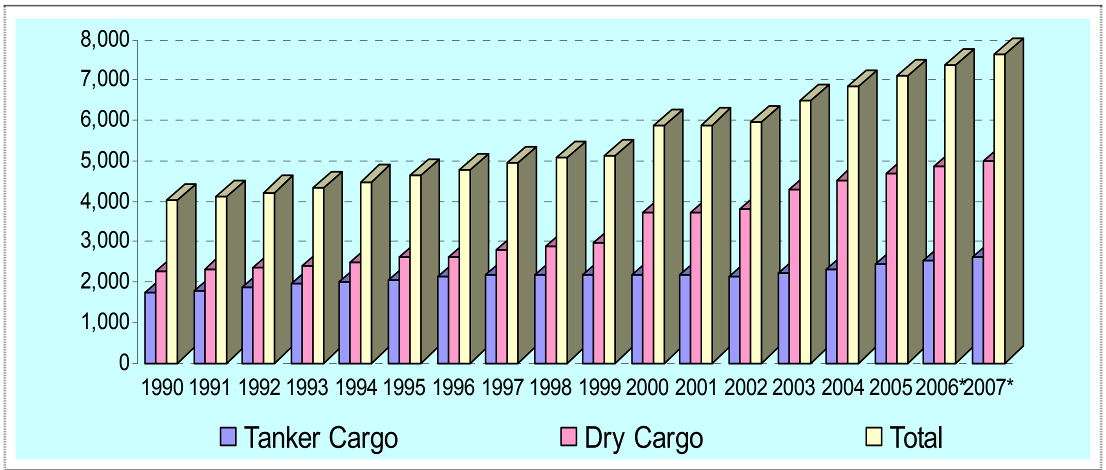

Figure 3.11 Development of seaborne trade from 1990-2007 (Million tons)

Source: Compiled from various issues of Review of Maritime Transport (1990-2006), UNCTAD.

Seaborne trade presents annually nearly 220 million tons[7] of cargo. Such a huge volume is equivalent to 3,385 Panamax vessels[8] with an average capacity of 65,000dwt. This implies a bunker consumption of 3,385 x 35 tons[9] = 118,475 tons per day or 350 x 118,475 tons = 41,466,250 mil tons of bunker per year.

3.2.2.3 Development of world tonnage and freight rates

An increase in world tonnage can come from an increase in the number of vessels or their average size. Both include demand for additional bunker. The calculations of correlation coefficient of world tonnage (0.84), freight rates (0.65) with the bunker price stress a positive relationship (*Appendix D, F*). *Figure 3.12* stresses that world tonnage and bunker price have increased from 1990 to 2006, especially after 1998. However, bunker price grew faster than world tonnage: average 9.3%year versus 2.4%/year (compiled from *Appendix F*).

[7] 220 mil tons = average seaborne trade (1990: 2007) x 4%/year.
[8] 3,385 vessels = 220 mil tons / 65,000 dwt
[9] Average consumption/day of a 65,000dwt Panamax at speed of 14-15 knots (see *Appendix E*)

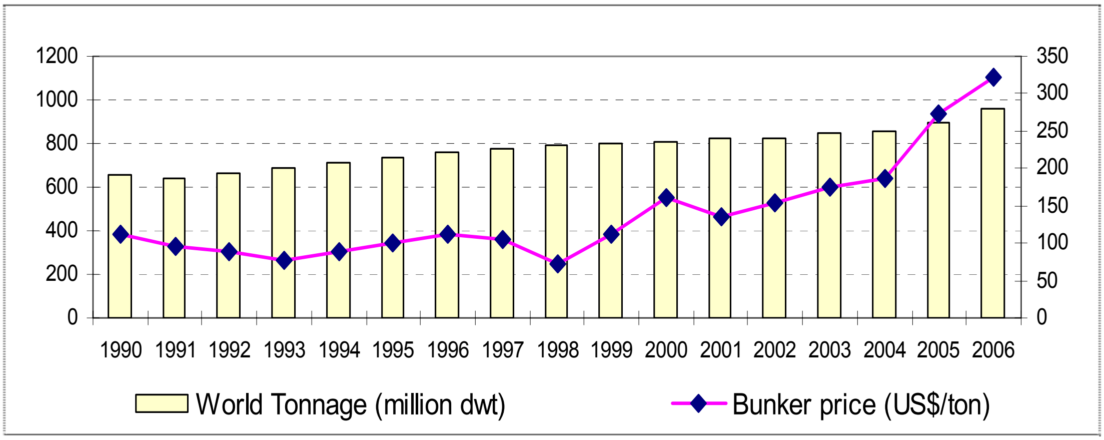

Figure 3.12 Development of world tonnage and bunker price 1990-2006

Source: Compiled from various issues of Review of Maritime Transport (1990 – 2006), UNCTAD

Naturally, when freight rates are high, the shipping industry tends to bring more ships into operation to take advantage of high freight rates, thus creating more demand for bunker. However, the fact is that it takes from 1.5 to 2.5 years for owners to build a new ship. As a result, during this time, even if the freight rates are high, the bunker demand is not increasing at the same pace as the freight rates increase. This is also the reason why correlation between world tonnage and bunker price (0.84) is higher than that between bunker price and freight rates (0.65). *Figure 3.13* shows the development of representative time charter rates from 1998 to 2007.

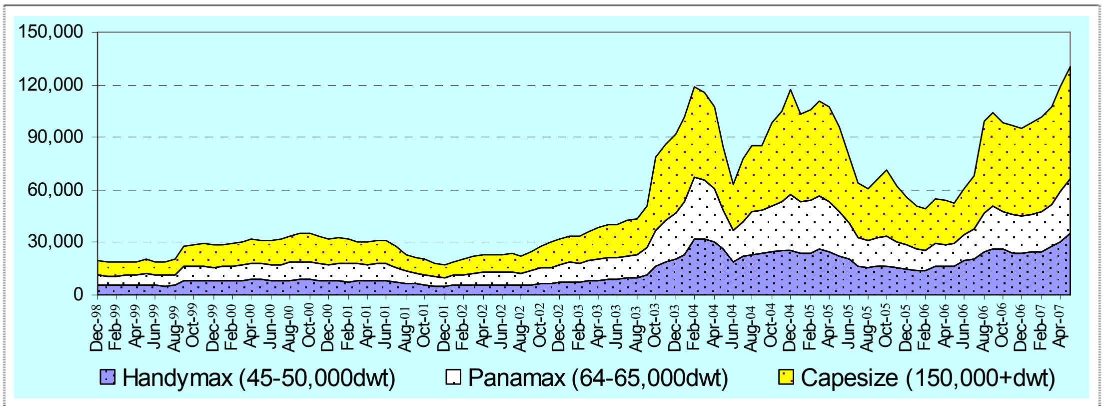

Figure 3.13 Development of representative dry bulk time charter rates for Handymax, Panamax and Capesize vessels (US$/day)

Source: Compiled from various issues of Drewry Monthly from 1998 to 2007 (see **Appendix D**)

Figure 3.13 shows that from 1998 to late 2002 charter rates were quite low and even decreased sometimes. However, after 2002, and particularly since late 2003, the charter rates have been booming. For instance, in September 2002 the time charter rate for a Capesize (150,000dwt) was only $11,000/day and jumped up to $24,000/day in September 2003 (an increased by 118%) and to $47,000/day in October 2004 (an increased by 327%). These charter rates stayed quite stable at about $25-28,000/day from mid-2005 to mid-2006 but rocketed again in late 2006 ($54,000/day in September 2006) to $64,000/day in May 2007 (*Appendix D*).

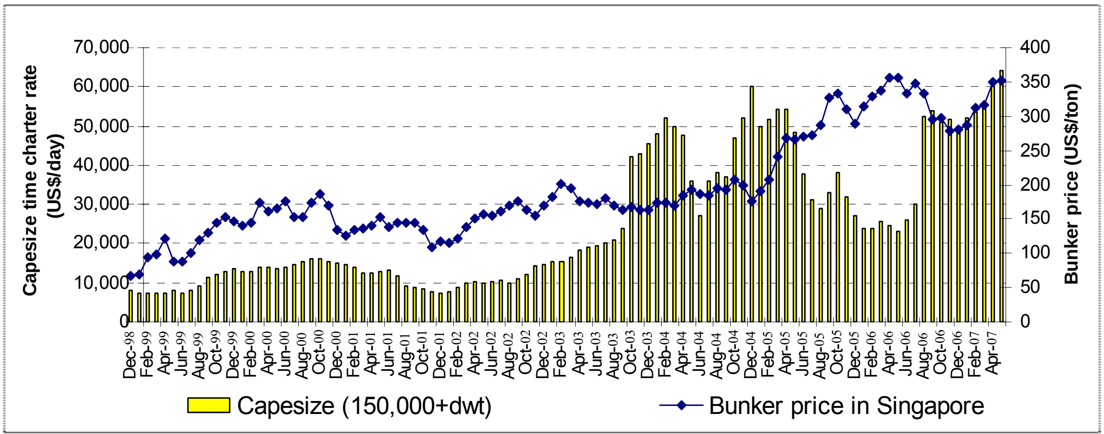

Figure 3.14 Development of time charter rates and bunker price (1998-2007)

Source: Compiled from various issues of Drewry Monthly from 1998 to 2007 (see **Appendix A&D**)

3.2.2.4 Fuel consumption and speed of vessels

Fuel consumption and vessel speed are two elements that have a direct impact on fuel costs. The fuel consumption of a ship depends on the efficiency of the ship engine. As a matter of fact, newly built ships generally consume less than aged ones (Ma, 2006, p. 96).

In the short term, owners can increase their shipping capacity by simply increasing the speed of a ship. However, the higher the speed of a ship, the higher the fuel consumption is (Germanischer Lloyd, 2006, p. 29). Therefore, when the bunker price increases, shipowners tend to reduce speed to save fuel costs. *Figure 3.15* shows the relationship of containership size, ship speed and its fuel consumption. (*Appendix E*).

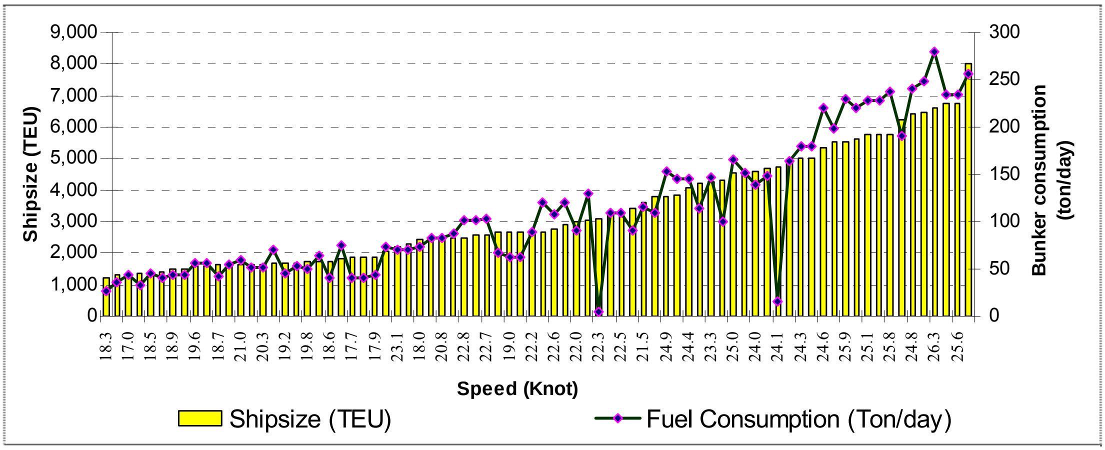

Figure 3.15 Relationship of size, speed and fuel consumption of containerships

Source: Compiled from World Shipping Encyclopaedia, WMU library software (Ship)

Since the proportion of bunker costs in the total costs increases, shipowners and ship operators always try to look for optimal speed (Ma, 2006, p. 96). For example, the study on "Speed & Bunker Costs" for 8,000TEU container ships fleet of Germanischer Lloyd found that for a bunker fuel price at $175/ton, the optimal fleet size lies at 8 ships with a relatively high speed of 26 knots. With bunker fuel price at $275/ton, the optimal fleet size lies at 9 ships with a speed of 22 knots. However, when bunker fuel prices increase to $400/ton, the optimal fleet size is 10 ships but the speed will decrease to 18 knots (2006, pp. 28-29).

Consequently, with the trend of deploying bigger and bigger ships (of course with optimal speed) in operations to take advantage of economics of scale, the shipping industry will need more and more bunker in the future.

3.3 Analysis of correlation between bunker price and influential factors

3.3.1 Correlation between freight rates and bunker price

As mentioned previously, bunker cost accounts for almost 50% of voyage costs. Normally, shipowners will compensate an increase in bunker costs with a higher freight rate (by passing such increases on to the shippers). Consequently, the higher the bunker price the higher the freight rates. As a result, bunker price and freight rates are positively correlated. This is true in the key bunker price-setting centers like Houston, Singapore and Rotterdam where bunker prices are highly responsive to changes in the bulk spot freight market (Kavussanos & Visvikis, 2006b, p. 297).

Calculations of correlation coefficient between bunker prices with different time charter rates also support the above argument. However, results stress some differences. The correlation coefficient (*Figure 3.16*) between Handymax charter rates and bunker prices in Singapore –Rotterdam –Houston are respectively 0.64 –0.64 – 0.68 while for Panamax charter rates are 0.50–0.50–0.53. The reason for a closer correlation between Handymax charter rates and bunker prices compared with Panamax's might be explained by the bigger size of Panamax vessels (60 -80,000 dwt) and by the long-term contract they are used for with the key commodities like Iron Ore, Coal and Grain. Panamax charter rates would therefore be rather inelastic to bunker price changes. In contrast, Handymax (35 -40,000 dwt) that are carrying a wider range of commodities (steel products, steam coal, scrap, and bauxite) with rather short-term contracts might be more affected by the day-to-day bunker price changes.

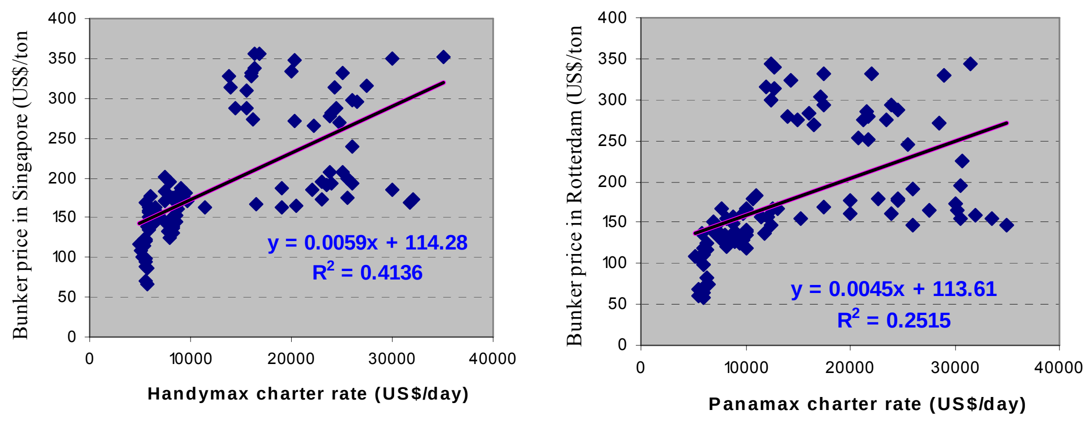

Figure 3.16 Correlations between time charter rates of Handymax and Panamax and bunker prices

Source: Bunker price and representative charter rates of Capesize and Panamax: compiled from various issues of Drewry Monthly from 1990 to 2007. (**Appendix A, D**)

Focusing on containerships, a study of Cariou & Wolff shows that a causal relation exists between the bunker price and Bunker Adjustment Factor (BAF) on the

Europe/Far East liner trade. BAF follows the main trend in bunker price (2006, p. 193). In other words, it can be understood that owners tend to cover an increase in bunker price rise by imposing BAF on the shippers.

3.3.2 Correlation between oil prices and bunker prices

Previous discussions (*part 3.2.1.1*) have shown how bunker price moves in close relationship with crude oil price. Many explanations for this phenomenon exist. Firstly, and from the demand side, crude oil and bunker are two primary commodities and essential energies with limited substitutes at least in the short and medium terms. Secondly, and from the supply side, bunker is the final product in the distillation process of crude oil, thus both have same the primary source.

As the bunker demand is limited at sea ports and bunker supply is limited by refining capacities, a slight difference still remains between bunker price and crude oil price at different ports (*Figure 3.17, 3.18*). The correlation coefficient between the WTI oil price and the bunker price in Singapore is 0.964 while between WTI oil price and bunker price in Houston is 0.968.

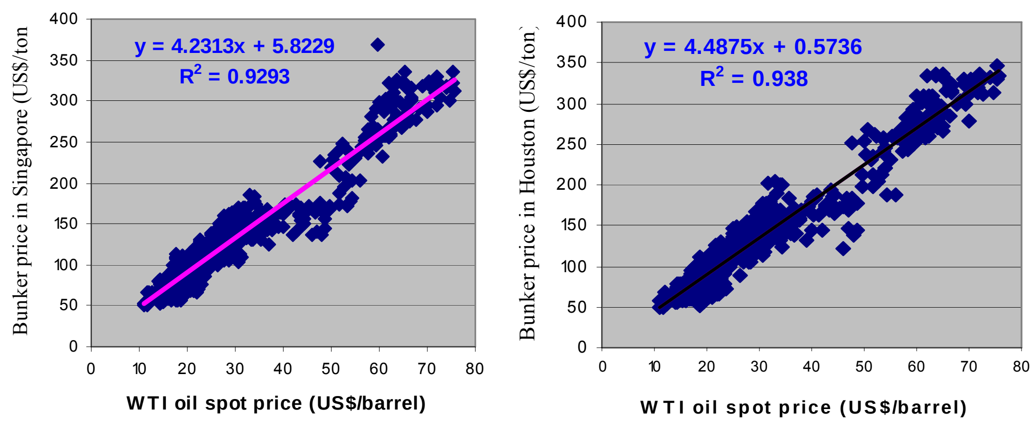

Figure 3.17 Correlation between crude oil prices and bunker prices (**Appendix B**)

Source: **Bunker price**: compiled from various issues of Fairplay Weekly from 1990 to 2007. Oil price (weekly base) retrieved 15 June, 2007 from http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_d.htm.

A similar calculation with the Brent spot oil price shows that the correlation coefficient with the bunker price in Singapore is 0.964 and in Rotterdam is 0.968.

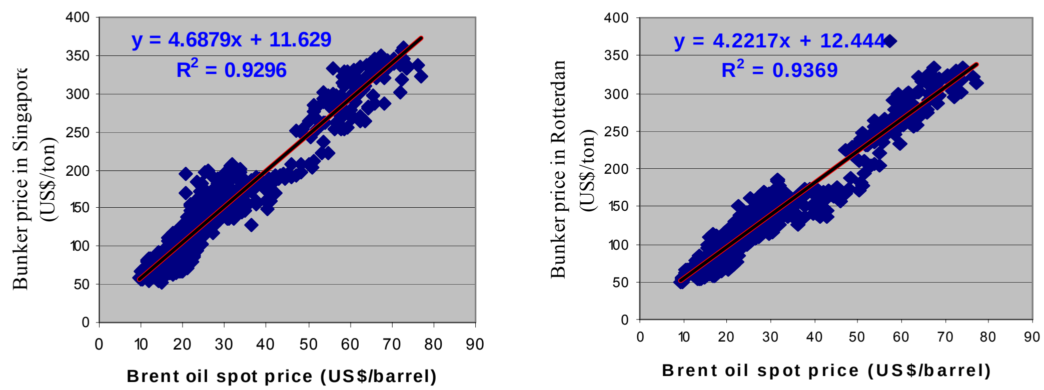

Figure 3.18 Correlation between crude oil prices and bunker prices (**Appendix B**)

Source: Compiled from **Appendix B**

Such slight differences in correlation coefficient between the oil prices and the bunker prices at different ports are later on stressed by Kavussanos & Visvikis who state that bunker prices usually follow the trends in the nearest oil cargo market centre (2006b, p. 290).

3.3.3 Correlation between international seaborne trade and bunker prices

Seaborne trade is related to bunker prices in the sense that seaborne trade generates the demand for bunker (Ma, 2006, p. 98). *Figure 3.19* shows that bunker price fluctuates almost in the same way with seaborne dry cargo.

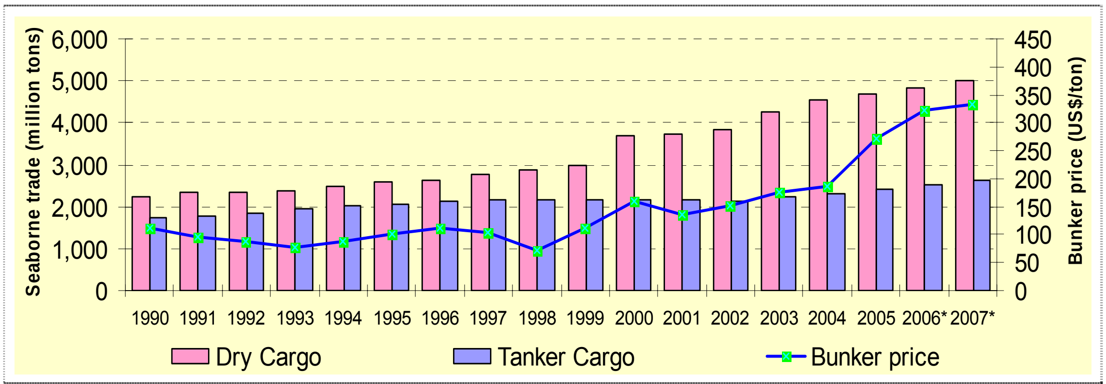

Figure 3.19 Development of seaborne dry cargo, tanker cargo and bunker price (1990-2007) (see **Table 3.7**).

Notes: * are estimated figures

Source: Seaborne trade: compiled from various issues of Review of Maritime Transport (1990-2006), UNCTAD. Bunker price: compiled from various issues of Drewry Monthly (1990-2007).

The correlation coefficient for bunker price with total seaborne trades is close to 0.894, with tanker seaborne cargoes 0.841 and with dry seaborne cargoes 0.889. The reason for these slight differences might be the bigger share of dry seaborne cargo (65-70%) compared to only 30-35% of tanker seaborne cargo in the total seaborne trade (see *Table 3.7*). Moreover, for many reasons, shipowners usually fix rather long-term contracts (3 -5 years) in carrying tanker seaborne cargo compared to the shorter-term for dry seaborne contracts.

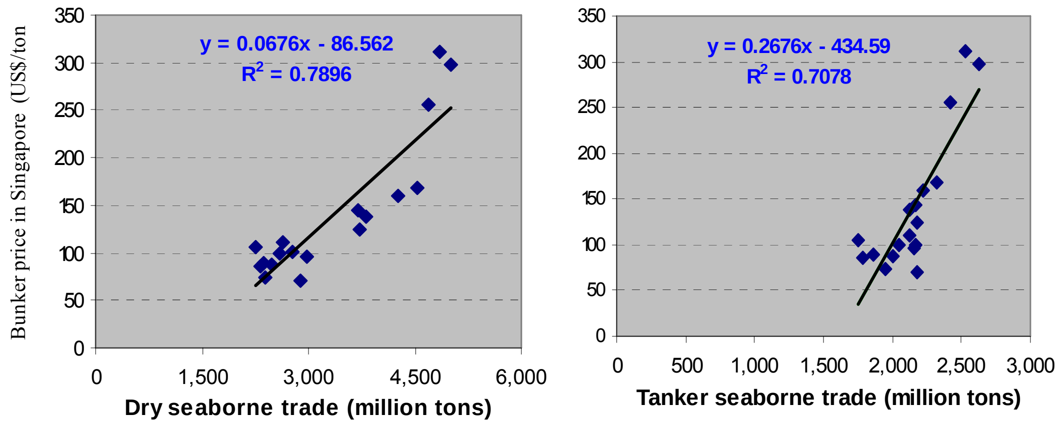

Figure 3.20 Correlation between seaborne trade and bunker prices

Source: **Bunker price**: compiled from various issues of Fairplay Weekly from 1990 to 2007. **Seaborne trade** from 1990-2007: compiled from various issues of Review of Maritime Transport (1990 -2006), UNCTAD.

3.3.4 Correlation between fuel consumption and bunker price

Fuel consumption is one factor affecting the bunker price. The fuel consumption rate of a ship depends on the efficiency of the ship engine, the commercial speed and the distance. The more efficient the ship engine the slower the speed, the shorter the shipping distance, the less the fuel the ship consumes.

The correlation coefficient between the fuel consumption of containerships and bunker price is 0.879 while that between bulk carriers and bunker price is only 0.234.

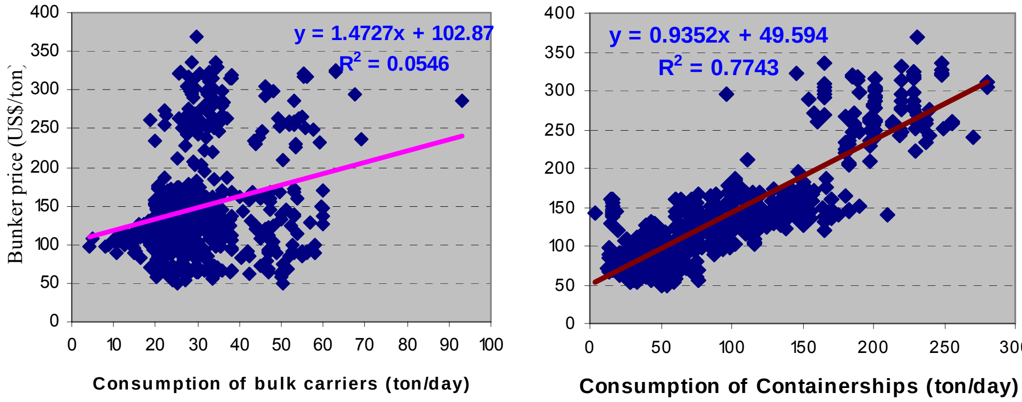

Figure 3.21 Correlations between fuel consumption of bulk carriers, containerships and bunker price (**Appendix E**)

Source: Bunker price: compiled from various issues of Fairplay Weekly from November, 1995 to May, 2007. Fuel consumption of bulk carriers and container vessels: compiled from World Shipping Encyclopaedia, WMU library (Ship category).

From *Figure 3.21,* the fuel consumption of bulk carriers would be rather inelastic to changes in bunker price (23.4%). Meanwhile the fuel consumption of containerships is highly responsive to changes in bunker price (87.9%). The reason for this difference is that in liner shipping, to keep pace with published schedules and high service frequency, containerships have to sail at higher speed compared to ships used in the tramping market. Calculations made on 601 containerships and 601 bulk carriers in *Appendix E* also supports this argument where the average speed of containerships is 21.81 knots while the average speed of bulk carriers is only 13.96 knots.

3.4 Chapter conclusion

The bunker market is dotted by two main trends: from 1990 to 1999, bunker prices existed at rather low levels (mean ranges from $84 to $89/ton) and behaved quite stably (standard deviation ranges from $20.44 to $23.56). In contrast, from 2000 to 2007, the bunker price jumped to nearly double compared with the period 1990-1999 (mean ranges from $155 to $173/ton) and fluctuations have been abnormally high (standard deviation range from $66.48 to $74.80). Particularly, only from 2005 to

2007, the bunker price rocketed to nearly double from the mean range of \$155-\$173/ton to the sky-high range of \$263.75-\$308/ton.

Such unpredictable bunker price behavior is explained by the operation of the laws of supply and demand in which supply factors are addressed by the sky-high crude oil price, the high oil consumption level versus the low oil production capacity, the limit of refining capacity of the world and main ports, fierce competition at oversea and local ports as well as the bunkering methodologies. On the demand side, the increase in bunker price is derived from the increase in the world's economy, the boom in international seaborne trade, the fast development of world tonnage, the high freight rate levels as well as the growing size and higher fuel consumption level of world's ships.

Some factors prove to be very close correlations with bunker price like freight rates (0.5-0.68 correlation coefficient), oil price (0.964 -0.968 correlation coefficient), seaborne trade (0.841 -0.894 correlation coefficient) and the fuel consumption of ships (0.234 -0.879 correlation coefficient). Consequently, these factors have a big impact on regulating bunker price.

CHAPTER 4 INTRODUCTION TO BUNKER HEDGING INSTRUMENTS

Bunker price is governed by the laws of supply and demand. Influential factors affecting the supply and demand of bunker engage themselves in the risk, especially the factors of oil price (supply) and freight rate (demand). Because of the risky nature oil price and freight rate, it then results in the highly volatile nature of bunker price as presented in Chapter 3. The application of financial hedging instruments in reducing risk arising from the fluctuation of price is not new in the commodity and financial markets. However, applying such financial instruments for hedging against bunker price has only developed recently in the shipping industry.

Around the mid–1980s, shipowners and ship operators, who are always confronted with much risk in the industry, realized that such successfully applied instruments like Futures, Options, Forward and Swaps contracts in the commodity and financial market could also be applied to reduce risk in the shipping industry. As a result, in 1988, the first bunker futures contract was launched at Singapore Futures Exchange. Eleven years later, in 1999, a similar contract was introduced at the London-based International Petroleum Exchange (Alizadeh & Nomikos, 2004, p. 282). However, because of the limited trading volume, both contracts failed to attract players and were then eventually withdrawn from the market. Bunker future contracts in Singapore Future Exchange stopped at the beginning of 1990s while the one in London IPE finished only 6 months after coming into operation (Alizadeh & Nomikos, 2004, p.295).

The reasons for such failures, discovered later on, were that it was because of the nature of bunker market where physical bunkers are taking place in different ports around the world while bunker futures contracts are for the delivery of bunker in specific locations. Consequently, futures price of bunker do not behave the same way as the physical bunker prices at different ports around the world. This, as a result, reduces the effectiveness of hedging through futures contracts (Alizadeh & Nomikos, 2004, p.282). Moreover, empirical evidence proved in the study of Alizaheh *et al* (2004) also supports this argument.

In the absence of an exchange-based futures contract for hedging bunker price, many researchers have put effort to search for the alternative cross-hedge instruments. A remarkable study undertaken by Alizaheh *et al* (2004) proved that the most "typically related commodity" that could serve a cross-hedge purpose for bunker is the energy (crude oil, gas oil and heating oil). Consequently, energy futures contracts could be the best alternative for bunker futures contract in hedging against bunker price. However, as presented in Chapter 2, such energy futures contract do not provide significant benefits in terms of hedging and risk reduction (Alizaheh *et al*, 2004, pp.350-352).

This chapter will introduce the possible hedging instruments that could be used to hedge against bunker price fluctuations. Some practical examples are also provided for easier understanding of the hedging function of such instruments.

4.1 Bunker hedging instruments

Without an exchange-based future contract, in order to reduce losses arising from the fluctuation of bunker price, shipowners, ship operators and other related parties could use a cross-hedge with an energy futures contract, a bunker forward contract, a bunker swaps agreement or a bunker options agreement to hedge against the bunker price fluctuations.

4.1.1 Hedging bunker price using a cross-hedge with energy futures contract

A future contract can be defined as a highly standardized instrument agreed between a contract seller and a contract buyer to delivery a certain quantity of the underlying asset at an agreed price and at a certain time in the future (Marshall, 1989, p. 6). All futures contract must be traded on an exchange-based market place with strict rules and regulations under the management of a clearing-house.

The size of a future contract is standardized by a number of units such as lots and each lot is equal to, for example, 1,000 tons of certain commodities. In a futures contract, a range of delivery dates is usually specified and the settlement is exercised on a daily-basis and is usually closed out prior to the contract maturity (Hull, 2006, p. 40). More characteristics of a future contract can be found in *Table 4.1*.

The reason to hedge against bunker price fluctuation using a cross-hedge with energy futures contract is that there is no exchange-based market for bunker futures trading. Moreover, *part 3.3* in chapter 3 concludes that there is a close correlation (0.968) between bunker price and crude oil price. As a result, theoretically we can use energy futures contract for a cross-hedge for bunker price. The function of a cross-hedge through energy futures contract as a hedging instrument for bunker price is complicated. However, to see how hedging bunker functioning through a cross-hedge with energy futures contract, we may consider the following simple example.

Suppose that on 15 June 2007, a shipowner fixes a contract to carry cargo from Houston to Rotterdam, the voyage will be carried out one month later (on 15 July 2007). The voyage will need about 6,000tons of IFO380 to be loaded at Houston on 15 July 2007. At present, there is energy futures contract (let's say Brent crude oil) traded at NYMEX with one lot = 1,000 barrels, standard contract is equal to one lot[10]. On 15 June, IFO380 price is \$360.5/ton[11], total bunker cost for 6,000tons is 6,000x360.5 = \$2,163,000. The shipowner is worried that the bunker price will increase on 15 July and he decides to hedge against such an increase by buying Brent crude futures contracts. Futures price of Brent crude on 15 June is \$70/barrel, thus the shipowner has to buy 2,163,000 / (1,000x\$70) = 31[12] future contracts.

[10] Standard contract of crude oil futures traded at NYMEX, retrieved from its website: http://www.nymex.com/intro.aspx.
[11] Quoted by Bunkerworld on its website: http://www.bunkerworld.com/markets/prices/
[12] 2,163,000 / (1,000x\$70) = 30.9, thus take the round number of 31 contracts.

As the shipowner expected, on 15 July the bunker price increases by $364/ton at Houston, thus on the spot market the shipowner has to load bunker to carry out the voyage and face a loss of 6,000 x ($364 -$360.5) = $21,000. However, on the future market, Brent crude increases by $74/barrel, thus the shipowner decides to sell 31 contracts and has a gain of 31x1,000 x ($74- $70) = $124,000. As a result, a portfolio of spot and futures market brings the shipowner a gain of $124,000 -$21,000 = $103,000 instead of a loss of $21,000 if he would have stayed unhedged.

However, if the bunker price decreases by $357/ton on 15 July instead of an increase as the shipowner expects, then on the spot market he has a saving of 6,000 x ($360.5 -$355) = $33,000. Meanwhile, on the futures market, Brent crude decreases by $68/barrel, thus the shipowner sells 31 contracts and faces a loss of 31x1,000x($70-$68) = $62,000. Consequently, a portfolio of spot and futures market results in a loss of only $62,000 -$33,000 = $29,000 instead of a saving of $33,000 if he had not hedge with the futures contract.

There may be other scenarios derived from the changes of bunker price and the changes of energy futures contract price thus resulting in the loss or gain of the shipowner. Such an amount of loss or gain then depends firstly on the forecast of bunker price (increase or decrease) and secondly on the rate of change between the bunker price and energy futures contract price.

However, Alizaheh *et al* found out that, for a cross-hedge with energy futures prices, the highest hedging effectiveness for hedging bunker price in Rotterdam falls in the IPE crude oil future with 43% effectiveness, followed by the NYMEX crude oil futures for hedging bunker in Singapore with 15.9% and finally a hedging effectiveness of 14% for bunker hedging in Houston using IPE gas oil futures (2004, pp. 1351-1352). In Chapter 5, with rather large observations, the author will investigate the hedging effectiveness and hedge ratio of a cross-hedge for bunker price at Singapore, Rotterdam and Houston using different energy futures prices including WTI crude oil futures and heating oil futures contracts.

4.1.2 Hedging with a bunker forward contract

In the absence of a future contract for hedging bunker and the low effectiveness of hedging bunker through a cross-hedge with energy futures contract as above-mentioned above, bunker risk management could also be carried out with a *tailor-made* over-the-counter (OTC) bunker agreement which was developed in the 1990s in an effort for the alternative of future contracts. Nowadays, many financial institutions and commodity trading houses such as Morgan Stanley Investment Bank, O.W. Bunker Malta bunker trader offer such OTC bunker derivative products. Forward Bunker contract is one of such OTC agreements (Alizadeh & Nomikos, 2004, p.282).

A Forward Bunker Agreement is defined as an OTC agreement between a bunker seller and a bunker buyer to exchange a specified quantity of bunker of certain quality, at an agreed price and at a certain place and time of delivery in the future (Kavussanos & Visvikis, 2006b, p. 291).

Hedging under the Forward Bunker contract, the whole gain or loss of the shipowner or ship operators from bunker price fluctuation could be realized at the end of the life (duration) of the contract. As a result, it allows the participants to "forward" the price before contract maturity (Alizadeh & Nomikos, 2004, p.282). *Table 4.1* provides the comparison between a Forward and a Futures contract.

Table 4.1 Comparison of Forward and Futures contracts

Forward contract	**Futures contract**
Private contract between two parties	Traded on an exchange-base
Contract is not standardized	Contract is standardized
One delivery date is specified	Allows a range of delivery date
Settled at the end of contract	Settled daily
Physical delivery or final cash settlement	Contract is usually closed out
Usually take place	Prior to maturity
Parties accept some credit risks	Virtually no credit risk

Source: Complied from Hull (2006, p. 41) and Kavussanos & Visvikis (2006b, p.291)

The function of the Forward Bunker contract as a hedging instrument can be explained in the following example. Suppose that, on 15 June 2007, a shipowner fixed a voyage charter to carry cargo from Singapore to Rotterdam, such a voyage will need 8,000 tons of IFO380 (to be loaded at Singapore) and will be carried out on 15 July 2007. On 15 June 2007, spot price of IFO380 at Singapore is USD 360.5/ton[13]. So if this price does not change until 15 July 2007, the voyage will cost him USD 8,000*360.5 = USD 2,884,000.

First scenario, the bunker price will increase and be higher than on 15 June 2007

When looking at the increasing bunker price trend provided by Bunkerworld on 15 June 2007 (see *Figure 4.1*), the owner expects that the bunker price will increase and will be higher than USD 360.5/ton on 15 July 2007.

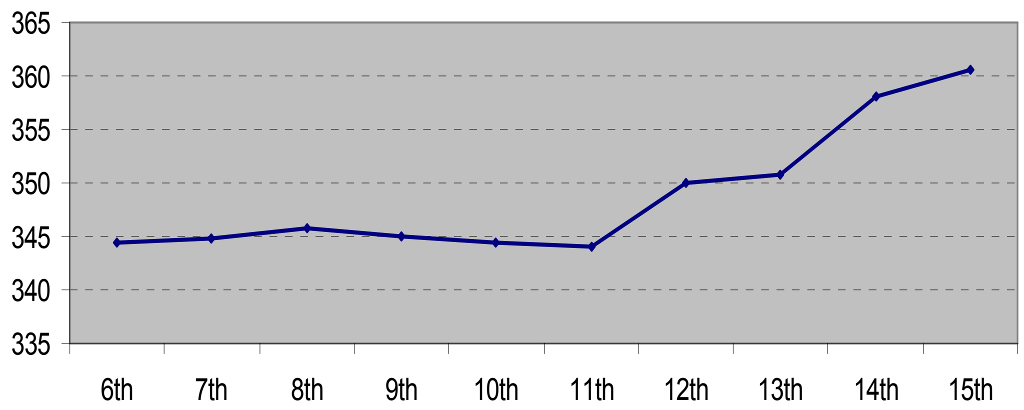

Figure 4.1 Bunker price from 6th to 15th of June 2007 (USD per ton)

Source: Retrieved 16 June 2007 from Bunkerworld on its website: http://www.bunkerworld.com/markets/prices/

In order to hedge himself against such a price increase, he decides to buy a Forward Bunker contract for such an amount of bunker to be delivered on 15 July 2007. The Forward bunker price is agreed at, for example, USD 365/ton at Singapore. By doing so, the owner has fixed the bunker cost for the voyage at USD 8,000*365 = USD 2,920,000.

[13] Quoted by Bunkerworld on its website: http://www.bunkerworld.com/markets/prices/

On 15 July 2007, suppose the owner decides on a final cash settlement with the forward contract provider and the bunker price is now at USD 368/ton at Singapore (higher than owner's expectation). To close the forward contract, on 15 July 2007, the owner sells his forward contract to the forward contract provider and gains USD 8,000*(368-365) = USD 24,000 (he could also require a physical delivery).

However, on 15 July 2007, to fulfill his voyage charter to carry cargo from Singapore to Rotterdam, the owner has to pay for the bunker cost at USD 8,000*368 = USD 2,944,000 instead of only USD 8,000*360.5 = USD 2,884,000 that he would have paid on 15 June 2007. So, on the spot market he lost USD 2,944,000 – USD 2,884,000 = USD 60,000. As a result, on both the spot and forward markets the owner only losses USD 60,000 – USD 24,000 = USD 36,000 (if he had not hedged himself by buying the forward contract, he will lose USD 60,000).

Second scenario, the bunker price will decrease and be lower than on 15 June 2007

If on 15 July 2007, the bunker price is only at USD 357/ton, because the forward contract price was at USD 365/ton, so to close the forward contract, the owner then sells his forward contract to the forward contract provider at the price of USD 357/ton and losses USD 8,000*(365-357) = USD 64,000.

However, on 15 July 2007, to fulfill his voyage charter to carry cargo from Singapore to Rotterdam, the owner only has to pay for the bunker cost USD 8,000*357 = USD 2,856,000 instead of only USD 8,000*360.5 = USD 2,884,000 that he would have paid on 15 June 2007. So, on the spot market he gains USD 2,884,000 – USD 2,856,000 = USD 28,000. As a result, on both the spot and forward markets the owner only losses USD 64,000 – USD 28,000 = USD 36,000 (if he had not bought the forward contract, he would have gained USD 28,000).

The conclusion from the two scenarios is that if the bunker price increase is higher than forward-agreed price, the gain in the forward contract (USD 24,000) will cover a part of the losses in the spot position (USD 60,000). If the bunker price decreases to a level lower than the spot price, the savings in the spot position will cover a part of the losses in the forward contract. Two possible outcomes of the owner in above example are summarized in *Table 4.2*.

Table 4.2 Two possible outcomes of owner's forward hedging bunker contract

On 15 June 2007

SPOT MARKET	**FORWARD MARKET**
Bunker price at Singapore: $ 360.5/ton Bunker cost = $8,000*360.5 = $ 2,884,000	Action: buys forward contract Bunker price agreed at: $365/ton Bunker cost = $8,000*365 = $ 2,920,000
First scenario: bunker price increase	**Second scenario**: bunker price decrease

On 15 July 2007 **(Spot market)**

Bunker price at Singapore: $ 368/ton Bunker cost = $ 8,000*368 = $ 2,944,000 Owner loses = $ 2,944,000 – $ 2,884,000 = $ 60,000	Bunker price at Singapore: $ 357/ton Bunker cost = $ 8,000*357 = $ 2,856,000 Owner gains = $ 2,884,000 – $ 2,856,000 = $ 28,000

On 15 July 2007 **(Forward market)**

Action: sells forward contract Bunker price at Singapore: $ 368/ton Agreed forward price: $ 365/ton Owner gains = $ 8,000*(368 – 365) = $ 24,000	Action: sells forward contract Bunker price at Singapore: $357/ton Forward price: $ 365/ton Owner loses = $ 8,000*(365 – 357) = $ 64,000

Portfolio of spot and forward positions

Net loss in portfolio of $ 36,000 instead of $ 60,000 loss	Net loss in portfolio of $ 36,000 instead of $ 28,000 gain

Source: Summarized by author from the example

From this example, it is understood that hedging by buying a forward contract can partly reduce the losses (or gains) associated with the bunker price fluctuation. With the trend of increasing bunker price as presented in Chapter 3, a forward contract then could help shipowners, ship operators or other related parties a great deal. In Chapter 5, direct-hedge using bunker forward contracts will be examined to know the hedging effectiveness as well as the hedge ratio of different bunker forward contracts.

4.1.3 Hedging with a bunker swaps agreement

Bunker swap is an OTC agreement between two bunker suppliers or bunker purchasers to exchange their cash flows arising from the fluctuation of future bunker prices by locking in an agreed fixed bunker price (Hull, 2006, p. 149 and Kavussanos & Visvikis, 2006b, p. 297). In this agreement, the parties agree the dates when the cash flows are to be paid as well as the way they use to calculate such cash flows. The calculation thus considers the future value of an interest rate, an exchange rate, or other market variables (Hull, 2006, p. 149).

A simple bunker swap (or plain vanilla) is an agreement in which a floating price for bunker (usually the market price) is exchanged for a fixed price for bunker (usually the price that is agreed to fix by the swap participants) over one or various specified periods and for a certain volume of bunker per period (Kavussanos & Visvikis, 2006b, p. 297). *Figure 4.2* gives a clearer explanation for a swap agreement.

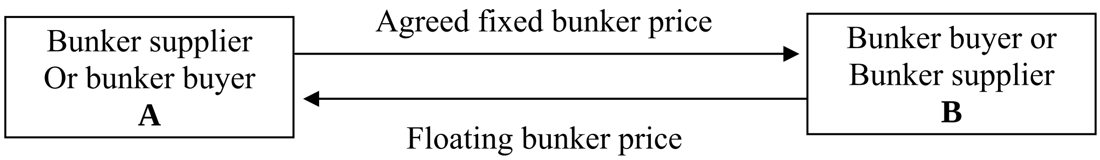

Figure 4.2 Swap transactions between bunker supplier/bunker buyer A and bunker buyer/bunker supplier B

Source: Compiled from Hull (2006, p.150) and Kavussanos & Visvikis (2006b, p. 297)

According to Hull, a bunker swap contract can be considered as a portfolio of bunker forward contracts or a bunker forward contract can be viewed as a simple example of a bunker swap. In the bunker forward contract, the exchange of cash flows is taken place just only on one future date while a bunker swaps could lead to cash flows exchange taking place on several future dates (2006, p. 149). *Table 4.3* gives a comparison between the characteristics of a forward contract and a swap contract.

Table 4.3 Comparison of Forward and Swap contracts

Forward contract	**Swap contract**
Single forward contract	Portfolio of forward contracts
One future delivery date is specified	Several future delivery dates
Settled at the end of contract	Settled by period
Physical delivery or final cash settlement	No physical delivery, only final cash
Parties accept some credit risks	High credit risk

Source: Complied from Hull (2006, p. 149) and Kavussanos & Visvikis (2006b, p. 297)

From the above explanation, it can be seen that the result of a swap bunker contract is the difference (in terms of cash) between the floating bunker price and the fixed (agreed) bunker price on the due dates. Consequently, the outcome of the hedging with such a swap bunker contract is the portfolio (combination) of the result of such a swap bunker contract and the result on the transactions of physical market.

To see how a bunker swap contract functions as a hedging instrument, consider the following example. Suppose in March 2007, an owner has fixed a COA[14] (Contract of Affreightment) to carry iron ore from Newcastle (one of the biggest Australia ports operating iron ore) to Kobe port (one of the big ports in Japan dealing with iron ore) at a fixed freight rate per ton agreed in COA. The contract is for 12 months, each shipment per month, from April 2007 to March 2008. To carry out one voyage from Newcastle to Kobe, the owner estimates that he needs approximately 1,000 tons[15] of bunker fuel/voyage to be loaded at Newcastle. Suppose that the spot bunker price in

[14] It is good to note that in a COA, as the freight rate is fixed at the time of signing contract, then the revenue of owner will be fixed. However, to carry out the contract, owner has to buy bunker at the floating (spot) price of the market at the time of the each voyage. Consequently, controlling bunker costs become very important for the owner to gain a profit in a COA.

[15] From my experience, on the Newcastle to Kobe iron ore trade, owners usually use small size like 70-80,000 tons ships. One voyage will take about 16-18 days and the ship consumes about 50-60 tons bunker/day. As a result, approximately the ship consumes about 1,000 tons bunker/voyage.

April 2007 at Newcastle is $350/MT[16]. Worried that the bunker price will increase in the next 12 months, he decides to hedge himself against such a price increase by entering into a swap contract with a Financial Institution or other Bunker Suppliers who provide such an OTC swap contract.

Because he estimates that each voyage will need about 1,000 MT of bunker, he decides to buy a swap contract with 12 lots (for 12 voyages) and each lot is 1,000 MT of bunker at the end of each month. The swap price is agreed at $360/MT[17] against the floating bunker prices prevailing at the last business day of each month in Newcastle between the owner and the swap provider.

At the end of March 2008, it appears that from April 2007 to March 2008, the spot bunker price behaved like in column (3) of *Table 4.4* and *Figure 4.3*.

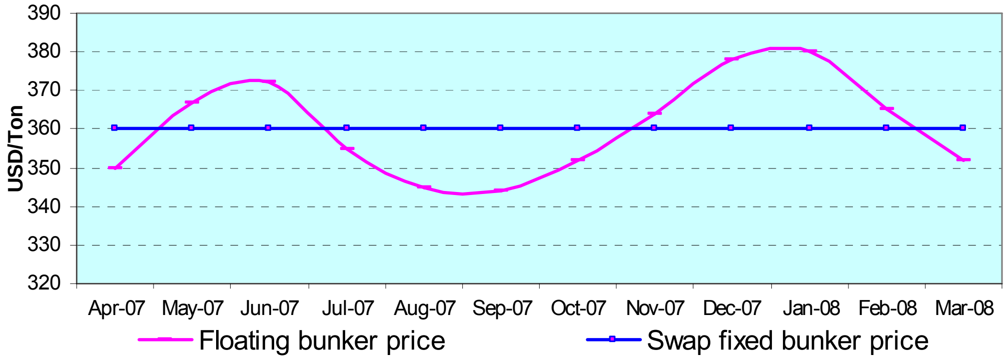

Figure 4.3 Floating bunker prices versus swap fixed bunker prices

Source: Data is supposed by author for the purpose of explaining the function of swap contract

As a result, the settlement of the swap contract is like that: for such floating (spot) bunker prices which are higher than $360/MT (swap fixed bunker price), the swap provider has to pay the difference between floating price and the swap price to the owner. Contrarily, for such floating (spot) bunker prices which are lower than $360/MT, the owner has to pay the difference to the swap provider.

[16] This is the real bunker price in April, 2007. See *Appendix*
[17] This is supposed by the author for the purpose of explaining the increasing of bunker price.

The calculation in *Table 4.4* clearly explains the settlement of the owner in this example. In *Table 4.4*, column (1) is the real amount of bunker needed for each voyage, column (2) is the swap contract size (lot). Column (7) is the final result of swap settlement for each lot. The total of column (7) is the gain (loss) of the owner after settling the swap contract ($4,000). However, on the physical market, the owner has to pay an amount of $4,350,140 for total bunker cost (total of column (1) x column (3) in *Table 4.4*).

Table 4.4 Bunker swap transactions for a 12-month COA from owner's side

Shipment	Bunker needed	Swapsize Contract	Spot price	Bunker costs	Swap price	Swap costs	Settlement
	(MT)	(MT)	($/MT)	(US$)	($/MT)	(US$)	
	(1)	**(2)**	**(3)**	**(4)=(2)*(3)**	**(5)**	**(6)=(2)*(5)**	**(7)=(4)-(6)**
Apr-07	980	1,000	350	350,000	360	360,000	-10,000
May-07	1,100	1,000	367	367,000	360	360,000	+7,000
Jun-07	950	1,000	372	372,000	360	360,000	+12,000
Jul-07	960	1,000	355	355,000	360	360,000	-5,000
Aug-07	1,000	1,000	345	345,000	360	360,000	-15,000
Sep-07	980	1,000	344	344,000	360	360,000	-16,000
Oct-07	985	1,000	352	352,000	360	360,000	-8,000
Nov-07	1,050	1,000	364	364,000	360	360,000	+4,000
Dec-07	1,020	1,000	378	378,000	360	360,000	+18,000
Jan-08	965	1,000	380	380,000	360	360,000	+20,000
Feb-08	1,060	1,000	365	365,000	360	360,000	+5,000
Mar-08	1,020	1,000	352	352,000	360	360,000	-8,000
Total	**12,070**	**12,000**		**4,324,000**		**4,320,000**	**+4,000**

Source: Data is supposed and calculated by the author for the purpose of explaining the swap contract.

As a result, with a portfolio of spot and swap positions, the owner only has to pay $4,346,140 instead of $4,350,140, the amount that he would had to pay for his total bunker cost for 12 voyages if he had not bought the swap contract. However, if the spot bunker behaved in another ways (not same in *Figure 4.3*), the owner may make a loss from the swap contract.

4.1.4 Hedging with a bunker options agreement

Basically, there are two kinds of option. A *call option* gives the holder the right to buy (or not to buy) an asset by a specific date at an agreed price. A *put option* gives the holder the right to sell (or not to sell) an asset by a specific date at an agreed price. The specific date in an option is the *expiration date* or *maturity date*. The agreed price is the *exercise price* or a *strike price* (Hull, 2006, p. 181). Consequently, a bunker option contract gives the holder the right to buy (or not to buy) or the right to sell (or not to sell) a certain amount of bunker, by a specific date and at a strike price (Kavussanos & Visvikis, 2006b, p. 299).

An option can be traded either on an exchange-based market or on over-the-counter market. However, according to Kavussanos & Visvikis, there is still no exchange-based market for trading bunker except over-the-counter market. As a result, for those who want to hedge their bunker with an option contract on the exchange-based market, have to search for an alternative through a cross-hedging with the energy options (2006b, p. 300).

Options have two styles: the *American option* –the option that can be exercised at any time up to the maturity date and the *European option* –the option that can only be exercised on the maturity date (Hull, 2006, p. 181). Option contracts are usually settled in cash terms and the contract holder has to pay an amount of money (or premium) to buy the option (Kavussanos & Visvikis, 2006b, p. 300).

The function of hedging against the bunker price fluctuation with an option contract can be explained as: when the shipowners or ship operators expect that the bunker price will increase in the coming time, they then go for a *call option* contract to buy a certain amount of bunker, by a certain maturity date in future and at a certain price (and he pays a certain amount of money as premium, usually 3-4% of the contract value). When the maturity date comes, if the spot bunker price is higher than the strike price, he then exercises the call option (the right to buy) and gains the difference between spot price and strike price. In contrast, if the spot price appears to be lower than the strike price, he can ignore the option and loses the premium.

To see how an option functions as a hedging instrument, consider the following example. Suppose that, on 15 September, 2007, an owner fixes a voyage charter with a charterer to carry cargo from the US Gulf (Houston) to Rotterdam, such voyage needs 4,000 tons of bunker fuel and will be carried out on 15 November, 2007. Suppose that, on 15 Sep, 2007, the spot bunker price is $344/ton. Expecting that such a bunker price will increase on 15 Nov, 2007, to hedge for such an increase, the owner then buys an option contract for 4,000 tons of bunker, at the strike price of $350/ton and will expire on 15 Nov, 2007. The option contract costs him $2/ton (total premium = $2*4,000 = $8,000).

On 15 Nov, 2007, suppose that the spot bunker price increases to $354/ton. So this spot price is higher than the strike price. The owner then exercises the option contract to buy 4,000 tons of bunker at the strike price ($350/ton) and gets the payoff of $4,000*(354-350) –$8,000 (premium) = $8,000 from the option contract provider. However, on the spot market, he has to buy 4,000 tons of bunker to exercise the intended voyage at the spot price of $354/ton and faces a loss of $4,000*(354-344) = $40,000. A portfolio of spot and option only results in a loss of $40,000 –$8,000 =$32,000 instead of the whole $40,000 if he had not used the option.

In the opposite scenario, instead of increasing to $354/ton the spot bunker price decreases to $340/ton. Thus, on the spot market, the owner gains (savings) an amount of $4,000*(344-340) =$16,000. On the option market, because the spot price is lower than the strike price, the owner then does not exercise the option contract and losses the premium of $8,000. As a result, a portfolio of spot and option brings a saving of $16,000 –$8,000 =$8,000 in total bunker cost for the owner.

To sum up, it is understood from the above explanations that hedging bunker price fluctuations with an option contract could result in a saving in the total bunker cost for shipowners. The amount of saving then depends on the negotiation of strike price and on the situation of the bunker market, of course. There are some other kinds of hybrid options such as Collars (zero-cost Collars, Range Forward or Tunnels, Participating Collars) or Swaptions. However, due to their complicated nature and the word limit of this dissertation, they are not mentioned in this dissertation.

4.2 Chapter conclusion

To conclude this chapter, it is understood that different hedging instruments result in different hedging effectiveness. The gain or loss of the shipowner relative to bunker costs then depends firstly on the situation of demand and supply of bunker market reflected in bunker price fluctuation, secondly on the accuracy of the shipowner's forecast on bunker price, then results in the importance of the bunker price forecast problem.

To test the effectiveness of hedging instruments, based on the available data range obtained from IMAREX and NYMEX, chapter 5 will investigate the hedging effectiveness of a *direct-hedge* using different forward bunker contracts traded at IMAREX and a *cross-hedge* using different energy futures contracts of WTI crude oil and heating oil traded at NYMEX.

CHAPTER 5 INVESTIGATING THE EFFECTIVENESS OF HEDGING AGAINST BUNKER PRICE FLUCTUATION

5.1 Analysis of methodologies for estimating the hedge ratio and hedging effectiveness

Theoretically, there are many methods to estimate the hedge ratio. Typically, Johnson (1960, p. 140) states that if we denote S_1 and F_1 the spot price and future price at time t_1, and S_2 and F_2 the spot and future price at time t_2, then when price changes from time t_1 to t_2 the gain (loss) of hedger will be $[(S_2 - S_1) - (F_2 - F_1)]$. The hedge is perfectly effective only if $[(S_2 - S_1) - (F_2 - F_1)]$ is equal to zero.

Ederington (1979) and Ferguson & Leistikow (1998) use an OLS (Ordinary Least Squares) linear regression to regress the futures price changes on the spot price changes to obtain the hedging effectiveness. The linear regression equation is:

$$S_{t+1} - S_t = \alpha + \beta * (F_{t+1} - F_t) + \varepsilon \quad (5.1)$$

where S_t and F_t denote spot and future price at time $_t$; S_{t+1} and F_{t+1} denote spot and futures price at time $_{t+1}$, α denotes a constant term (a residual or the intercept), β denotes the slope of coefficient or the minimum hedge ratio and ε is an allowance for error. Yang & Allen (2004) estimate the hedge ratio of the Australian futures markets by using a bivariate Vector Autoregression (VAR) model where the spot and futures prices are modeled under the bivariate VAR equations:

$$\Delta S_t = \alpha_s + \sum_{i=1}^{k} \beta_{si} \Delta F_{t-i} + \sum_{i=1}^{k} \theta_{si} \Delta F_{t-i} + \varepsilon_{st} \quad (5.2)$$

$$\Delta \mathrm{F}_t = \alpha_f + \sum_{i=1}^{k} \beta_{fi} \Delta \mathrm{S}_{t-i} + \sum_{i=1}^{k} \theta_{fi} \Delta F_{t-i} + \varepsilon_{ft} \quad (5.3)$$

In equations (5.3) and (5.4), ΔS_t and ΔF_t represent the changes in the logarithm of spot and futures prices. α_s and α_f denote the constant term (a residual or intercept); β_s , β_f , θ_s and θ_f are the parameters; ε_{st} and ε_{ft} are the independently distributed random vectors. If ∂_{ss} and ∂_{ff} denote vector autoregression of spot and futures prices, then ∂_{ss} = Var(ε_{st}), ∂_{ff} = Var(ε_{ft}) and Cov(ε_{st}, ε_{ft}) = ∂_{sf}, the minimum variance hedge ratio h^* (risk minimizing hedge ratio) can be obtained by the equation $h^* = \frac{\partial_{sf}}{\partial_{ff}}$ (5.4)

Kavussanos & Nomikos (2000b) use a VECM model in the ARCH family introduced by Engle (1982) to investigate the hedge effectiveness of the BIFFEX contracts where the spot and future price are presented by the vector $X_t = (S_t\ F_t)'$.

$$\Delta X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t;\ \varepsilon_t = \begin{pmatrix} \varepsilon_{S,t} \\ \varepsilon_{F,t} \end{pmatrix} \Bigg| \Omega_{t-1} \sim IN(0,\ H_t) \tag{5.5}$$

$$H_t = \begin{pmatrix} h_{SS,t} & h_{SF,t} \\ h_{SF,t} & h_{FF,t} \end{pmatrix} = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \tag{5.6}$$

In equations (5.5) and (5.6), Γi and Π are 2 x 2 coefficient matrices measuring the short run and long-run adjustment of the system to changes in X_t and ε_t is the vector of the residuals $(\varepsilon_{S,t}\ \varepsilon_{F,t})'$, Ht is the time-varying covariance matrix, C is a 2 x 2 lower triangular matrix and A and B are 2 x 2 diagonal coefficient matrices.

However, the models of the ARCH family especially the VAR and VECM model are complicated and require a deep knowledge of not only the mathematics but also the time-series structure of data. As a result, in this dissertation the author only deploys the OLS regression model to estimate the hedge ratio and hedging effectiveness of hedging against bunker price fluctuations by testing (1): a **direct-hedge** with bunker forward prices traded at IMAREX and (2): a **cross-hedge** with WTI crude oil futures prices (contract 1, 2, 3 and 4) and Heating oil futures prices (contract 1, 2, 3 and 4) traded at NYMEX.

5.2 Analyzing the using of the OLS regression model

The linear regression equation (5.1) estimates the constant term α (a residual or an intercept) and the slope of coefficient β (hedge ratio). It also generates certain statistics associated with the regression including *t-statistics* and the *R*-squared.

Equation (5.1) can be reduced as $\Delta S_t = \alpha + \beta * \Delta F_t + \varepsilon;\ \varepsilon \sim (0, \sigma^2)$ (5.7)

Where $\Delta S_t = (S_{t+1} - S_t)$ and $\Delta F_t = (F_{t+1} - F_t)$ represent the changes in the logarithms[18] of spot and futures prices respectively. *T-statistics* measures the significance of the estimated parameters including the constant term α and the slope β, in other words, it measures the degree of confidence in the accuracy of α and β. The slope β is expected to be equal to or as close to 1 as possible and *t-statistics* of β is expected to be statistically significant (*t-statistics*> 2) while the of the constant term α is expected not to be significant (or *t-statistics* < 2).

R-squared (often written R^2) is the coefficient of determination between ΔS_t and ΔF_t and the R^2 value measures the effectiveness of the hedge performance. The higher the R^2 the greater the hedge effectiveness is.

5.3 Investigating hedging bunker effectiveness using the OLS regression model

5.3.1 Using a direct-hedge with bunker forward contracts traded at IMAREX

Established in 2000 with the objective of becoming the largest international marketplace for shipping derivatives, IMAREX (International Maritime Exchange) has become the first authorized and regulated marketplace for trading and clearing such derivatives in the world (IMAREX, 2007c). IMAREX went public on April 4, 2005 when it was listed on the Oslo Stock Exchange. Launching the bunker fuel oil derivatives since December 5, 2005, IMAREX is now the only global market place offering electronic trading of bunker fuel oil derivatives with straight-through clearing (IMAREX, 2007a).

[18] The reason to transform the data series into logarithms is to have the exponential trend in time-series become linear after transformation and, to some extent, stabilise the non-stationary variables.

IMAREX provides the bunker fuel contracts for all of its trading and clearing members. The main bunker futures contracts are Rotterdam 3.5% sulphur barges FOB; Northwestern Europe (NWE) 1.0% sulphur barges FOB; Singapore IFO180cst FOB; Singapore IFO380cst FOB; and Fujairah IFO380cst FOB. The prices are quoted for at USD per metric ton and for contract durations of 1 month, 6 months, 12 months, 6 quarters and 2 calendar years. The standardized contract is decided by 'lot', one lot = 1,000MT, the minimum contract is 0.1 lot, maximum contract is 999 lots (990,000MT) (IMAREX, 2007a). After nearly 1.5 years of trading, bunker futures trading including the bunker forward and bunker swap at IMAREX has developed very fast both in volume and value (*Appendix G*).

5.3.1.1 Data collection

Bunker spot prices at the three main markets Singapore, Rotterdam and Houston are obtained on a daily basis from IMAREX, Singapore office. Bunker at Singapore and Houston is IFO380cst, bunker at Rotterdam is FO3.5% sulphur and reported in US dollar per metric ton. The data range of Singapore and Houston is from 5 December 2005[19] to 16 July 2007 (399 observations); for Rotterdam is from 24 January 2006 to 16 July 2007 (374 observations).

For the forward prices, bunker 1-month forward and 12-month forward prices for Singapore are IFO380cst and are obtained on a daily basis and also at the same period of spot prices (399 observations). Forward prices at Rotterdam are for FO3.5% sulphur and also reported on for the same period as spot prices (374 observations).

It can be seen from *Table 5.1* that bunker spot prices have stronger correlation with the forward price at the same market and the shorter the forward period the closer the correlation is. For example, the spot price at Singapore has a stronger correlation with forward prices (1-month & 12-month) at Singapore than with forward prices at Rotterdam (0.98842 & 0.84664 versus 0.73587 & 0.75292).

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[19] IMAREX started to provide the fuel derivatives contracts on 05 December, 2005

Table 5.1 Correlations on Logarithms of bunker spot and forward prices in different markets

	SinSpot	SinFwd1	SinFwd12	RotSpot	RotFwd1	RotFwd12	HouSpot
SinSpot	1.00000						
SinFwd1	0.98842	1.00000					
SinFwd12	0.84664	0.87730	1.00000				
RotSpot	0.72231	0.67955	0.48820	1.00000			
RotFwd1	0.73587	0.69373	0.50906	0.99459	1.00000		
RotFwd12	0.75292	0.70678	0.55005	0.92129	0.91767	1.00000	
HouSpot	0.88917	0.91461	0.85407	0.56672	0.58689	0.59798	1.00000

Notes: - Sample for Singapore & Houston market is from 05/12/2005 to 16/07/2007 (399 observations); for Rotterdam is from 24/01/2006 to 16/07/2007 (374 observations).
- SinSpot, RotSpot and HouSpot present Singapore, Rotterdam and Houston spot price respectively. SinFwd1 and RotFwd1 represent Singapore and Rotterdam 1-month forward price. SinFwd12 and RotFwd12 represent Singapore and Rotterdam 12-month forward price.

At Singapore, the spot price has a stronger correlation with the 1-month forward price (0.98842) than with the 12-month forward price (0.84664). The reason for such a phenomenon is that when forward contracts approach delivery time, the forward prices converge toward the spot prices (Marshall, 1989, p. 194). This phenomenon also suggests that the shorter forward-period is better for hedging against the spot price than the longer forward-period contract. Moreover, spot prices at Houston tend to correlate closely to Singapore forward prices compared to Rotterdam forward prices (0.91461 & 0.85407 versus 0.58689 & 0.59798). In other words, market participants at Houston, in some extent, should use forward contracts at Singapore to hedge against their spot price rather than forward contracts at Rotterdam.

5.3.1.2 Estimating the hedge ratio and hedging effectiveness

For proper application of OLS regression model, Jarque and Bera (1980) tests for normal distribution of spot and forward prices and Philips & Perron (1988) tests for the stationarity of the spot and forward bunker prices series are deployed to test the fitness of the data ranges with OLS regression operations. Moreover, mean and standard deviation methods are also applied to know the fluctuation of the bunker spot and forward prices.

5.3.1.2.1. Test of stationarity (Unit root test)

The results of Jarque and Bera (J-B) tests and Philips & Perron (PP) tests are presented in *Table 5.2* from which J-B tests in *column 4* indicate that spot and forward prices of bunker at three markets are normally distributed.

Table 5.2 Descriptive statistics of Logarithmic returns of spot and forward bunker prices

	N	Mean	Std.Dev.	J-B	PP(4) levels	PP(4) 1st Diffs
	(1)	(2)	(3)	(4)	(5)	(6)
Singapore						
Spot price	399	5.730120	0.099985	22.46205	-0.968789	-19.69838
1-month forward	399	5.730378	0.098054	22.64121	-1.154445	-19.86503
12-month forward	399	5.803744	0.086199	30.68033	-1.590480	-20.52512
1-month basis[20]	398	0.000258	0.015193	65.12392	-5.593383	-
12-month basis	398	0.073624	0.053231	5.117985	-1.850358	-23.42175
Rotterdam						
Spot price	374	5.654124	0.111577	16.70201	-0.979190	-20.38821
1-month forward	374	5.657683	0.106373	16.43918	-0.804041	-21.00818
12-month forward	374	5.748377	0.083992	78.29686	-1.610518	-18.02928
1-month basis	373	0.003559	0.012468	258.1117	-7.022324	-
12-month basis	373	0.094253	0.047288	25.46025	-1.696076	-32.13108
Houston						
spot price	399	5.705191	0.103961	22.60862	-1.552546	-18.35393

Notes: - Sample for Singapore and Houston markets are from 5/12/2005 to 16/07/2007; for Rotterdam is from 24/01/2006 to 16/07/2007.
- J-B is the Jarque -Bera (1980) test for normality, the statistic is $X^2(2)$ distributed.
- N is the number of observation. N for 1-month and 12-month basis is after adjusted.
- PP is the Phillips & Perron (1988) unit root test; **test critical value** of 1% level is -3.43734, 5% level is -2.86451 and 10% level is -2.56841; the truncation lag for the test is set to 4; 1st Diffs is the PP test of first difference.

Moreover, standard deviations in *column 3* imply that spot prices seem to be more volatile than forward prices and the nearer the forward period, the more it fluctuates. For instance, the 1-month forward price is more volatile than the 12-month forward (0.099985 versus 0.098054 at Singapore and 0.106373 versus 0.083992 at Rotterdam market). Results of Philips & Perron tests indicate that both spot and forward bunker prices are non-stationary I*(1)* in levels (1%, 5% and 10% levels -*column 5*).

[20] Basis = forward price – spot price

However, their 1st difference tests in *column 6* indicate that both spot and forward bunker prices are stationary I*(0)* in the 1st difference. This result suggests that OLS regression estimation should then be carried out on the 1st difference.

5.3.1.2.2. Estimate the hedge ratio and hedging effectiveness

The author tries to estimate the hedge ratio (β), the hedging effectiveness (R^2) as well as the constant term α and standard error *ε* by using the OLS regression model to regress the changes on the logarithm of spot bunker prices at Singapore, Rotterdam and Houston and the changes on the logarithm of different bunker forward prices.

If we define the 1st difference of logarithms of Singapore spot price as $\Delta_{SinSpot}$, Rotterdam spot price as $\Delta_{RotSpot}$, and Houston spot price as $\Delta_{HouSpot}$, we have:

$\Delta_{SinSpot}$ = LogSinSpot(+1) – LogSinSpot(0)

$\Delta_{RotSpot}$ = LogRotSpot(+1) – LogRotSpot(0)

$\Delta_{HouSpot}$ = LogHouSpot(+1) – LogHouSpot(0)

And the 1st difference of logarithms of Singapore 1-month and 12-month forward prices as $\Delta_{SinFwd1}$ and $\Delta_{SinFwd12}$, Rotterdam 1-month forward and 12-month forward prices as $\Delta_{RotFwd1}$ and $\Delta_{RotFwd12}$, we have:

$\Delta_{SinFwd1}$ = LogSinFwd1(+1) – LogSinFwd1(0)

$\Delta_{SinFwd12}$ = LogSinFwd12(+1) – LogSinFwd12(0)

$\Delta_{RotFwd1}$ = LogRotFwd1(+1) – LogRotFwd1(0)

$\Delta_{RotFwd12}$ = LogRotFwd12(+1) – LogRotFwd12(0)

Consequently, at Singapore market, we try to estimate if the change in bunker spot price can be explained by the change in forward prices by regressing the equation:

$$\Delta_{SinSpot} = \alpha + \beta * \Delta_{SinFwd1} + \varepsilon \qquad (5.8)$$

$$\Delta_{SinSpot} = \alpha + \beta * \Delta_{SinFwd12} + \varepsilon \qquad (5.9)$$

At Rotterdam, the equations are:

$\Delta_{RotSpot} = \alpha + \beta^*\Delta_{RotFwd1} + \varepsilon$ (5.10)

$\Delta_{RotSpot} = \alpha + \beta^*\Delta_{RotFwd12} + \varepsilon$ (5.11)

At Houston, because the forward prices are not available, we try to estimate if change in spot price can be explained by changes in forward price at Singapore and Rotterdam. Consequently, regression equations at Houston are:

$\Delta_{HouSpot} = \alpha + \beta^*\Delta_{SinFwd1} + \varepsilon$ (5.12)

$\Delta_{HouSpot} = \alpha + \beta^*\Delta_{SinFwd12} + \varepsilon$ (5.13)

$\Delta_{HouSpot} = \alpha + \beta^*\Delta_{RotFwd1} + \varepsilon$ (5.14)

$\Delta_{HouSpot} = \alpha + \beta^*\Delta_{RotFwd12} + \varepsilon$ (5.15)

Moreover, as mentioned above, we expect that the *t-statistics* of constant term α is not significant (*t-statistics* < 2) and *t-statistics* of the slope β is significant (*t-statistics* > 2). Furthermore, the selection of the best hedge is when β equals or is close to 1. The results of regressing equations from (5.8) to (5.15) are presented in *Table 5.3*.

Table 5.3 OLS estimations for spot bunker prices against different forward bunker prices at Singapore, Rotterdam and Houston

	N	α (*t-statistics*)	β (*t-statistics*)	R^2	ε
Singapore spot price					
SinFwd1	398	0.000171 (*0.335*)	0.786798 (*23.219*)	0.576546	0.033885
SinFwd12	398	0.000323 (*0.509*)	0.689305 (14.548)	0.348324	0.047379
Rotterdam spot price					
RotFwd1	373	8.300000 (*0.156*)	0.913615 (*28.821*)	0.691260	0.031699
RotFwd12	373	0.000198 (*0.267*)	0.899641 (*15.419*)	0.390553	0.058346
Houston spot price					
SinFwd1	398	0.000781 (*1.093*)	0.0494370 (*1.042*)	0.002736	0.047428
SinFwd12	398	0.000736 (*1.041*)	0.1612100 (*3.046*)	0.022903	0.052914
RotFwd1	373	0.000768 (*1.020*)	0.0079430 (*0.176*)	0.000084	0.045088
RotFwd12	373	0.000785 (*1.043*)	-0.038579 (*-0.653*)	0.001150	0.059036

Notes: - Sample for Singapore & Houston market is from 12/01/2005 to 16/07/2007; for Rotterdam is from 24/01/2006 to 16/07/2007.
- SinSpot, RotSpot and HouSpot present Singapore, Rotterdam and Houston spot price respectively. SinFwd1 and RotFwd1 represent Singapore and Rotterdam 1-month forward price. SinFwd12 and RotFwd12 represent Singapore and Rotterdam 12-month forward price.
- N is the adjusted number of observations.

It can be seen from *Table 5.3* that the *t-statistics* satisfies both conditions: the in-significance of constant term α and the significance of the hedge ratio β for the Singapore and Rotterdam markets. For the Houston market, *t-statistics* results are not significant for hedge ratio β except for the hedge with the 12-month forward contract traded at Singapore (*t-statistics* = 3.046). With the acceptable standard errors, the results once again confirm that the shorter the forward period, the higher the hedging effectiveness is. *Table 5.3* suggests that bunker 1-month forward contracts at Rotterdam provide the highest hedge ratio (0.913615) and the highest hedging effectiveness (R^2 = 0.691260 or 83.14%) for Rotterdam spot price compared with a hedge ratio of 0.899641 and a hedging effectiveness of 62.49% (0.390553) given by the 12-month forward contracts.

On the Singapore market, 1-month forward contracts result in a hedge ratio of 0.786798 and a hedging effectiveness of 75.93% (0.576546) for the Singapore spot price while 12-month forward contracts only provide a hedge ratio of 0.689305 and a hedging effectiveness of 59.01% (0.348324). On the Houston market, without the data of forward contracts, we try to use forward contracts at Singapore and Rotterdam to hedge against spot price at Houston. However, the results coming out in *Table 5.3* are not so good. Only 12-month forward contracts at Singapore could satisfy the significance of *t-statistics* (3.046) but the hedge ratio of 0.1612100 and hedging effectiveness of 15.13% (0.022903) are said to be not sufficient for a direct-hedge.

The implication for shipowners and ship operators is that they can use bunker forward contracts to hedge against bunker spot price fluctuations. The hedging effectiveness is different from market to market and for different forward-periods. In Singapore, 1-month forward contracts provide 75.93% hedging effectiveness while 12-month contracts result in 59.01%. The results are somewhat better in Rotterdam with 83.14% effectiveness of 1-month forward contracts and 62.49% for 12-month contracts. Moreover, it is not suggested to use forward contracts on one market to hedge against the spot price on the other market.

5.3.2 Using a cross-hedge with WTI crude oil and heating oil futures contracts traded at NYMEX

The New York Mercantile Exchange is the world's largest physical commodity futures exchange and was established for more than 130 years ago. Trading is conducted through two divisions: the NYMEX Division and the COMEX Division. Energy futures are traded on the NYMEX Division. The standard contract is of 1,000 barrels. Crude oil spot and futures are quoted in US dollars per barrel while heating is quoted in US dollar per gallon. Trading is open for every member from Monday to Friday.

Futures contracts for WTI crude and heating oil include four kinds: Contract 1, Contract 2, Contract 3 and Contract 4. For heating oil, Contract 1 expires on the last business day of the month preceding the delivery month. Thus, the delivery month for Contract 1 is the calendar month following the trade date. For crude oil, Contract 1 expires on the third business day prior to the 25th calendar day of the month preceding the delivery month. If the 25th calendar day of the month is a non-business day, trading ceases on the third business day prior to the business day preceding the 25th calendar day. Contracts 2, 3 and 4 represent the successive delivery months following Contract 1 (EIA, 2007b).

5.3.2.1 Data collection

Weekly bunker spot prices for Singapore, Rotterdam and Houston are collected from various issues of Fairplay Weekly published on Monday from 01/01/1990 to 28/05/2007 (909 observations) [21]. Spot and futures energy prices traded at NYMEX including WTI crude oil and heating oil (Contracts 1, 2, 3 and 4) are obtained on a weekly-base from the website of the Energy Information Administration of the US Government. Futures prices are the closing prices on Friday of each week. The data range of WTI crude price is from 05/01/1990 to 01/06/2007 (909 observations). The data range of heating oil Contracts 1 and 3 are for the same period while futures Contract 2 are from 04/02/1994 to 01/06/2007 (696 observations) and futures Contract 4 are from 14/01/1994 to 01/06/2007 (699 observations) (EIA, 2007a).

[21] See **Appendix B**

Table 5.4 Correlation matrix of Logarithmic changes in spot bunker prices in three markets and crude and heating futures prices

	SinSpot	RotSpot	HouSpot	WTISpot	WTIF1	WTIF2	WTIF3	WTIF4	HeatSpot	HeatF1	HeatF2	HeatF3	HeatF4
SinSpot	1.00000												
RotSpot	0.98132	1.00000											
HouSpot	0.97832	0.98314	1.00000										
WTISpot	0.94549	0.94436	0.94601	1.00000									
WTIF1	0.94482	0.94400	0.94548	0.99982	1.00000								
WTIF2	0.94097	0.94118	0.94335	0.99828	0.99876	1.00000							
WTIF3	0.93626	0.93720	0.93992	0.99562	0.99629	0.99928	1.00000						
WTIF4	0.93143	0.93303	0.93614	0.99250	0.99331	0.99763	0.99951	1.00000					
HeatSpot	0.92683	0.92570	0.92540	0.98627	0.98627	0.98500	0.98282	0.98029	1.00000				
HeatF1	0.92960	0.92892	0.92950	0.99108	0.99126	0.99154	0.99040	0.98860	0.99664	1.00000			
HeatF2	0.95689	0.96003	0.96302	0.99252	0.99276	0.99450	0.99466	0.99403	0.99237	0.99848	1.00000		
HeatF3	0.92052	0.92299	0.92476	0.98798	0.98863	0.99234	0.99386	0.99416	0.98476	0.99411	0.99882	1.00000	
HeatF4	0.95197	0.95661	0.95987	0.98832	0.98883	0.99293	0.99509	0.99614	0.98234	0.99104	0.99610	0.99901	1.00000

Notes: **Notes:** - Sample for spot bunker price at Singapore, Rotterdam and Houston market is from 01/01/1990 to 28/05/2007 (909 observations); for WTI crude oil spot and futures prices are from 05/01/1990 to 01/06/2007 (909 observations); for Heating oil spot and futures contract 1 and 3 are from 05/01/1990 to 01/06/2007 (909 observations); for Heating oil futures contract 2 are from 04/02/1994 to 01/06/2007 (696 observations) and futures contract 4 are from 14/01/1994 to 01/06/2007 (699 observations).

- SinSpot, RotSpot and HouSpot present Singapore, Rotterdam and Houston spot bunker price respectively. WTISpot and HeatSpot represent WTI crude oil and Heating oil spot price respectively. WTIF1, WTIF2, WTIF3 and WTIF4 represent WTI crude oil futures contract 1, 2, 3 and 4. HeatF1, HeatF2, HeatF3 and HeatF4 represent the Heating oil futures contract 1, 2, 3 and 4 respectively.

It is understood from *Table 5.4* that all energy futures prices are strongly correlated with bunker spot prices on three markets. Typically, returns on bunker spot prices are more correlated to WTI crude Contracts than heating oil contracts. Correlations are especially high between Rotterdam and Singapore bunker spot prices and WTI crude contracts. As a result, this may suggest that WTI crude contracts are better for hedging against bunker spot prices fluctuation than heating oil contracts.

5.3.2.2 Estimate the hedge ratio and hedging effectiveness

Jarque & Bera (1980) test for normal distribution of bunker spot and energy futures prices and Philips & Perron (1988) test for the stationarity of the bunker spot and futures energy prices series are deployed to test the fitness of the data ranges with OLS regression operation. Moreover, mean and standard deviation methods are also applied to know the fluctuation of the bunker spot and energy futures prices.

5.3.2.2.1. Test of stationariry (Unit root test)

Results of different tests presented in *Table 5.5* suggest that bunker spot prices and all other energy futures prices are significant with the Jarque & Bera tests, thus they are normally distributed. Moreover, *mean* of futures price implies that there is not so much difference in price level among Contracts 1, 2, 3 and 4 (*mean* is of 3.2495, 3.2467, 3.2426 and 3.2379 for WTI futures Contracts 1, 2, 3 and 4 respectively and 4.2643, 4.3221, 4.2669 and 4.3179 for heating oil futures Contracts 1, 2, 3 and 4 respectively). However, *standard deviations* suggest that bunker spot prices and all energy futures prices behave almost in the same way (standard deviation of around 0.44) except for WTI futures Contracts 2, 3, 4 and heating oil futures Contracts 2, 4 which prove a little higher fluctuation. This is because, in the short-run bunker spot price and energy prices subject to the change in local supply and demand. However, in the long-run both bunker and energy prices are driven by the same underlying factor, that is the world oil market (Alizadeh *et al*, 2004, p. 1342).

For the Philips & Perron stationarity tests, the results suggest that all prices are non-stationary I*(1)* variables in levels while their 1^{st} difference are significant in the 1^{st} difference tests. OLS estimations should then be on the 1^{st} difference.

Table 5.5 Descriptive statistics of Logarithmic returns of spot bunker price and futures energy prices

	SinSpot	RotSpot	HouSpot	WTISpot	WTIF1	WTIF2	WTIF3	WTIF4	HeatSpot	HeatF1	HeatF2	HeatF3	HeatF4
Mean	4.8176	4.7372	4.7447	3.2501	3.2495	3.2467	3.2426	3.2379	4.2656	4.2643	4.3221	4.2669	4.3179
Maximum	5.8889	5.9094	5.8450	4.3259	4.3255	4.3442	4.3543	4.3605	5.3310	5.3433	5.3713	5.3968	5.4161
Minimum	3.9703	3.9120	3.9120	2.3979	2.4060	2.4301	2.4544	2.4774	3.3662	3.4068	3.4269	3.4468	3.4667
Std. Dev.	0.4675	0.4455	0.4637	0.4394	0.4398	0.4409	0.4412	0.4409	0.4464	0.4476	0.4902	0.4448	0.4878
J-B	51.471	61.121	61.805	98.574	100.437	122.598	144.732	166.894	102.327	118.593	58.665	164.130	77.275
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PP(4) Levels*	-1.82	-1.68	-1.48	-1.02	-1.00	-0.84	-66.00	-0.49	-0.99	-0.83	-0.54	-0.69	-0.42
PP(4) 1st Diff*	-31.10	-32.57	-32.27	-27.44	-27.06	-25.88	-25.82	-25.85	-25.37	-26.49	-21.97	-25.94	-21.15
Observations	909	909	909	909	909	909	909	909	909	909	696	909	699

Notes: - Sample for spot bunker price at Singapore, Rotterdam and Houston market is from 01/01/1990 to 28/05/2007; for WTI crude oil spot and futures prices are from 05/01/1990 to 01/06/2007; for Heating oil spot and futures contract 1 and 3 are from 05/01/1990 to 01/06/2007; for Heating oil futures contract 2 are from 04/02/1994 to 01/06/2007 and futures contract 4 are from 14/01/1994 to 01/06/2007.

- SinSpot, RotSpot and HouSpot present Singapore, Rotterdam and Houston spot bunker price respectively. WTISpot and HeatSpot represent WTI crude oil and Heating oil spot price respectively. WTIF1, WTIF2, WTIF3 and WTIF4 represent WTI crude oil futures contract 1, 2, 3 and 4. HeatF1, HeatF2, HeatF3 and HeatF4 represent the Heating oil futures contract 1, 2, 3 and 4 respectively.

- J-B is the Jarque -Bera (1980) test for normality, the statistic is $X^2(2)$ distributed.

- * PP is the Phillips & Perron (1988) unit root test; test critical value of 1% level is -3.43, 5% level is -2.86 and 10% level is -2.56; the truncation lag for the test is set to 4; 1st Diffs is the first difference of PP test.

5.3.2.2.2. Estimate the hedge ratio and hedging effectiveness

The author estimates the hedge ratio (β), the hedging effectiveness (R^2) as well as the constant term α and standard error ε by using OLS regression model to regress the changes on the logarithm of spot bunker prices at Singapore, Rotterdam and Houston and the changes in the logarithms of different energy futures prices.

If we define the 1st difference of logarithm of Singapore spot price as $\Delta_{SinSpot}$, Rotterdam spot price as $\Delta_{RotSpot}$, and Houston spot price as $\Delta_{HouSpot}$, we have:

$\Delta_{SinSpot} = LogSinSpot(+1) – LogSinSpot(0)$

$\Delta_{RotSpot} = LogRotSpot(+1) – LogRotSpot(0)$

$\Delta_{HouSpot} = LogHouSpot(+1) – LogHouSpot(0)$

And the 1st difference of logarithm of WTI futures prices as $\Delta_{WTIFi\ (i = 1 \div 4)}$, of heating oil futures prices as $\Delta_{HeatFi\ (i = 1 \div 4)}$, we have:

$\Delta_{WTIFi} = LogWTIF_i(+1) – LogWTIF_i(0) \quad _{(i = 1 \div 4)}$[22]

$\Delta_{HeatFi} = LogHeatF_i(+1) – LogHeatF_i(0) \quad _{(i = 1 \div 4)}$

Consequently, we try to estimate if the changes in bunker spot prices in Singapore can be explained by the changes in energy futures prices by regressing the equations:

$\Delta_{SinSpot} = \alpha + \beta*\Delta_{WTIFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.16)

$\Delta_{SinSpot} = \alpha + \beta*\Delta_{HeatFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.17)

In the same sense, in Rotterdam and Houston we have following equations:

$\Delta_{RotSpot} = \alpha + \beta*\Delta_{WTIFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.18)

$\Delta_{RotSpot} = \alpha + \beta*\Delta_{HeatFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.19)

$\Delta_{HouSpot} = \alpha + \beta*\Delta_{WTIFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.20)

$\Delta_{HouSpot} = \alpha + \beta*\Delta_{HeatFi} + \varepsilon \quad _{(i = 1 \div 4)}$ (5.21)

Estimations of equations (5.16) and (5.17) for Singapore are presented in *Table 5.6*.

[22] $i = 1 \div 4$ present futures contracts 1, 2, 3 and 4, respectively.

Table 5.6 OLS estimations for Singapore spot bunker price against different energy futures contracts

Independent variable	N	α (*t-statistics*)	β (*t-statistics*)	R^2	ε
WTI future1	908	0.00106 (*0.526*)	0.29286 (*5.877*)	0.036732	0.049826
WTI future2	908	0.00097 (*0.485*)	0.35231 (*6.387*)	0.043098	0.055153
WTI future3	908	0.00093 (*0.463*)	0.37792 (*6.334*)	0.042409	0.059663
WTI future4	908	0.00089 (*0.441*)	0.40206 (*6.271*)	0.041605	0.064110
Heating Oil future1	908	0.00113 (*0.559*)	0.24752 (*4.990*)	0.026752	0.049600
Heating Oil future2	695	0.00177 (*0.795*)	0.21917 (*3.576*)	0.018120	0.061287
Heating Oil future3	908	0.00093 (*0.464*)	0.35968 (*6.133*)	0.039863	0.058645
Heating Oil future4	698	0.00163 (*0.737*)	0.32012 (*4.563*)	0.029048	0.070155

Notes: - Sample for spot bunker price at Singapore, Rotterdam and Houston market is from 01/01/1990 to 28/05/2007; for WTI crude oil spot and futures prices are from 05/01/1990 to 01/06/2007; for Heating oil spot and futures contract 1 and 3 are from 05/01/1990 to 01/06/2007; for Heating oil futures contract 2 are from 04/02/1994 to 01/06/2007 and futures contract 4 are from 14/01/1994 to 01/06/2007.

- N is the number of observation after adjusted.

These results once again confirm that WTI contracts with higher hedge ratio (β) and hedging effectiveness (R^2) are better for hedging than heating contracts. For instance, WTI Contract 4 provides the highest hedge ratio (0.40206) and quite high hedging effectiveness (R^2= 0.041605 or 20.39%), followed by WTI Contract 3 with hedge ratio of 0.37792 and hedging effectiveness of 20.59%. While the highest performance of heating contracts falls in contract 3 with a hedge ratio of 0.35968 and hedging effectiveness of 19.96%.

Moreover, the estimated results from equations (5.18) and (5.19) for Rotterdam in *Table 5.7* suggest that a hedge ratio of WTI contracts is increasing from contract 1 to contract 4, and contract 4 also provides the highest hedge ratio (0.51386) with a hedging effectiveness of 26.42% (R^2 = 0.069808). Contracts 1, 2 and 3 also result in a better hedge ratio (0.35605, 0.44126 and 0.47961, respectively) and hedging effectiveness (23.61%, 26.35% and 26.48%, respectively) compared with the heating oil contracts where only contract 3 proves a quite good hedge ratio of 0.41596 with a hedging effectiveness of 23.40%. Other contracts of heating oil contracts give poor results.

Table 5.7 OLS estimations for Rotterdam spot bunker price against different energy futures contracts

Independent variable	N	α (*t-statistics*)	β (*t-statistics*)	R^2	ε
WTI future1	908	0.00108 (*0.550*)	0.35605 (*7.314*)	0.055767	0.048675
WTI future2	908	0.00096 (*0.493*)	0.44126 (*8.222*)	0.069446	0.053664
WTI future3	908	0.00090 (*0.460*)	0.47961 (*8.267*)	0.070157	0.058009
WTI future4	908	0.00084 (*0.430*)	0.51386 (*8.245*)	0.069808	0.062319
Heating Oil future1	908	0.00117 (*0.591*)	0.29671 (*6.102*)	0.039485	0.048619
Heating Oil future2	695	0.00159 (*0.714*)	0.27431 (*4.477*)	0.028115	0.061267
Heating Oil future3	908	0.00095 (*0.485*)	0.41596 (*7.244*)	0.054763	0.057414
Heating Oil future4	698	0.00173 (*0.777*)	0.38233 (*5.408*)	0.040333	0.070692

Notes: the same notes as in **Table 5.6**.

Table 5.8 presents results from equations (5.20) and (5.21) for the Houston market where the performance is not so good except for heating oil contract 4 and WTI contract 4.

Table 5.8 OLS estimations for Houston spot bunker price against different energy futures contracts

Independent variable	N	α (*t-statistics*)	β (*t-statistics*)	R^2	ε
WTI future1	908	0.00120 (*0.539*)	0.23956 (*4.367*)	0.020624	0.054846
WTI future2	908	0.00114 (*0.512*)	0.27912 (*4.587*)	0.022700	0.060846
WTI future3	908	0.00110 (*0.497*)	0.29694 (*4.511*)	0.021969	0.065823
WTI future4	908	0.00108 (*0.485*)	0.31096 (*4.395*)	0.020884	0.070739
Heating Oil future1	908	0.00126 (*0.565*)	0.19786 (*3.631*)	0.014344	0.054491
Heating Oil future2	695	0.00179 (*0.711*)	0.26621 (*3.846*)	0.020899	0.069217
Heating Oil future3	908	0.00109 (*0.490*)	0.29751 (*4.606*)	0.022887	0.064584
Heating Oil future4	698	0.00164 (*0.657*)	0.37210 (*4.694*)	0.030694	0.079262

Notes: same notes in **Table 5.6**.

Contract 4 of heating oil provides the best hedging performance for Houston bunker spot with a hedge ratio of 0.37210 and hedging effectiveness of 17.52% (R^2 = 0.030694) while the result for contract 4 of WTI crude oil is 0.31096 and 14.45% respectively. However, estimated results of Houston also prove that the hedging effectiveness and hedge ratio increase when moving from contract 1 to contract 4.

To sum up this part, it is understood that different energy futures contracts result in different levels of risk reduction when using them for a cross-hedge for bunker prices fluctuation. The highest hedging performance falls in WTI crude futures contract 3, 4, 2 and 1 with 26.48%, 26.42%, 26.35% and 23.61% hedging effectiveness (risk reduction) respectively when hedging bunker spot price fluctuation in Rotterdam. Whereas, the lowest performance results in heating oil future contract 1, WTI future contract 1, 4 and heating oil future contract 2 with hedging effectiveness of 11.98%, 14.36%, 14.45% and 14.46% respectively when hedging bunker price in Houston.

Moreover, the best hedging for Singapore bunker spot price falls in WTI contract 2, 3, 4 and heating oil contract 3 with hedging effectiveness of 20.76%, 20.59%, 20.40% and 19.97% respectively. While the best performance for Houston is with heating future contracts 4 and 3 with hedging effectiveness of 17.52% and 15.13% respectively. The reason for poor hedging effectiveness obtained by a cross-hedge is that, unlike a direct-hedge where the underlying commodities in spot and futures markets are similar, in a cross-hedge underlying commodities in spot and futures market are different thus fluctuations in both markets are not the same which may lead to poor hedging performance (Alizadeh *et all*, 2004, p.1351).

5.4 Chapter conclusion

Results obtained from OLS estimations for a direct-hedge with bunker forward contracts and a cross-hedge with different energy futures contracts once again confirm Marshall's statement in chapter 2 that "a direct-hedge is usually more effective than a cross-hedge" (1989, p. 200). Compared with a direct-hedge, the best hedging effectiveness of a cross-hedge falls in WTI crude futures Contracts 3, 4, 2 and 1 with a risk reduction of 26.48%, 26.42%, 26.35% and 23.61% respectively when hedging against bunker spot price fluctuation in Rotterdam.

In contrast, a direct-hedge with 1-month and 12-month bunker forward contracts could result in the risk reduction of 83.14% (hedge ratio = 0.913615) and 62.49% (hedge ratio = 0.899641) respectively when hedging Rotterdam bunker spot price and 75.93% (hedge ratio = 0.786798) and 59.01% (hedge ratio = 0.689305) respectively when hedging against the bunker spot prices fluctuation in Singapore.

CHAPTER 6 CONCLUSION

This dissertation has contributed to the literature on shipping studies in many aspects.

First of all, some basic concepts of the spot market, futures markets and hedging have been identified for easier understanding and their application in hedging practice. A healthy review of hedging in general and more particularly in the shipping industry, such as hedging freight rates and hedging bunker prices, is provided to address the matter of shipping risks as well as the way the industry minimizes such risks.

Secondly, a systematic series of data from 1990 to 2007 about world economy, world tonnage, world merchandise export value, world oil production and consumption, world oil refining capacity and refining marginal costs, world bunker supply and demand, international seaborne trade, time charter rates, bunker prices (daily, weekly, monthly base), oil prices, speed and fuel consumption of vessels have been carefully collected from leading Shipping Magazines such as Fairplay Weekly, Drewry Monthly, Review of Maritime Transport for quantifying works in this dissertation. Such data are a valuable source of reference for further research.

Thirdly, statistical methods of *mean* and *standard deviation* are applied to explain the behavior of bunker prices from 1990 to 2007 where the period 1990-1999 is characterized by low levels and stable prices while the period 2000-2007 is dotted with unpredictable behavior with sky high prices and abnormal fluctuations. Moreover, an economic analysis of the determinant factors of the bunker market are provided, the laws of supply and demand are also applied to explain the unpredictable behavior of bunker prices in which supply factors are addressed by the sky-high crude oil price, the high oil consumption levels versus the low oil production capacities, the limits of refining capacity of the world and main ports, fierce competition overseas and in local ports as well as the bunkering methodologies. On the demand side, the increase in bunker price is derived from the increase in the world's economy, the boom in international seaborne trade, the fast development of world tonnage, the high freight rate levels as well as the bigger size and higher fuel consumption level of world ships.

Fourthly, the *correlation* method is deployed to investigate the most influential factors of the bunker market. Consequently, the results prove that crude oil prices, international seaborne trade, time charter rates and fuel consumption have a strong correlation with bunker prices. As a result, such factors contribute in driving the bunker market over the last 17 years (1990 -2007).

Fifthly, the four hedging instruments, including energy futures contracts, bunker forward contracts, bunker options agreement as well as bunker swaps agreement are identified for the wide choices of shipowners and ship operators in hedging their bunker price fluctuations. Besides, some practical examples taken from the author's experience are also provided to prove the hedging functions of the four instruments.

Finally, some methodologies for estimating the hedge ratio and hedging effectiveness are reviewed and analyzed. Special attention is paid to the Ordinary Least Squares (OLS) regression model. Practical work has been done to investigate the hedging effectiveness of a direct-hedge with bunker forward contracts and a cross-hedge with different energy futures contracts. Compared with a direct-hedge, the best hedging effectiveness of a cross-hedge falls in WTI crude futures Contracts 3, 4, 2 and 1 with a risk reduction of 26.48%, 26.42%, 26.35% and 23.61% respectively when hedging against bunker spot price fluctuation in Rotterdam.

In contrast, a direct-hedge with 1-month and 12-month bunker forward contracts could result in the risk reduction of 83.14% (hedge ratio = 0.913615) and 62.49% (hedge ratio = 0.899641) respectively when hedging the Rotterdam bunker spot price and 75.93% (hedge ratio = 0.786798) and 59.01% (hedge ratio = 0.689305) respectively when hedging against bunker spot price fluctuations in Singapore.

Findings from this dissertation bring some main implication for shipowners, ship operators and any related parties who wish to reduce bunker price risks by hedging. If a direct-hedge is available, they can use bunker 1-month and 12-month forward contracts to hedge against bunker price fluctuation when loading bunker in Rotterdam and Singapore with rather high rate of risk reduction from 59.01% to 83.14%. In contrast, without a direct-hedge, a cross-hedge with different energy futures contracts can also help with significant rate of risk reduction from 23.61% to 26.48% respectively with WTI crude futures contracts when loading bunker in Rotterdam.

Limitation of analysis

The purpose to go deeply inside to study the WTI crude and heating oil futures contracts traded at NYMEX has limited the paper from choosing other energies traded on other markets such as Brent crude, Gas oil (traded at IPE London) for a wider choice of market participants. Moreover, it seems that the OLS regression model is suitable for estimating the hedge ratio and hedging effectiveness with such big observations. However, there are still many other methods, especially from the ARCH family that should be taken into consideration.

Further research

One source for further research on this topic should start from diversifying the energy futures contracts in the cross-hedge test which could bring better hedging effectiveness, not only on two (WTI and heating oil). Moreover, if the data are available, researchers pursuing this topic should also consider testing the hedging effectiveness of the bunker swaps and options agreement.

To support good decision making in hedging bunker, one problem arising is the forecast of bunker price. With the available data set and regression model, another source for further research should then be done on the forecasting of bunker price.

Furthermore, while an OLS regression model seems to result in good performance with big observations, there are still many other methods worth taking into account. For instance, the models of the ARCH family such as Vector Autogression model (VAR) and Vector Error Correction Model (VECM) which prove a high performance in many studies of Angle (1982) and Kavussanos & Nomikos (2000, 2004). However, such models require not only a deep knowledge of mathematics and statistics but also sophisticated computer software.

Finally, hedging bunker is only one factor in managing risk in the shipping industry. Further research should also investigate the hedging effectiveness of freight rate hedging, new building price hedging as well as foreign exchange hedging. Once such research is done, it might be more meaningful for the shipping industry.

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Appendix A - Monthly Average Bunker Prices 1990-2007 (IFO380)

Unit: US$

Seq.	Month	Singapore	Rotterdam	Houston	Los Angeles
1	Jan-90	106	97	105	101
2	Feb-90	95	95	90	97
3	Mar-90	95	87	87	97
4	Apr-90	90	81	85	91
5	May-90	84	79	83	83
6	Jun-90	63	63	67	73
7	Jul-90	73	72	80	68
8	Aug-90	132	116	117	121
9	Sep-90	148	133	121	128
10	Oct-90	149	144	142	171
11	Nov-90	147	145	143	146
12	Dec-90	158	153	131	120
13	Jan-91	189	149	125	149
14	Feb-91	118	84	75	84
15	Mar-91	77	77	66	72
16	Apr-91	83	79	71	70
17	May-91	85	78	72	79
18	Jun-91	84	76	70	85
19	Jul-91	87	78	77	75
20	Aug-91	83	77	73	72
21	Sep-91	81	75	72	72
22	Oct-91	89	89	76	86
23	Nov-91	90	95	84	80
24	Dec-91	78	81	70	77
25	Jan-92	72	73	59	68
26	Feb-92	70	72	60	66
27	Mar-92	78	82	64	67
28	Apr-92	87	82	77	82
29	May-92	89	87	84	90
30	Jun-92	93	94	88	92
31	Jul-92	92	93	92	106
32	Aug-92	97	94	96	106
33	Sep-92	104	95	95	102
34	Oct-92	106	109	99	98
35	Nov-92	92	98	95	98
36	Dec-92	77	85	80	85
37	Jan-93	83	79	83	85
38	Feb-93	87	79	77	85
39	Mar-93	86	85	80	85
40	Apr-93	93	87	85	86
41	May-93	90	80	81	101
42	Jun-93	79	68	71	92
43	Jul-93	71	66	68	78
44	Aug-93	76	69	76	74
45	Sep-93	78	69	74	72
46	Oct-93	75	69	75	83
47	Nov-93	62	68	64	69
48	Dec-93	60	62	63	61
49	Jan-94	72	67	69	68
50	Feb-94	70	83	69	76
51	Mar-94	66	81	69	79
52	Apr-94	83	78	77	84
53	May-94	95	87	79	86
54	Jun-94	95	92	82	105

55	Jul-94	104	104	99	106
56	Aug-94	106	92	94	110
57	Sep-94	82	78	78	100
58	Oct-94	91	90	94	96
59	Nov-94	98	105	97	95
60	Dec-94	91	98	93	98
61	Jan-95	97	111	93	98
62	Feb-95	110	107	101	98
63	Mar-95	107	110	99	103
64	Apr-95	108	108	102	103
65	May-95	107	110	99	113
66	Jun-95	95	96	102	105
67	Jul-95	88	84	88	85
68	Aug-95	89	88	87	87
69	Sep-95	86	91	86	86
70	Oct-95	95	89	86	85
71	Nov-95	104	92	92	94
72	Dec-95	116	107	102	110
73	Jan-96	115	104	100	112
74	Feb-96	113	100	103	108
75	Mar-96	112	116	106	109
76	Apr-96	115	119	108	118
77	May-96	104	104	104	109
78	Jun-96	93	91	98	98
79	Jul-96	101	94	96	101
80	Aug-96	104	104	99	99
81	Sep-96	119	118	111	111
82	Oct-96	123	130	132	123
83	Nov-96	122	120	121	126
84	Dec-96	128	124	115	125
85	Jan-97	113	115	113	123
86	Feb-97	101	104	97	101
87	Mar-97	98	94	96	99
88	Apr-97	101	92	97	98
89	May-97	100	91	100	109
90	Jun-97	99	92	100	103
91	Jul-97	100	94	97	103
92	Aug-97	106	101	107	106
93	Sep-97	113	101	105	114
94	Oct-97	113	108	112	112
95	Nov-97	111	114	113	110
96	Dec-97	96	96	91	98
97	Jan-98	73	76	77	86
98	Feb-98	65	72	79	74
99	Mar-98	71	72	64	65
100	Apr-98	80	82	81	73
101	May-98	75	76	74	84
102	Jun-98	64	73	72	74
103	Jul-98	65	71	74	75
104	Aug-98	62	66	67	66
105	Sep-98	78	69	70	70
106	Oct-98	86	71	72	79
107	Nov-98	80	64	68	78
108	Dec-98	66	58	55	64
109	Jan-99	70	68	61	66
110	Feb-99	95	60	55	62
111	Mar-99	98	64	67	70
112	Apr-99	122	75	83	80

113	May-99	87	75	85	94
114	Jun-99	88	83	85	89
115	Jul-99	101	98	97	93
116	Aug-99	120	116	116	117
117	Sep-99	130	121	121	132
118	Oct-99	145	128	130	145
119	Nov-99	152	132	130	140
120	Dec-99	146	131	129	144
121	Jan-00	140	130	130	142
122	Feb-00	144	134	137	146
123	Mar-00	174	154	145	165
124	Apr-00	161	127	130	154
125	May-00	166	133	139	158
126	Jun-00	175	149	151	166
127	Jul-00	153	139	138	158
128	Aug-00	153	138	142	151
129	Sep-00	174	165	154	167
130	Oct-00	186	166	163	186
131	Nov-00	169	161	153	164
132	Dec-00	134	131	124	138
133	Jan-01	125	118	133	136
134	Feb-01	133	134	142	141
135	Mar-01	136	129	132	148
136	Apr-01	141	125	115	133
137	May-01	152	132	123	152
138	Jun-01	138	130	121	146
139	Jul-01	144	124	120	138
140	Aug-01	144	131	121	140
141	Sep-01	144	137	138	131
142	Oct-01	135	119	115	135
143	Nov-01	108	107	100	103
144	Dec-01	117	109	103	110
145	Jan-02	115	108	101	115
146	Feb-02	122	111	102	112
147	Mar-02	138	125	125	132
148	Apr-02	151	141	140	152
149	May-02	158	145	143	151
150	Jun-02	156	138	144	160
151	Jul-02	162	147	144	161
152	Aug-02	169	151	149	165
153	Sep-02	176	166	162	176
154	Oct-02	163	157	154	175
155	Nov-02	154	131	130	143
156	Dec-02	170	140	145	157
157	Jan-03	183	182	202	115
158	Feb-03	201	179	191	112
159	Mar-03	195	156	168	132
160	Apr-03	176	137	145	152
161	May-03	173	146	144	151
162	Jun-03	172	156	156	180
163	Jul-03	180	167	177	199
164	Aug-03	170	167	180	178
165	Sep-03	163	155	155	176
166	Oct-03	167	160	164	166
167	Nov-03	163	160	164	162
168	Dec-03	164	146	153	165
169	Jan-04	173	155	157	184
170	Feb-04	173	146	160	179

171	Mar-04	169	154	160	176
172	Apr-04	184	164	168	184
173	May-04	192	178	186	195
174	Jun-04	187	169	176	210
175	Jul-04	185	176	175	201
176	Aug-04	195	179	180	211
177	Sep-04	193	177	183	205
178	Oct-04	207	190	235	250
179	Nov-04	199	164	184	236
180	Dec-04	175	158	182	207
181	Jan-05	190	172	207	200
182	Feb-05	207	194	195	225
183	Mar-05	240	225	226	253
184	Apr-05	269	272	257	278
185	May-05	265	245	268	303
186	Jun-05	271	254	266	283
187	Jul-05	273	270	261	284
188	Aug-05	287	283	279	288
189	Sep-05	327	303	329	342
190	Oct-05	332	293	320	352
191	Nov-05	310	276	290	327
192	Dec-05	288	280	295	323
193	Jan-06	314	300	310	335
194	Feb-06	328	316	325	339
195	Mar-06	338	314	319	347
196	Apr-06	355	340	340	356
197	May-06	355	344	349	371
198	Jun-06	334	324	320	354
199	Jul-06	347	331	334	355
200	Aug-06	332	331	340	358
201	Sep-06	296	294	298	314
202	Oct-06	297	285	283	300
203	Nov-06	278	279	274	294
204	Dec-06	281	276	279	302
205	Jan-07	287	252	266	296
206	Feb-07	313	276	284	336
207	Mar-07	316	287	283	336
208	Apr-07	350	330	310	348
209	May-07	351	344	349	382

Source: Compiled by author from various issues of Drewry Monthly from 1990 to 2007.

(Drewry Shipping Consultants. (1990-2007). *Drewry Monthly* 1990-2007. Author).

Appendix B - Weekly Average Bunker Price (IF0380) and Weekly Average Crude Oil Price

Unit: Bunker Price in US$/ton; Crude Oil Prices in US$/barrel

Seq.	Date	Bunker Prices				Crude Oil Prices	
		Rotterdam	Singapore	Houston	Los Ageles	WTI**	Brent*
1	01/01/1990	84	96	89	102	21.78	20.93
2	08/01/1990	85	96.5	90.5	103	23.29	22.37
3	15/01/1990	86	97	92	105	22.62	21.67
4	22/01/1990	86.5	99	95	106	22.71	21.05
5	29/01/1990	87	98	92	107	23.08	20.49
6	05/02/1990	88.5	94.5	85	102	22.7	20.65
7	12/02/1990	87	93	85	96	22.23	20.26
8	19/02/1990	93	90	87	97.5	22.27	19.82
9	26/02/1990	93	92	88	97	21.81	19.45
10	05/03/1990	94	92.5	89.5	97	21.51	19.17
11	12/03/1990	86	90	87	96	21.01	18.94
12	19/03/1990	83	89.5	86	93	20.19	18.41
13	26/03/1990	78	92	82	89	19.73	17.81
14	02/04/1990	79	90	77	88	20.26	18.04
15	09/04/1990	79	90	78	89	19.83	17.8
16	16/04/1990	79	89	81	90	17.96	15.89
17	23/04/1990	76	87	83	87	17.6	15.88
18	30/04/1990	76	81.5	81	81	18.2	16.65
19	07/05/1990	80	82.5	83	83	18.37	16.17
20	14/05/1990	76	81	83	80	18.71	16.34
21	21/05/1990	73	83	79	78.5	19.19	17.24
22	28/05/1990	67	73.5	78	78.5	16.83	16.12
23	04/06/1990	59	62.5	76.5	77	17.72	15.55
24	11/06/1990	56	58	60	63	16.77	14.93
25	18/06/1990	58	59	59	62	17.11	15.01
26	25/06/1990	59	60	60	61	15.9	14.9
27	02/07/1990	63	60	65	65	16.84	15.52
28	09/07/1990	60	62.5	65	63.5	16.68	15.39
29	16/07/1990	80	74	69	63	17.64	15.83
30	23/07/1990	78	72	78	64	18.83	17.77
31	30/07/1990	72	82	84	74	19.89	18.91
32	06/08/1990	72	81	85	76	21.98	20.9
33	13/08/1990	108	125	114	114	27.32	26.4
34	20/08/1990	120	140	109	112	27.27	27.18
35	27/08/1990	115	136	120	123	30.08	30.48
36	03/09/1990	122	136	120	130	27.13	27.65
37	10/09/1990	124	136	121	124	29.67	31.09
38	17/09/1990	126	140	118	117	30.99	32.01
39	24/09/1990	140	155	123	126	34.21	35.71
40	01/10/1990	146	160	132	150	39.16	40.79
41	08/10/1990	150	155	138	140	36.64	37.64
42	15/10/1990	146	148	145	158	39.88	40.27
43	22/10/1990	125	128	140	175	36.84	36.28
44	29/10/1990	141	147	135	151	31.32	30.63
45	05/11/1990	137	146	139.5	175	34.95	35.03
46	12/11/1990	141	145	140.5	150	33.89	34.13
47	19/11/1990	139	136	143	137.5	31.5	32.24
48	26/11/1990	147	150	140.5	125.5	30.69	31.01
49	03/12/1990	137	160	140	125.5	32.32	33.98
50	10/12/1990	144.5	142	140	119	27.72	29.72
51	17/12/1990	145	141	136	109	26.39	28.06

52	24/12/1990	145	155	128	107	27.56	27.67
53	31/12/1990	145	160	117	112	27.21	27.47
54	07/01/1991	142	166	123.5	129	26.38	26.07
55	14/01/1991	160	197	121	145	27.55	25.33
56	21/01/1991	130	200	139	187	26.85	25.86
57	28/01/1991	120	195	127	135	24.08	20.77
58	04/02/1991	97	170	85	95	21.41	20.72
59	11/02/1991	78	120	78	85	21.3	20.63
60	18/02/1991	67	91	70	75	22.12	20.44
61	25/02/1991	69.5	69	65	71	19.38	18.13
62	04/03/1991	71.5	74	62	71	18.73	18.66
63	11/03/1991	69	67	63	63	19.86	19.77
64	18/03/1991	70	66	65	60	19.89	19.28
65	25/03/1991	71	68	62	52	20.3	18.8
66	01/04/1991	69	69	62.5	52	19.58	18.28
67	08/04/1991	68	70	63	53	19.63	17.95
68	15/04/1991	71	73	62.5	54	20.89	19.17
69	22/04/1991	72	77	64	57	21.48	19.71
70	29/04/1991	74	78	70	75	21.19	19.63
71	06/05/1991	71	79	74	70	21.23	19.72
72	13/05/1991	71	78.5	70	70	21.69	19.81
73	20/05/1991	71	78	67	80	20.95	18.9
74	27/05/1991	73	82	68	76.5	21.04	18.82
75	03/06/1991	72	81	69	77	21.21	18.87
76	10/06/1991	70	79	67	82	20.63	18.55
77	17/06/1991	69.5	79.55	67	85.5	19.84	17.86
78	24/06/1991	69.5	77.5	64.5	82	20.08	18.06
79	01/07/1991	69	80	66.5	68	20.21	18.2
80	08/07/1991	69	85	70	61.5	20.8	18.55
81	15/07/1991	72	84	70.5	70	21.43	19.24
82	22/07/1991	74	85	78	71	21.91	20.02
83	29/07/1991	73	86	77	68	21.4	19.66
84	05/08/1991	69	82	69	68	21.46	19.57
85	12/08/1991	69	80	66	66	21.5	19.52
86	19/08/1991	69	79	66	64	21.44	19.39
87	26/08/1991	69	81	66	67	21.99	20.09
88	02/09/1991	71	79	66.5	66	21.98	20.17
89	09/09/1991	68	77	67.5	66	21.84	20.34
90	16/09/1991	68	70	68.5	71	21.54	20.08
91	23/09/1991	70	73	68	63	21.85	20.47
92	30/09/1991	70	72	65.5	61	22.24	20.94
93	07/10/1991	73	77	69	68	22.41	21.49
94	14/10/1991	76	79	72	90	23.08	22.11
95	21/10/1991	85	85	73	90	23.82	22.75
96	28/10/1991	90.5	89	75	86	23.46	22.54
97	04/11/1991	90.5	90	78	87	23.32	22.05
98	11/11/1991	90	86	79	79.5	23.47	22.18
99	18/11/1991	92	86	79	74	22.57	21.36
100	25/11/1991	88	86	79	74	22.04	20.76
101	02/12/1991	85	85	79	76	21.49	19.85
102	09/12/1991	84	82	73	78	20.55	19.24
103	16/12/1991	78	79	74	79	19.64	18.45
104	23/12/1991	74	76	61	64	19.2	18.31
105	30/12/1991	72	71	62	69	18.68	17.73
106	06/01/1992	71	73	60	63	19.11	18.18
107	13/01/1992	66	70	53	60	18.41	17.77
108	20/01/1992	65.5	70	51	59	18.81	18.37
109	27/01/1992	65	68	53.5	60.5	18.66	18.11
110	03/02/1992	65	64	57.5	58	19.05	18.28

111	10/02/1992	63	68	58.5	58	19.42	18.47
112	17/02/1992	63	68	56	61.5	19.49	18.58
113	24/02/1992	63	63	55	60	18.62	17.74
114	02/03/1992	66	65	53	60	18.51	17.42
115	09/03/1992	75	67	57.5	59.5	18.55	17.28
116	16/03/1992	75	75	56	61	18.76	17.4
117	23/03/1992	77	75	62	59.5	19.1	17.73
118	30/03/1992	74	75	60	60.5	19.09	17.75
119	06/04/1992	75	78	64	62	19.73	18.52
120	13/04/1992	75	83	69	75	20.43	19.01
121	20/04/1992	75	82	74	75	20.06	18.86
122	27/04/1992	74.5	84	77	79	20.06	18.86
123	04/05/1992	76	83	75	99	20.63	19.37
124	11/05/1992	79	87	80	86	20.86	19.76
125	18/05/1992	80	85	80	82	20.8	19.79
126	25/05/1992	81	86	80	84	20.49	19.49
127	01/06/1992	92	93	80	83	21.98	20.68
128	08/06/1992	92	89	87	110	22.38	21.08
129	15/06/1992	90	94	87	85	22.35	21.21
130	22/06/1992	88	89	86	86	22.26	21.16
131	29/06/1992	94	87	83	83	22.68	21.31
132	06/07/1992	92	89	81	87	22.03	20.62
133	13/07/1992	87	89	84.5	95.5	21.48	19.95
134	20/07/1992	90	89.5	92	104	21.58	20.02
135	27/07/1992	88.5	89.5	97	102	21.95	20.26
136	03/08/1992	89	89	100	100	21.95	20.58
137	10/08/1992	91	90	99	104	21.34	19.88
138	17/08/1992	90.5	91	96	100	21.18	19.68
139	24/08/1992	90	93	93	98	21.39	19.79
140	31/08/1992	90	98.5	86	97	21.43	19.62
141	07/09/1992	89	103	86	97	21.66	19.9
142	14/09/1992	93	106	94	95	21.94	20.28
143	21/09/1992	90	106	93	92	22.21	20.45
144	28/09/1992	92.5	103	93	94	21.71	20.35
145	05/10/1992	100	105	93	102	21.81	20.26
146	12/10/1992	111	105	93	94	21.9	20.33
147	19/10/1992	108	106	97	93	22.25	20.76
148	26/10/1992	106.5	102	110	93	21.58	20.37
149	02/11/1992	103	94.5	97	94	20.95	19.55
150	09/11/1992	102	91.5	106	93	20.52	19.19
151	16/11/1992	99	92	112	93	20.37	19.25
152	23/11/1992	90	88.5	94	95	20.35	19.28
153	30/11/1992	90	83.5	86	94	20.16	19.12
154	07/12/1992	88.5	81	83	94	19.38	18.57
155	14/12/1992	77.5	82.5	110	88	19.01	18.12
156	21/12/1992	78	81.5	106	87	19.38	18.04
157	28/12/1992	80	81	96	85	19.91	18.23
158	04/01/1993	81	76	73	80	19.63	17.87
159	11/01/1993	71	74	79	80	19	17.51
160	18/01/1993	72	79	83	80	18.62	17.05
161	25/01/1993	65	78	80	80	18.61	16.98
162	01/02/1993	69	88	76	80	19.9	18
163	08/02/1993	71	85.5	75	77	20.22	18.58
164	15/02/1993	71	84.5	74	80	20.13	18.45
165	22/02/1993	71.5	81	75	80	19.51	18.05
166	01/03/1993	77	83	75	77	20.4	18.81
167	08/03/1993	84	84	75	77	20.69	19.15
168	15/03/1993	81	82	75	81	20.45	19.02
169	22/03/1993	78	83	73	78	20.14	18.66

170	29/03/1993	80	80	75	78	20	18.42
171	05/04/1993	79	79.5	75	80	20.44	18.73
172	12/04/1993	82	86	78	79	20.37	18.71
173	19/04/1993	78	86	79	81	20.28	18.67
174	26/04/1993	78	89.5	83	82	19.95	18.56
175	03/05/1993	75	86	83	83	20.3	18.67
176	10/05/1993	76	85	82	92	20.47	18.97
177	17/05/1993	78	85	81	97	20.06	18.76
178	24/05/1993	72	85	79	115	19.43	18.15
179	31/05/1993	71	81	71	95	19.84	18.25
180	07/06/1993	66	82	72	85	19.95	18.34
181	14/06/1993	67	81	72	90	19.43	18.06
182	21/06/1993	58	71.5	69	84	18.76	17.31
183	28/06/1993	60	71	65	86	18.52	17.2
184	05/07/1993	57	66	60	82	18.61	17.15
185	12/07/1993	57	68	60	72	18.02	16.8
186	19/07/1993	57	64	62	70	17.72	16.66
187	26/07/1993	61	65	61	58	17.54	16.68
188	02/08/1993	61	72	68	60	18.18	16.95
189	09/08/1993	62	74	73	62	17.67	16.6
190	16/08/1993	63	70	70	65	17.87	16.61
191	23/08/1993	61	76.5	75	70	17.84	16.72
192	30/08/1993	64	73	69	68	18.49	16.85
193	06/09/1993	64	75	69	57	18.1	16.53
194	13/09/1993	59	75	73	62	16.96	15.78
195	20/09/1993	62	70	69	65	16.94	15.47
196	27/09/1993	66	73	67	66	17.67	16.03
197	04/10/1993	69	76	70	66	18.33	16.72
198	11/10/1993	64	76	73	76	18.46	16.9
199	18/10/1993	62	72	72	76	18.57	16.96
200	25/10/1993	63	72	71	78	18.12	16.61
201	01/11/1993	63	64	68	70	17.37	15.86
202	08/11/1993	63.5	62	66	68	17.29	15.76
203	15/11/1993	66	63	65	66	16.71	15.22
204	22/11/1993	64	59	61	60	16.75	15.36
205	29/11/1993	62	53	57	60	16.08	14.87
206	06/12/1993	57	54	58	62	15.21	14.16
207	13/12/1993	54	56	58	60	14.68	13.73
208	20/12/1993	54	60	57	60	14.31	13.99
209	27/12/1993	54	59	61	57	14.4	13.52
210	03/01/1994	53.5	60	60.5	58	14.21	13.17
211	10/01/1994	55	68	62	60	15.03	14.18
212	17/01/1994	57	72	64	60	14.67	14
213	24/01/1994	59	73	64	62.5	15.02	14.22
214	31/01/1994	73	73	67	75	15.34	14.64
215	07/02/1994	78	71	67	73	15.76	15.13
216	14/02/1994	75	72	68	73	14.87	13.91
217	21/02/1994	80	63	66	72	14.13	13.18
218	28/02/1994	81	67	64	68	14.44	13.24
219	07/03/1994	77	65	65	70	14.68	13.5
220	14/03/1994	79	61	61	68	14.24	13.3
221	21/03/1994	80	60	60	76	14.82	14.18
222	28/03/1994	76	65	67	85	15.15	14.59
223	04/04/1994	77	76	68	79	14.44	13.4
224	11/04/1994	76	85	71	79	15.65	14.34
225	18/04/1994	73	79	74	81	16.07	15.01
226	25/04/1994	81	85	77	80	17.02	15.56
227	02/05/1994	78.5	86	78	81	16.93	15.84
228	09/05/1994	81	92	74	83	17.2	16

229	16/05/1994	86	99	74	83	17.93	16.29
230	23/05/1994	83	92	75	87	18.21	16.08
231	30/05/1994	83	92	84	87	18.14	16.35
232	06/06/1994	90	91	80	91	18.24	16.27
233	13/06/1994	87	99	83	100	18.26	16.06
234	20/06/1994	86	91	86.5	103	19.61	16.67
235	27/06/1994	88	94	88	100	19.8	17.44
236	04/07/1994	98	96	89	100	19.16	17.34
237	11/07/1994	98	93	89	100	19.39	17.06
238	18/07/1994	99	108	97	101	20.16	18.09
239	25/07/1994	98	110	99	102	19.39	17.42
240	01/08/1994	99	112	100	104	19.66	17.82
241	08/08/1994	94	119	103	106	20.09	18.44
242	15/08/1994	87	102	99	110	18.88	17.51
243	22/08/1994	83	100	82	108	17.85	16.43
244	29/08/1994	83	82	73	92	17.23	15.59
245	05/09/1994	73	78	75	100	17.52	15.93
246	12/09/1994	73	81	73	93	17.65	15.91
247	19/09/1994	76	79	69	93	16.93	15.45
248	26/09/1994	76	85	76	93	17.38	15.85
249	03/10/1994	79	84	81	91	17.83	16.35
250	10/10/1994	95	89	85	90	18.13	16.72
251	17/10/1994	86	91	91	91	17.37	16.07
252	24/10/1994	89	87	89	88	17.35	16.21
253	31/10/1994	93	92	96	88	17.93	16.82
254	07/11/1994	100	94	95	86	18.69	17.58
255	14/11/1994	105	110	90	89	18.25	17.46
256	21/11/1994	113	94	92	89	17.51	16.8
257	28/11/1994	98	96	95	94	17.73	17.06
258	05/12/1994	92	89	98	98	17.78	16.85
259	12/12/1994	94.5	93	95	96	16.99	16
260	19/12/1994	94	90	90	94	16.86	15.72
261	26/12/1994	99	91.5	90.5	93	17.1	15.62
262	02/01/1995	110	93	89	95	17.71	16.19
263	09/01/1995	110	95	87	95	17.62	16.07
264	16/01/1995	108	97	95	98	17.55	16.23
265	23/01/1995	106	102	89	98	18.45	16.88
266	30/01/1995	103	104	85	91	18.34	16.85
267	06/02/1995	99	101	111	93	18.5	16.99
268	13/02/1995	101	109	92	94	18.42	16.97
269	20/02/1995	106	107	103	95	18.55	17.1
270	27/02/1995	108	104	99	99	18.75	17.18
271	06/03/1995	108	106	99	99	18.5	16.93
272	13/03/1995	108	108	99	99	18.27	16.7
273	20/03/1995	107	106	100	103	18.13	16.41
274	27/03/1995	103	103	95	104	18.69	17.17
275	03/04/1995	107	106	92	100	19.12	17.94
276	10/04/1995	106	109	101	101	19.43	18.24
277	17/04/1995	105	108	100	102	19.53	18.37
278	24/04/1995	103	107	100	103	20.26	18.9
279	01/05/1995	105	108	99	106	20.29	19.07
280	08/05/1995	106.5	106.5	106	112	20.24	18.81
281	15/05/1995	106.5	100	109	111	19.74	18.26
282	22/05/1995	110	106	105	112	19.98	18.42
283	29/05/1995	105	105	106	109	19.37	18.24
284	05/06/1995	112	104	107	107	18.92	17.65
285	12/06/1995	97.5	99	105	108	19.05	17.98
286	19/06/1995	93	80	101	106	18.91	17.76
287	26/06/1995	88	88	97	100	17.88	16.67

288	03/07/1995	82	85	96	95	17.71	16.64
289	10/07/1995	83	83	96	96	17.28	16.11
290	17/07/1995	83	85	94	93	17.34	15.92
291	24/07/1995	76	87	80	87	17.21	15.65
292	31/07/1995	79	89	79	86	17.41	15.75
293	07/08/1995	82	87	81	84.5	17.72	16.02
294	14/08/1995	83	88	82.5	84	17.81	16.07
295	21/08/1995	85.5	88	82.5	85	17.6	15.89
296	28/08/1995	88	87	82.5	84	19.02	16.29
297	04/09/1995	88	83	84	85	17.88	16.22
298	11/09/1995	88.5	84	82	86	18.37	16.69
299	18/09/1995	87	82	84.5	82.5	18.72	16.94
300	25/09/1995	88.5	84	84.5	81.5	18.32	16.89
301	02/10/1995	85	85	84	76	17.55	16.37
302	09/10/1995	85	85	84	76.5	17.29	16.23
303	16/10/1995	84	89	85	77	17.28	15.98
304	23/10/1995	83	94	86	80	17.51	15.96
305	30/10/1995	86	99	85	88	17.56	16.12
306	06/11/1995	84	101	78	86	17.79	16.65
307	13/11/1995	86	99	87	86	17.76	16.79
308	20/11/1995	88	102	87	86	18.06	16.75
309	27/11/1995	93	103	101	93	17.99	16.82
310	04/12/1995	97	104	92	97	18.32	17.21
311	11/12/1995	108	115	94	106	18.74	17.53
312	18/12/1995	104	117.5	100	107	19.02	17.78
313	25/12/1995	102	116	99	107	19.12	18.14
314	01/01/1996	100	120	102	109	19.44	18.72
315	08/01/1996	110	122	106	111	19.99	19.18
316	15/01/1996	102	108	102	116	19.43	18.53
317	22/01/1996	98	106	99	110	18.64	17.61
318	29/01/1996	94.5	105	93	105.5	18.35	17.19
319	05/02/1996	99	110	91	97	17.64	16.64
320	12/02/1996	90	99	100	104	17.72	16.99
321	19/02/1996	94	99	104	102	18.8	17.98
322	26/02/1996	95	100	108	100	21.45	18.79
323	04/03/1996	105	106	102	98	19.49	18.77
324	11/03/1996	110	110	95	95	19.72	18.84
325	18/03/1996	113	106	97	106	20.8	19.3
326	25/03/1996	113	104	107	100	23.16	20.55
327	01/04/1996	116	103	106	110	22.03	20.98
328	08/04/1996	115.5	107	108	109	22.49	20.94
329	15/04/1996	116	110	110	109	23.95	22.67
330	22/04/1996	115	110.5	110	109	24.34	20.52
331	29/04/1996	111	111	105	108	23.8	20.28
332	06/05/1996	102	103	104	111	21.16	19.47
333	13/05/1996	110	108	102	109	20.98	19.63
334	20/05/1996	93	95	104	108	21.06	19.06
335	27/05/1996	94	90	98	99	22.24	19.2
336	03/06/1996	88.5	87	98	100	20.37	18.67
337	10/06/1996	83	80	92.5	88	20.04	18.31
338	17/06/1996	89	97	96	93	20.15	18.16
339	24/06/1996	88	93	100	97	20.95	18.56
340	01/07/1996	90	97	100	96	20.55	18.8
341	08/07/1996	90	98.5	98	99	21.4	19.62
342	15/07/1996	90	98	98	99	21.65	19.8
343	22/07/1996	91	93	92	97	21.8	19.93
344	29/07/1996	88	96	88	95	20.96	19.3
345	05/08/1996	98	96	88	95	20.66	19.07
346	12/08/1996	100	95	96	97	21.35	19.73

347	19/08/1996	100	108	96	97	22.25	20.95
348	26/08/1996	100	103	100	94	22.5	21.15
349	02/09/1996	111	116	98	97	21.82	20.78
350	09/09/1996	114	115	105	105	23.48	22.18
351	16/09/1996	111	117	115	116	24.42	23.08
352	23/09/1996	113	117	113	109	23.52	22.11
353	30/09/1996	112	115	112	114	24.33	22.85
354	07/10/1996	126	120	118	119	24.44	23.59
355	14/10/1996	125	122	136	120	24.93	24.18
356	21/10/1996	128	122	136	120	25.45	24.77
357	28/10/1996	124	119	131	120	25.15	24.7
358	04/11/1996	112	113	119	123	23.91	23.2
359	11/11/1996	117	120	119	121	22.92	21.99
360	18/11/1996	111	119	120	120	23.9	22.88
361	25/11/1996	121	124	123	124	24.03	23.21
362	02/12/1996	127	120	124	123	24.21	23.05
363	09/12/1996	120	120	111	122	25.14	24.18
364	16/12/1996	123	124	106	119	24.2	23.27
365	23/12/1996	112	114	113	118	26.02	23.97
366	30/12/1996	113	116	115	119	25.44	23.57
367	06/01/1997	119	124	110	120	25.59	24.12
368	13/01/1997	100	103	89	91	26.3	24.67
369	20/01/1997	101	95	111	116	25.42	23.23
370	27/01/1997	94	99	101	104	24.4	22.9
371	03/02/1997	98	97	99	100	24.24	22.98
372	10/02/1997	100	96	92	98	23.49	22.53
373	17/02/1997	100	103	89	91	22.21	20.83
374	24/02/1997	89	96	92	95	22.18	20.54
375	03/03/1997	92	98	84	91	20.83	19.83
376	10/03/1997	85	95	85	94	20.77	19.36
377	17/03/1997	90.5	96	98	94	20.64	19.1
378	24/03/1997	89	95	98	93	21.72	19.51
379	31/03/1997	91	99	98	93	20.83	18.73
380	07/04/1997	86	98	94	90	19.76	17.84
381	14/04/1997	86	95	95	94	19.38	17.14
382	21/04/1997	87	97	93	95	19.65	17.33
383	28/04/1997	84.5	97	93	98.5	19.85	17.76
384	05/05/1997	83	97	93.5	105	19.99	18.08
385	12/05/1997	89	97	97.5	106.5	19.94	18.06
386	19/05/1997	72	67	69	76	21.45	19.42
387	26/05/1997	84	98	95.5	102	21.43	19.91
388	02/06/1997	84.5	94	95.5	94.5	20.9	19.15
389	09/06/1997	89.5	97	99.5	98	20.12	18.3
390	16/06/1997	88.5	95	95	101	18.88	16.88
391	23/06/1997	84.5	95	91	102	18.93	17.27
392	30/06/1997	86	95	89	97	19	17.74
393	07/07/1997	88.5	96.5	95	97	19.95	18.41
394	14/07/1997	89	97	93.5	94.5	19.44	18.17
395	21/07/1997	91	97	98	103	19.49	18.26
396	28/07/1997	93	98	96	102	19.52	18.57
397	04/08/1997	95.5	103	97	104.5	20.13	18.96
398	11/08/1997	96	105	102	102	20.35	19.17
399	18/08/1997	98	107	107	101	19.99	18.63
400	25/08/1997	94	102	107	102	19.92	18.6
401	01/09/1997	96	105	105	109	19.5	17.83
402	08/09/1997	97	104	101	108	19.61	18.1
403	15/09/1997	98	108	99	111	19.44	18.11
404	22/09/1997	99	111	101	112	19.44	18.22
405	29/09/1997	101	113	102	111	20.12	18.83

406	06/10/1997	104	110	110.5	107	21.62	20.14
407	13/10/1997	103	110	108	108	22.01	20.75
408	20/10/1997	103	110	106.5	107.5	21.03	19.55
409	27/10/1997	107	113	115	107	21	19.56
410	03/11/1997	108	109	117	109	20.92	19.27
411	10/11/1997	107	107	111	109	20.65	19.14
412	17/11/1997	112	107	108	106	20.66	19.59
413	24/11/1997	107	111	105	105	19.81	19.2
414	01/12/1997	101	103	100	99	19.3	18.85
415	08/12/1997	94	103	94.5	92	18.69	17.92
416	15/12/1997	86	96	86	89	18.44	17.32
417	22/12/1997	86	90.5	82	87	18.31	17.04
418	29/12/1997	86	86	79	87	18.31	17.06
419	05/01/1998	80	76	79.5	88	17.58	16
420	12/01/1998	72	68	70	80	16.83	15.38
421	19/01/1998	72	67	69	76	16.47	14.92
422	26/01/1998	61	67	72	74	16.02	14.72
423	02/02/1998	66	60	69	72	17.3	15.61
424	09/02/1998	66	60	69	71	16.65	14.92
425	16/02/1998	69	60	74	67	16.25	14.36
426	23/02/1998	67	60	70	73	16.03	13.68
427	02/03/1998	69.5	62.5	63	62	15.3	13.32
428	09/03/1998	68	73	62	62	15.23	13.13
429	16/03/1998	65	71	56	56	14.4	12.31
430	23/03/1998	67	70	56	54	14.04	11.95
431	30/03/1998	75	77	71	60	16.42	14.61
432	06/04/1998	78	78	83	62	15.98	13.79
433	13/04/1998	79	80	79	69	15.55	12.99
434	20/04/1998	85	77	79	72	15.53	13.55
435	27/04/1998	80	81	78	74	14.5	13.64
436	04/05/1998	79	92	72	81	15.71	14
437	11/05/1998	71	76	78	68	15.48	13.95
438	18/05/1998	72	67	69	76	15.03	14.39
439	25/05/1998	67	62	70	76	13.91	14.56
440	01/06/1998	67	61	71	72	14.99	14.45
441	08/06/1998	68	62	66	68	15.02	13.63
442	15/06/1998	65	60	66	74	13.42	12.46
443	22/06/1998	67	60	69	70	12.04	10.92
444	29/06/1998	67	66	75	69	14.17	11.96
445	06/07/1998	68	67	73	75	14.41	11.87
446	13/07/1998	65	63	69	77	13.94	11.66
447	20/07/1998	63	55	67	65	14.48	12.04
448	27/07/1998	64	61	66	65	13.89	12.12
449	03/08/1998	57	59	57	52	14.24	12.61
450	10/08/1998	64	59	66	63	13.83	12.1
451	17/08/1998	63	62	63	61	13.12	11.39
452	24/08/1998	61	62	60	57	13.33	12
453	31/08/1998	62	63	59	56	13.65	12.16
454	07/09/1998	64	68	57	55	13.98	12.42
455	14/09/1998	70	79	69	64	14.45	12.61
456	21/09/1998	69	79	70	68	14.88	12.92
457	28/09/1998	72	86	72	72	15.78	14.55
458	05/10/1998	72.5	90	72	77	15.83	14.43
459	12/10/1998	68	80	69	74	15.02	13.61
460	19/10/1998	66	78	72	74	14.21	12.45
461	26/10/1998	68	84	67	76	13.81	11.74
462	02/11/1998	66	83	67	75	14.34	12.35
463	09/11/1998	65	80	68	75	14.13	11.9
464	16/11/1998	65	80	66	75	13.63	11.36

465	23/11/1998	60	70	59	70	12.4	10.56
466	30/11/1998	55	64	59	68	11.62	10.56
467	07/12/1998	53	59	52	61	11.28	9.85
468	14/12/1998	50	59	50	61	11.16	9.44
469	21/12/1998	50	66	56	58	11.5	9.89
470	28/12/1998	53	67	58	58	11	9.78
471	04/01/1999	66	70	60	62	11.83	10.41
472	11/01/1999	66	65	55	60	12.67	10.94
473	18/01/1999	66	66	62	60	12.62	11.36
474	25/01/1999	63	68	54	60	12.26	11.04
476	01/02/1999	62	66	53	60	12.46	11.11
477	08/02/1999	57	56	54	55	12.16	10.52
478	15/02/1999	56	56	50	55	11.81	9.88
479	22/02/1999	57	59	58	61	11.66	10.07
480	01/03/1999	61	65	66	64	12.36	10.58
481	08/03/1999	60	61	62.5	64.5	12.9	10.79
482	15/03/1999	66	81	79	78	14.19	11.67
483	22/03/1999	66.5	78.5	78	77	14.91	12.75
484	29/03/1999	67.5	66	76	71	15.55	13.57
485	05/04/1999	74	74	78	70	16.61	14.62
486	12/04/1999	71	73	77	68	16.45	14.13
487	19/04/1999	70	80	78	68.5	16.77	14.7
488	26/04/1999	70	80	78	68.5	17.93	16.07
489	03/05/1999	79	89	87	86	18.23	16.18
490	10/05/1999	89	91	89	86	18.62	16.48
491	17/05/1999	72	80.5	79	88.5	18	15.22
492	24/05/1999	71	81	80	88	17.18	14.55
493	31/05/1999	70	83	82	88	17.07	14.9
494	07/06/1999	73	87	80.5	84	16.77	14.49
495	14/06/1999	80	88	83	83	17.96	16.13
496	21/06/1999	92	88	86	86	18.21	16.12
497	28/06/1999	88	87	83	86.5	18.05	16.03
498	05/07/1999	89	90	87	87.5	19.04	16.88
499	12/07/1999	95	95	95	83	19.87	18.62
500	19/07/1999	98	103.5	100	86.5	20.21	19.25
501	26/07/1999	95.5	102	98.5	90	19.89	19.28
502	02/08/1999	105.5	103	95	90	20.62	19.76
503	09/08/1999	114.5	113	110	107	20.54	19.44
504	16/08/1999	112.5	119	111.5	109	21.44	20.21
505	23/08/1999	121	128.5	125	121	21.62	20.8
506	30/08/1999	116	125.5	117.5	115	21.21	20.25
507	06/09/1999	110.5	123	120	124	21.88	20.9
508	13/09/1999	117	127.5	126	126	23	21.94
509	20/09/1999	120.5	126	120	135	24.28	23.08
510	27/09/1999	122	135	129	132	24.53	23.02
511	04/10/1999	122	137	130	132	24.58	23.25
512	11/10/1999	131	145	128	132	22.72	22.42
513	18/10/1999	122	135	129	132	22.54	21.78
514	25/10/1999	129.5	147	123	130	22.65	21.79
515	01/11/1999	126	152	120	132	22.5	21.82
516	08/11/1999	123.5	150	118	129	22.72	22.22
517	15/11/1999	128	153	122	130	24.22	24.77
518	22/11/1999	131	154	135	137	26.05	25.19
519	29/11/1999	131	154	135	137	27.35	25.82
520	06/12/1999	130	151	132	138	25.46	25.35
521	13/12/1999	129.5	139.5	125	138	26.19	25.74
522	20/12/1999	124	145	126	135	26.2	25.44
523	27/12/1999	123	144	125	136	26.07	25.41
524	03/01/2000	123	142	122	138.5	26.34	25.28

525	10/01/2000	124.5	135.5	122.5	134	24.95	23.64
526	17/01/2000	125.5	134.5	122	130	26.27	24.34
527	24/01/2000	130	135	133.5	139	29.37	26.38
528	31/01/2000	131.5	136	138	144	28.34	26.99
529	07/02/2000	133	136	142	139	28.08	27.33
530	14/02/2000	132	143	135	143.5	28.83	27.63
531	21/02/2000	133	145.5	129.5	142	29.87	27.81
532	28/02/2000	145	152	136	150	30.1	27.76
533	06/03/2000	166.5	174.5	152	152	31.07	29.49
534	13/03/2000	169	197.5	154	178	32.14	30.3
535	20/03/2000	148	163.5	140	165	31.29	28.39
536	27/03/2000	131.5	164	133	151.5	27.99	25.47
537	03/04/2000	130	178	131	150	26.92	24.33
538	10/04/2000	130	161	123.5	165	25.6	23.28
539	17/04/2000	125	155.5	135	153	24.87	21.66
540	24/04/2000	125	156	132	147.5	26.66	22.99
541	01/05/2000	117	159	139	146	25.95	23.28
542	08/05/2000	118	162	146	145	26.75	24.96
543	15/05/2000	121	164	132	153	28.7	26.9
544	22/05/2000	131.5	165	135	157.5	29.88	28.67
545	29/05/2000	138	169	145	157	29.46	29.05
546	05/06/2000	143	169.5	152	164	29.98	29.64
547	12/06/2000	141	169	145	159.5	29.79	28.67
548	19/06/2000	147	165	149	169	32.45	29.81
549	26/06/2000	147	174	143	160	33.55	29.78
550	03/07/2000	149	175	149	167	32.12	31.03
551	10/07/2000	141	157	143	161	30.4	30.9
552	17/07/2000	131	152.5	134	149	30.44	30.53
553	24/07/2000	127	143.5	129	150	30.65	27.95
554	31/07/2000	128.5	142	135	150	28.02	26.02
555	07/08/2000	130	140	122.5	164	28.5	26.48
556	14/08/2000	131	147.5	124	143	30.14	28.34
557	21/08/2000	133	145.5	128.5	143	31.82	30.07
558	28/08/2000	137	153.5	152	145.5	32.46	31.77
559	04/09/2000	145	159	147	160	33.08	34.32
560	11/09/2000	159	172.5	149	157	34.42	36.43
561	18/09/2000	161	175	152	159	34.7	33.26
562	25/09/2000	160	172	151	165	35.49	33.09
563	02/10/2000	152	168	148	163.5	31.13	29.41
564	09/10/2000	159	173	148.5	180	31.27	29.83
565	16/10/2000	177	208	169	183	33.9	31.83
566	23/10/2000	156	186	155.5	178.5	33.48	30.97
567	30/10/2000	156	186	151.5	180.5	33.92	31.35
568	06/11/2000	145	175.5	142	164	32.78	30.9
569	13/11/2000	143	166	135	155	33.46	31.59
570	20/11/2000	150	167.5	146	161	35	33.32
571	27/11/2000	151	157	141	150.5	35.91	33.46
572	04/12/2000	149.5	151	131.5	151	34.1	32.53
573	11/12/2000	132	136	123	144	29.69	28.28
574	18/12/2000	121	126	119	129.5	29.05	25.94
575	25/12/2000	108	122.5	110.5	120.5	27.38	23.48
576	01/01/2001	149.5	151	131.5	122	26.52	22.48
577	08/01/2001	105.5	126.5	116	123.5	27.8	24.05
578	15/01/2001	105	121.5	112.5	125	28.81	25.02
579	22/01/2001	103.5	115	114	123.5	30.63	25.37
580	29/01/2001	109.5	117.5	132	122.5	31.35	27.15
581	05/02/2001	125	127.5	125.5	128	29.59	27.19
582	12/02/2001	113	137.5	138	138.5	30.92	29.62
583	19/02/2001	119.5	127	131	137.5	29.67	27.63

584	26/02/2001	119	130	132.5	131	28.65	26.29
585	05/03/2001	133	128	132	134	27.91	25.26
586	12/03/2001	127	141.5	135.5	148	28.45	25.93
587	19/03/2001	119.5	133	118.5	130	27.02	24.33
588	26/03/2001	111	130.5	110	130.5	26.42	23.48
589	02/04/2001	111.5	132	105.5	121.5	26.86	24.04
590	09/04/2001	112	137	109	119.5	26.76	24
591	16/04/2001	115	139	106	124.5	28.27	26
592	23/04/2001	119	146	105	128	27.89	26.27
593	30/04/2001	121	148	109	123.5	26.99	26.05
594	07/05/2001	124	148	115	148.5	28.36	27.28
595	14/05/2001	120	151	116.5	150.5	28.12	27.77
596	21/05/2001	128	149.5	116.5	138.5	29.08	28.34
597	28/05/2001	122.5	146.5	116.5	141	28.92	29.31
598	04/06/2001	121	140.5	111	144	28.44	28.86
599	11/06/2001	119	136	104.5	134	27.98	28.87
600	18/06/2001	124	134	113.5	135	28.9	28.87
601	25/06/2001	121	129.5	114	134.5	27.09	26.82
602	02/07/2001	117	128	115	128.5	26.37	26.63
603	09/07/2001	116.5	131	117.5	133.5	26.87	25.9
604	16/07/2001	113	127.5	115	132	27.07	24.47
605	23/07/2001	119	139.5	112.5	125	25.26	23.47
606	30/07/2001	118	140	114	123.5	26.5	24.69
607	06/08/2001	123.5	136	117	126	27.1	24.83
608	13/08/2001	123	142.5	116	128	27.87	25.6
609	20/08/2001	124	142	117.5	129.5	27.52	25.41
610	27/08/2001	124.5	139	119	132	27.25	25.48
611	03/09/2001	127	143	129.5	134.5	26.84	26.57
612	10/09/2001	132	145	136.5	140.5	27.38	26.64
613	17/09/2001	139	161	144	149.5	28.22	28.47
614	24/09/2001	129	155	121.5	128	27.09	26.41
615	01/10/2001	116	137.5	113.5	132.5	22.35	20.95
616	08/10/2001	114	132	111.5	126.5	22.6	21.11
617	15/10/2001	115	138	113.5	125.5	22.66	20.91
618	22/10/2001	103.5	128	101	124	21.92	19.88
619	29/10/2001	104	122	100.5	110	21.78	20.46
620	05/11/2001	96	110.5	91.5	105	21.17	19.72
621	12/11/2001	102.5	115	106	100.5	20.7	19.31
622	19/11/2001	97	102	83.5	83.5	19.61	18.42
623	26/11/2001	105.5	106	91.5	87	18.28	18.57
624	03/12/2001	108	106.5	98	89	19.13	18.8
625	10/12/2001	103	111.5	100	95	19.47	18.99
626	17/12/2001	98	109.5	99	109	18.45	18.02
627	24/12/2001	102	119.5	99	118.5	19.2	18.74
628	31/12/2001	103	116	100	120	20.94	19.1
629	07/01/2002	104	113	103	123	20.8	20.29
630	14/01/2002	108	109	101.5	107.5	20.54	20.42
631	21/01/2002	105	110	100	105	18.61	18.52
632	28/01/2002	103	112	95	103	19.21	18.77
633	04/02/2002	100	115	95.5	102	19.71	19.3
634	11/02/2002	102	119.5	96	107	19.97	19.91
635	18/02/2002	105.5	122	100	103	21.18	20.99
636	25/02/2002	109	119	102	103	20.7	20.02
637	04/03/2002	117	128	111.5	110.5	21.43	20.6
638	11/03/2002	119.5	138.5	118.5	118	23.31	22.27
639	18/03/2002	123.5	138	119	126.5	24.4	23.42
640	25/03/2002	121	137	130.5	134.5	25.25	24.43
641	01/04/2002	127	146	130	132.5	25.86	25.03
642	08/04/2002	137	147.5	141	156	26.99	26.42

643	15/04/2002	126.5	141.5	124.5	141.5	25.24	24.89
644	22/04/2002	135	149.5	134.5	139	25.54	24.89
645	29/04/2002	142	149	138.5	145.5	26.46	26.24
646	06/05/2002	140.5	152	141	142	26.88	26.41
647	13/05/2002	143	158.5	142	144	27.27	26.15
648	20/05/2002	146.5	159	147	148	28.43	26.35
649	27/05/2002	142	158	133	140.5	27.18	24.61
650	03/06/2002	136.5	151	141	138	25.22	24
651	10/06/2002	138	153	146	152.5	25.01	22.99
652	17/06/2002	136	152	141	145	24.94	23.2
653	24/06/2002	131.5	150	137	157	25.61	24.55
654	01/07/2002	137.5	153	144	164	26.52	25.16
655	08/07/2002	144	155.5	142.5	166	26.81	25.63
656	15/07/2002	146	157.5	142.5	148	26.7	25.55
657	22/07/2002	140.5	161.5	141	144	27.62	26.28
658	29/07/2002	137	161	143	144	26.64	25.45
659	05/08/2002	139.5	165.5	145.5	150	26.87	25.68
660	12/08/2002	138.5	163	142	156	26.77	25.52
661	19/08/2002	143	163.5	146	156	28.52	26.44
662	26/08/2002	150	168	149	162	30.09	27.58
663	02/09/2002	158	171	155	167	28.84	27.53
664	09/09/2002	162	176.5	156	166	28.65	27.45
665	16/09/2002	162.5	174.5	159	166	29.59	28.51
666	23/09/2002	164	173	158	175	29.39	28.32
667	30/09/2002	164	171.5	161	172.5	30.63	29.17
668	07/10/2002	166	166.5	165	174	30.25	28.89
669	14/10/2002	153.5	159.5	154	173	29.37	28.17
670	21/10/2002	150	161	150	171	29.65	28.45
671	28/10/2002	138	152	135	144.5	27.88	26.62
672	04/11/2002	131.5	146	138	147.5	27.03	25.55
673	11/11/2002	120.5	139.5	118	133	25.97	24.3
674	18/11/2002	118.5	138	119	113.5	25.68	23.4
675	25/11/2002	130	172	131	146.5	26.98	24.16
676	02/12/2002	125	159.5	132	145.5	26.83	25.19
677	09/12/2002	124	161.5	130	120.5	27.14	25.91
678	16/12/2002	137	170.5	142	156.5	27.82	26.84
679	23/12/2002	154.5	173.5	171	170.5	30.35	29.56
680	30/12/2002	158	173	175	165	32.38	31.01
681	06/01/2003	168.5	174	180	159	31.96	30.97
682	13/01/2003	169	169.5	202	148	31.54	30.37
683	20/01/2003	186	199	204	156.5	33.04	31.48
684	27/01/2003	174	191.5	199	166	34.46	31.81
685	03/02/2003	174	189	189	224	33.19	31.2
686	10/02/2003	184	205.5	199	206	33.95	31.58
687	17/02/2003	164.5	195	184	150	35.79	32.79
688	24/02/2003	168.5	199.5	170.5	180	36.78	33
689	03/03/2003	162	196	168	172	36.98	33.72
690	10/03/2003	159	191.5	164	152	36.98	34.11
691	17/03/2003	158	200.5	168	162.5	36.66	33.72
692	24/03/2003	129	188	146	159	30.46	28.18
693	31/03/2003	144	192.5	158	182	30.43	26.95
694	07/04/2003	126	169.5	135	171	29.33	26.93
695	14/04/2003	121.5	154	129.5	148	28.03	24.96
696	21/04/2003	127	163.5	132.5	156	29.28	24.92
697	28/04/2003	126	182	134	118.5	28.43	24.66
698	05/05/2003	133	184	148	117	25.69	23.55
699	12/05/2003	137	165.5	149	149	26.58	24.31
700	19/05/2003	140.5	153.5	130.5	137	28.54	26.21
701	26/05/2003	144.5	166	135	135	29.29	27.19

702	02/06/2003	150.5	156	139	158	29.1	26.56
703	09/06/2003	145	160.5	153	151	30.68	27.92
704	16/06/2003	139.5	160.5	146	151	31.46	28.38
705	23/06/2003	147.5	171.5	158	152	30.6	26.88
706	30/06/2003	154	174.5	165.5	175	30.01	27.19
707	07/07/2003	168.5	175	169	180	30.31	28.4
708	14/07/2003	169.5	181.5	177	201	30.73	28.42
709	21/07/2003	168	181	168	194	31.48	28.74
710	28/07/2003	160	174	166	171	30.61	28.02
711	04/08/2003	167	175.5	176	166	30.73	28.52
712	11/08/2003	166.5	171.5	180	160	32.11	30.19
713	18/08/2003	158.5	167.5	177	157	31.31	29.6
714	25/08/2003	159	167	175	160	31.19	29.7
715	01/09/2003	158	166	171	169	31.56	30.12
716	08/09/2003	156	165	166	174.5	29.2	28.16
717	15/09/2003	145	162	147	163	28.92	27.57
718	22/09/2003	141	155	139	155	27.39	25.9
719	29/09/2003	148	161	154.5	157	27.73	26.49
720	06/10/2003	158	166	158.5	157	29.43	28.38
721	13/10/2003	157	170.5	164	166	30.69	29.88
722	20/10/2003	151	162.5	163	154	31.49	31
723	27/10/2003	157	160.5	157.5	147.5	30.17	29.66
724	03/11/2003	153	160	153	144	29.28	28.46
725	10/11/2003	159	164	161.5	155	29.79	28.05
726	17/11/2003	159	165.5	164	151	31.56	29.01
727	24/11/2003	147	158.5	159	156	32.58	29.61
728	01/12/2003	141	158	152.5	150	30.11	28.34
729	08/12/2003	136.5	160.5	143	151	30.63	28.93
730	15/12/2003	138.5	165.5	153	150	32.16	30.17
731	22/12/2003	135.5	164.5	152	152	33.2	30.87
732	29/12/2003	133.5	160	147	153.5	32.24	28.84
733	05/01/2004	139	159.5	154.5	158	32.68	29.78
734	12/01/2004	155	169.5	156	172	33.89	31.5
735	19/01/2004	145	174.5	143	185	34.51	31.7
736	26/01/2004	131.5	173	154	166	35.45	31.88
737	02/02/2004	130.5	168	150.5	163	33.61	30.39
738	09/02/2004	130	169	153	162	33.41	29.66
739	16/02/2004	139.5	170	152.5	160	33.88	30.12
740	23/02/2004	140	167.5	150.5	155	35.54	31.39
741	01/03/2004	146	168	156.5	156.5	36.08	32.27
742	08/03/2004	151	165	158.5	154.5	36.67	33.73
743	15/03/2004	142.5	165	151	156	36.44	33.36
744	22/03/2004	142	165.5	156	166	37.78	34.56
745	29/03/2004	142	165.5	154	170.5	36.65	33.59
746	05/04/2004	144	169	152.5	175	35.23	32.23
747	12/04/2004	151	172	161	176	35.7	32.75
748	19/04/2004	161.5	173.5	160.5	168.5	37.39	33.95
749	26/04/2004	155	174	166	168	37.32	33.7
750	03/05/2004	161	179.5	163	170	37.31	34.64
751	10/05/2004	164.5	185.5	174	168	39.24	36.38
752	17/05/2004	173.5	191.5	185.5	183	40.37	37.62
753	24/05/2004	168.5	188.5	187.5	184	40.84	38.43
754	31/05/2004	167.5	184.5	183	195	40.65	37.95
755	07/06/2004	162.5	185	179	198	40.01	37.25
756	14/06/2004	150	176.5	169	199	37.99	35.34
757	21/06/2004	158	180.5	165.5	191	37.86	35.09
758	28/06/2004	150	176.5	159	199	37.7	34.71
759	05/07/2004	159.5	182	166	195	37.14	34
760	12/07/2004	163.5	179.5	168	193	39.73	36.51

761	19/07/2004	164	179.5	163.5	184	40.33	37.76
762	26/07/2004	173	184	163	182	41.27	39.05
763	02/08/2004	173	189	173	183	42.5	40.66
764	09/08/2004	169	193	178	186	43.81	42.01
765	16/08/2004	171.5	193.5	171.5	198	45.24	43.16
766	23/08/2004	168	190	174	197	47.28	44.56
767	30/08/2004	156	187	165	189	44.34	42.23
768	06/09/2004	160	186	169	189	43.28	41
769	13/09/2004	162	186	174	185	43.33	40.6
770	20/09/2004	162	185	174	187	44.39	41.55
771	27/09/2004	167	194.5	182.5	193	47.82	45.3
772	04/10/2004	168	193	197	215	49.71	47.11
773	11/10/2004	174	196	212	235	51.77	48.09
774	18/10/2004	177.5	203.5	220	254.5	54.12	50.96
775	25/10/2004	181.5	206	236	259.5	54.43	50.5
776	01/11/2004	171	207	213	255.5	53.43	50.15
777	08/11/2004	171	207	213	255.5	49.81	45.78
778	15/11/2004	137	189.5	139	200	48	42.83
779	22/11/2004	141	185	147	194.5	47.02	40.63
780	29/11/2004	144	189	145	201	48.79	42.78
781	06/12/2004	136	168.5	121	179	46.06	41.31
782	13/12/2004	136	158.5	143.5	179	41.91	37.6
783	20/12/2004	155	173.5	194	171	43.5	39.98
784	27/12/2004	150	169.5	187	180	44.39	41.15
785	03/01/2005	141	159	176	184	42.52	39.79
786	10/01/2005	149	170.5	186.5	188	44.07	42.07
787	17/01/2005	163.5	189.5	184.5	186	46.79	44.59
788	24/01/2005	168.5	195	177	191	47.85	45.08
789	31/01/2005	157	190.5	177	199	48.56	45.82
790	07/02/2005	165	195.5	169	201.5	46.97	44.04
791	14/02/2005	168	193.5	173.5	201.5	46.08	43.29
792	21/02/2005	175	195	180	200	47.82	45.22
793	28/02/2005	187	207	197	226	51.75	48.23
794	07/03/2005	194.5	212	205	224	52.74	51.33
795	14/03/2005	203.5	221.5	188	224	54.22	53.09
796	21/03/2005	203.5	221.5	188	224	55.93	54.85
797	28/03/2005	207	236.5	212	235	52.95	53.76
798	04/04/2005	230.5	254	230	256	54.97	52.23
799	11/04/2005	235	261.5	260	264	55.24	53.79
800	18/04/2005	211	242	231.5	253	51.44	50.43
801	25/04/2005	247	284.5	259	251	52.39	51.23
802	02/05/2005	242	268.5	261.5	286	52	51.64
803	09/05/2005	233.5	263.5	267.5	288.5	50.64	50.05
804	16/05/2005	229	247	237	267.5	50.33	48.7
805	23/05/2005	225.5	252	251	257	47.77	46.98
806	30/05/2005	219	253	254	253.5	50.15	48.59
807	06/06/2005	238.5	266.5	255	259	53.76	50.46
808	13/06/2005	239	265.5	257	258	53.74	51.9
809	20/06/2005	243	262.5	258	251	56.18	54.17
810	27/06/2005	251.5	264.5	250	249	59.04	56.95
811	04/07/2005	246.5	262	244	257.5	58.21	56.69
812	11/07/2005	257	274	267	265	60.36	57.98
813	18/07/2005	251	255	249	263	59.18	57.43
814	25/07/2005	246	253	242	246	57.3	56.39
815	01/08/2005	246	253.5	253.5	248	59.39	58.5
816	08/08/2005	261	268	258.5	253.5	61.64	60.42
817	15/08/2005	271	281.5	272	269.5	64.85	64.46
818	22/08/2005	270	283	266	266	64.92	64.23
819	29/08/2005	275	296.5	285.5	302.5	66.34	65.68

820	05/09/2005	290	326	302.5	309.5	68.47	66.09
821	12/09/2005	267.5	306.5	292	312.5	64.81	63.24
822	19/09/2005	274.5	308	280	306	63.84	61.22
823	26/09/2005	280	309	322.5	331.5	66.43	63.63
824	03/10/2005	287	315	328	335	66.06	62.16
825	10/10/2005	272	313.5	295.5	307	63.06	58.93
826	17/10/2005	278	329	294	318.5	62.87	58.59
827	24/10/2005	262.5	322.5	286	317.5	62.28	58.15
828	31/10/2005	262.5	312	281	318.5	61.33	58.5
829	07/11/2005	261	310	278	311	60.34	58.74
830	14/11/2005	250	297	260	296	58.8	56.79
831	21/11/2005	255	294	256	280.5	57	53.77
832	28/11/2005	246.5	290	258	287	58.13	53.57
833	05/12/2005	264.5	301.5	265	291	57.78	53.59
834	12/12/2005	265	300.5	279	297	59.83	56.07
835	19/12/2005	256	278.5	281	301	60.32	58.75
836	26/12/2005	258	279	282	300	57.97	56.36
837	02/01/2006	263	286	289	311	59.82	57.38
838	09/01/2006	279.5	298	292.5	315	63.39	61.72
839	16/01/2006	283	305.5	286	309	63.74	62.18
840	23/01/2006	302	321	314	329	66.79	63.54
841	30/01/2006	301	321	315	326	66.82	63.77
842	06/02/2006	303.5	322	321.5	321.5	66.59	64
843	13/02/2006	299	318.5	309	322	63.06	61.23
844	20/02/2006	291	314	292.5	319	59.37	58.04
845	27/02/2006	298	316.5	309	329	59.93	59.39
846	06/03/2006	293.5	331.5	309	333.5	62.27	61.06
847	13/03/2006	287	329.5	301	317	60.89	59.5
848	20/03/2006	296.5	335	306	327.5	62.64	62.42
849	27/03/2006	302	331.5	309	317.5	61.36	61.61
850	03/04/2006	316	338	314.5	317	65.67	64.76
851	10/04/2006	316	341	324	334.5	66.56	66.93
852	17/04/2006	317.5	342.5	329.5	328	68.85	68.91
853	24/04/2006	330.5	357	337	348	71.87	72.54
854	01/05/2006	324	361	314	366.5	70.38	72.84
855	08/05/2006	324	346	334	370	72.14	72.92
856	15/05/2006	320.5	346	332	363.5	71.5	70.44
857	22/05/2006	317.5	339.5	323.5	347.5	69.07	67.84
858	29/05/2006	320	338.5	329	341	70.35	68.47
859	05/06/2006	316	339	320	333.5	71.53	68.75
860	12/06/2006	310	333	312.5	332.5	71.54	67.89
861	19/06/2006	291.5	320	300	323	69.48	66.17
862	26/06/2006	295	320	278	314	69.94	68.33
863	03/07/2006	304	337.5	311	323	72.65	71.82
864	10/07/2006	301	338	313	335	74.65	73.45
865	17/07/2006	335	335	345.5	358	75.21	73.99
866	24/07/2006	316.5	332	332	362.5	73.98	73.52
867	31/07/2006	317.5	334	331	359	73.87	73.53
868	07/08/2006	321.5	337	330	334	75.2	76.32
869	14/08/2006	313	323.5	333	336	75.63	76.98
870	21/08/2006	314	319	314	319.5	71.79	72.35
871	28/08/2006	295	302.5	325	330.5	72.12	71.92
872	04/09/2006	286	287	310.5	320	70.01	68.35
873	11/09/2006	278	287.5	298	308	67.53	65.76
874	18/09/2006	276	288	271	291	63.98	61.38
875	25/09/2006	257.5	279	261	272	61.4	60.23
876	02/10/2006	268	291	259	298	61.94	58.76
877	09/10/2006	368.5	290.5	267	296	59.77	57.15
878	16/10/2006	270	292	274.5	284	58.58	58.33

879	23/10/2006	259	277.5	266	285.5	58.48	58.51
880	30/10/2006	258.5	281	274	282	58.88	57.73
881	06/11/2006	260.5	280	254	279	58.55	56.48
882	13/11/2006	263	269	273	284.5	59.96	58.02
883	20/11/2006	255	253	255	284.5	57.56	57.85
884	27/11/2006	253	256.5	260	299.5	57.24	59.2
885	04/12/2006	255	264	266	333	62.02	62.59
886	11/12/2006	258.5	264	275.5	320	62.32	63.63
887	18/12/2006	260.5	268.5	264	259.5	61.91	62.56
888	25/12/2006	260	270	260	267	62.4	62.44
889	01/01/2007	233	275	258	264.5	60.66	59.69
890	08/01/2007	236	281	253	263.5	57.76	55.63
891	15/01/2007	230	281	246	271	54.11	51.79
892	22/01/2007	209.5	276	236	300	51.51	51.4
893	29/01/2007	221.5	298	242	312.5	53.57	54.87
894	05/02/2007	251.5	333	269	322.5	57.11	55.92
895	12/02/2007	260	296.5	276	316	58.99	57.9
896	19/02/2007	249.5	288	265	308	58.41	55.54
897	26/02/2007	265	295	272	300	59.57	58.16
898	05/03/2007	261.5	296	272	322.5	61.64	60.62
899	12/03/2007	258.5	299	268.5	335.5	60.85	60.35
900	19/03/2007	263	302	261.5	312	57.94	60.87
901	26/03/2007	281	322.5	277	319.5	58.26	61.09
902	02/04/2007	298	338	295	336	64.18	66.1
903	09/04/2007	297.5	331	297	340	64.82	68.55
904	16/04/2007	305.5	335	301	331	62.58	68.2
905	23/04/2007	311	337	306	315	63.06	66.21
906	30/04/2007	335	349	329	338	65.26	67.39
907	07/05/2007	326	345.5	336.5	346.5	63.82	66.04
908	14/05/2007	322.5	338	333	377	61.9	63.91
909	21/05/2007	321	337.5	335	378	63.61	67.55
910	28/05/2007	323	339.5	337	336	64.89	70.65

Notes: ** WTI Spot Price FOB; * Europe Brent Spot Price FOB (Dollars per Barrel)

Source: **Bunker price:** Compiled by author from various issues of Fairplay Weekly from 1990 to 2007. **Oil prices:** Retrieved and compiled from World Wide Web: http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_w.htm.

Appendix C - World Oil Production and Oil Consumption (1996-2006)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Oil Production (million tons)											
EU 25	158.63	157.32	161.94	168.35	159.94	149.37	152.11	142.24	131.96	120.26	109.44
EU 27	165.52	164.10	168.53	174.77	166.27	155.64	158.22	148.16	137.69	125.72	114.47
OECD	1006.53	1019.42	1011.54	988.86	1011.07	999.55	1005.39	995.62	975.94	930.60	910.53
OPEC 11	**1380.04**	**1448.26**	**1509.94**	**1447.38**	**1526.03**	**1486.72**	**1393.33**	**1481.34**	**1594.05**	**1629.83**	**1632.66**
OPEC 12	**1415.40**	**1484.76**	**1545.94**	**1484.08**	**1562.88**	**1523.27**	**1437.93**	**1523.80**	**1642.25**	**1690.56**	**1702.06**
Non-OPEC	1643.19	1670.31	1675.89	1665.60	1698.72	1691.37	1716.08	1706.41	1710.07	1689.82	1681.59
Former Soviet Union	353.28	361.91	362.51	369.97	393.40	424.57	466.22	513.60	558.47	577.15	599.82
WORLD PRODUCTION	**3376.51**	**3480.47**	**3548.34**	**3482.95**	**3618.15**	**3602.67**	**3575.63**	**3701.35**	**3862.60**	**3896.79**	**3914.07**
Oil Consumption (million tons)											
USA	836.55	848.02	863.76	888.89	897.64	896.07	897.36	912.26	948.71	951.37	**938.81**
N.America	**994.31**	**1012.32**	**1033.34**	**1058.45**	**1071.37**	**1071.59**	**1071.06**	**1091.84**	**1134.59**	**1139.36**	**1124.59**
S&C America	**208.85**	**219.40**	**226.20**	**225.74**	**223.98**	**226.86**	**224.79**	**217.14**	**222.30**	**229.92**	**236.48**
Netherlands	37.38	39.45	39.36	40.55	41.67	43.68	43.82	44.06	46.17	49.58	49.57
Europe	**932.11**	**936.40**	**942.03**	**935.33**	**927.91**	**934.30**	**932.97**	**940.58**	**953.74**	**960.04**	**970.14**
Middle East	**210.44**	**213.48**	**216.04**	**220.23**	**226.91**	**231.36**	**239.91**	**248.33**	**260.72**	**270.70**	**280.08**
Africa	**106.06**	**108.93**	**112.68**	**115.59**	**116.16**	**116.21**	**117.53**	**120.08**	**124.12**	**127.89**	**130.50**
China	173.80	196.05	197.05	209.60	223.63	227.89	247.41	271.71	318.87	327.81	349.83
Singapore	30.27	32.41	33.30	31.56	33.47	36.42	35.50	33.93	38.15	40.86	44.04
Asia Pacific	**895.18**	**942.62**	**918.66**	**961.68**	**989.88**	**992.24**	**1020.36**	**1057.30**	**1118.24**	**1133.36**	**1147.99**
WORLD CONSUMPTION	**3346.96**	**3433.15**	**3448.95**	**3517.01**	**3556.22**	**3572.55**	**3606.63**	**3675.27**	**3813.71**	**3861.27**	**3889.77**

Source: Retrieved 18 June, 2007 and compiled by author from World Wide Web:
http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2007/STAGING/local_assets/downloads/spreadsheets/statistical_review_full_report_workbook_2007.xls.

Appendix D - Representative Monthly Dry Bulk Time Charter Rates (1998 - 2007)

Unit: US$/day

Month	**Handymax** (45-50,000dwt)	**Panamax** (64-65,000dwt)	**Capesize** (150,000+dwt)
Dec-98	5,750	6,000	8,000
Jan-99	5,500	5,500	7,500
Feb-99	5,500	5,500	7,500
Mar-99	5,500	6,000	7,500
Apr-99	5,500	6,250	7,500
May-99	5,750	6,500	8,000
Jun-99	5,500	6,250	7,500
Jul-99	5,250	6,000	8,000
Aug-99	5,500	6,250	9,000
Sep-99	8,200	8,250	11,500
Oct-99	8,200	8,250	12,250
Nov-99	8,400	8,000	13,000
Dec-99	8,000	7,500	13,500
Jan-00	8,250	7,750	13,000
Feb-00	8,500	8,000	13,000
Mar-00	8,600	8,250	13,750
Apr-00	8,750	9,000	14,000
May-00	8,750	9,000	13,500
Jun-00	8,250	8,790	13,750
Jul-00	8,500	8,900	14,500
Aug-00	8,500	10,000	15,500
Sep-00	9,000	10,000	16,000
Oct-00	9,000	10,000	16,250
Nov-00	8,500	9,750	15,500
Dec-00	8,000	9,250	15,000
Jan-01	8,000	10,000	14,500
Feb-01	7,700	10,000	14,000
Mar-01	8,250	9,750	12,500
Apr-01	7,940	9,500	12,500
May-01	8,400	9,750	13,000
Jun-01	8,250	9,550	13,250
Jul-01	7,400	8,350	11,750
Aug-01	6,500	7,675	9,125
Sep-01	6,450	5,900	8,875
Oct-01	5,900	5,985	8,565
Nov-01	5,150	5,485	7,750
Dec-01	4,900	5,250	7,250
Jan-02	5,400	5,750	7,750
Feb-02	5,400	6,000	8,750
Mar-02	5,650	6,375	10,000
Apr-02	5,800	7,250	10,300
May-02	5,800	7,150	10,000
Jun-02	5,800	7,000	10,250
Jul-02	5,800	7,250	10,750
Aug-02	5,600	7,000	9,750
Sep-02	6,000	7,750	11,000
Oct-02	6,500	8,750	12,250
Nov-02	6,750	9,000	14,250
Dec-02	7,500	10,000	14,750
Jan-03	7,500	11,000	15,500

Feb-03	7,500	10,750	15,250
Mar-03	8,000	11,500	16,500
Apr-03	8,500	11,750	18,500
May-03	8,750	12,400	19,000
Jun-03	8,900	12,200	19,250
Jul-03	9,500	12,600	20,250
Aug-03	9,645	13,145	20,850
Sep-03	11,500	15,250	24,000
Oct-03	16,514	20,000	42,000
Nov-03	19,000	24,000	42,750
Dec-03	20,500	26,000	45,500
Jan-04	23,000	30,500	48,000
Feb-04	32,000	35,000	52,000
Mar-04	31,750	33,500	50,000
Apr-04	30,000	30,250	47,500
May-04	26,000	22,750	36,000
Jun-04	19,000	17,500	27,000
Jul-04	22,000	20,000	36,000
Aug-04	23,000	24,500	38,000
Sep-04	24,000	24,500	37,000
Oct-04	25,000	26,000	47,000
Nov-04	25,500	27,500	52,000
Dec-04	25,500	32,000	60,000
Jan-05	23,500	30,000	50,000
Feb-05	23,750	30,500	51,750
Mar-05	26,000	30,750	54,250
Apr-05	24,700	28,500	54,250
May-05	22,250	25,500	48,500
Jun-05	20,250	20,750	37,750
Jul-05	16,250	16,500	31,000
Aug-05	15,500	16,000	29,000
Sep-05	16,000	17,150	33,000
Oct-05	16,100	17,500	38,000
Nov-05	15,500	15,000	32,000
Dec-05	14,500	14,000	27,000
Jan-06	14,000	12,500	24,000
Feb-06	13,800	11,900	23,800
Mar-06	16,400	12,700	25,500
Apr-06	16,300	12,700	24,700
May-06	16,800	12,500	23,100
Jun-06	20,000	14,300	26,000
Jul-06	20,250	17,500	30,000
Aug-06	25,000	22,000	52,500
Sep-06	26,500	24,000	54,000
Oct-06	26,000	21,500	51,000
Nov-06	23,750	21,750	51,500
Dec-06	24,000	21,250	50,000
Jan-07	24,500	21,750	52,000
Feb-07	24,250	23,500	53,500
Mar-07	27,500	24,500	55,000
Apr-07	30,000	29,000	60,000
May-07	35,000	31,500	64,000

Source: Compiled by author from various issues of Drewry Monthly from 1998 to 2007. (Drewry Shipping Consultants. (1998-2007). *Drewry Monthly* 1990-2007. Author).

Appendix E - Fuel Consumption of Containerships and Bulk Carriers (built after 1990)

	Containerships	Speed (Knot)	TEU	Fuel Consum-ption (Ton/day)	Bulk Carriers	Speed (knot)	Dwt	Fuel Consum-ption (Ton/day)
1	Sandy Rickmers	22.00	1,216	69.00	Shin Hoyo Maru	11.00	1,753	4.10
2	Aglaia	22.20	1,216	69.00	Xin Yang	11.70	2,846	5.00
3	Amalthea	22.20	1,216	69.00	Hiraozan Maru	12.50	4,576	8.80
4	TS Kobe	18.30	1,221	27.00	Sumise Maru	12.60	6,138	12.70
5	Ratana Thida	19.00	1,228	44.20	Wilson Skaw	12.50	6,460	12.50
6	Acx Cherry	18.00	1,241	36.00	Wilson Stadt	12.50	6,463	10.80
7	Acx Cosmos	18.00	1,241	36.00	Yoshu Maru 5	13.30	6,506	12.90
8	Xetha Bhum	17.00	1,288	42.00	Shin Kenyo	12.50	6,564	10.50
9	Kuo Fu	17.00	1,295	33.10	Ryoyo Maru 8	12.50	6,677	8.10
10	Kuo Chang	18.20	1,295	33.10	Tenyo Maru	12.50	6,686	15.00
11	Kuo Wei	18.20	1,295	36.50	Seiyo Maru	12.20	6,710	10.80
12	Kuo Hung	18.20	1,295	36.50	Senpo Maru	12.80	7,483	12.60
13	Aegean Express	18.20	1,295	36.50	Auriga	12.00	7,567	9.50
14	Arabian Express	18.20	1,295	36.50	Sumise Maru 20	12.80	8,562	15.00
15	Kuo Lung	18.20	1,295	36.50	Sumise Maru 1	13.00	8,581	15.00
16	Kuo Chia	18.20	1,295	39.80	Malmnes	13.50	9,891	14.00
17	Wan Hai 212	17.50	1,298	33.20	Nordanhav	13.00	9,891	14.50
18	Wan Hai 211	17.50	1,298	33.20	Sea Orchid	13.60	9,994	14.60
19	CMA CGM Oyapock	17.00	1,334	43.50	Hokuyo Maru	12.80	10,750	15.20
20	Teval	18.50	1,338	42.00	Takuyo Maru	13.00	10,750	15.40
21	Cala Palenque	19.00	1,338	42.00	Rikuryu Maru	12.20	10,836	12.50
22	Wan Hai 213	17.50	1,368	33.20	Libro Doro	13.20	12,609	18.40
23	Wan Hai 215	17.50	1,368	33.20	Active	13.30	12,974	17.00
24	Wan Hai 216	17.50	1,368	33.20	Alert	13.30	12,974	17.00
25	YM Hongkong II	18.50	1,380	44.80	Shin Hsing 2	10.70	13,601	21.80
26	Cape Town Bridge	18.50	1,380	44.80	Warta	12.80	13,790	16.50
27	Durban Bridge	18.50	1,380	44.80	Odra	13.00	13,790	16.50
28	Soraya	25.00	1,388	96.00	Big Fish	13.00	15,578	16.50
29	MSC Adriana	23.00	1,388	113.00	Glory Ocean	13.50	16,061	19.50
30	Kota Wirawan	19.10	1,404	38.00	Glory Sky	13.50	16,264	19.50
31	Asian Trader	19.00	1,404	41.00	Glory Pacific	13.50	16,321	19.50
32	Sinar Toba	19.10	1,404	41.00	Oriental Sapphire	13.50	16,765	12.00
33	STX Singapore	19.10	1,404	41.00	Trimnes	13.50	17,309	19.80
34	Jin Yun He	19.10	1,432	48.00	Ida	14.00	18,172	18.30
35	Caiyunhe	19.10	1,432	48.00	Olga	14.00	18,173	18.30
36	Qiyunhe	19.10	1,432	48.00	Gwendolyn	13.50	18,233	21.30
37	Sinar Biak	17.00	1,441	33.10	Sider Tis	14.00	18,286	20.50
38	Cala Providencia	19.00	1,452	52.50	Al Jaber 18	14.00	18,297	23.90
39	Olivia	19.00	1,452	52.50	Changi Hope	13.50	18,320	21.60
40	Kota Anggerik	18.90	1,454	44.50	Seletar Hope	13.50	18,320	23.00
41	Kota Anggun	18.90	1,454	44.50	Beagle VI	13.50	18,320	23.00
42	Kota Arif	18.90	1,454	44.50	Edwine Oldendor	13.80	18,320	23.00
43	Godafoss	20.00	1,457	60.00	Borkum	14.00	18,355	23.00
44	Dettifoss	20.00	1,457	60.00	Royal Pescadore	14.20	18,369	20.60
45	Jitra Bhum	18.80	1,498	39.50	HwaLien Express	14.20	18,842	20.60
46	Itha Bhum	18.80	1,498	45.00	Lita	14.00	18,849	18.30
47	Kama Bhum	18.00	1,498	46.50	Orient Ace	13.20	19,092	19.80
48	Cape Norviega	18.90	1,510	43.80	Asia Cement 7	14.10	19,651	25.00
49	Tiger Wave	20.90	1,510	43.80	Taisetsu Maru	13.70	20,150	22.40
50	San Francisco	19.00	1,512	40.00	Bao Xing	13.00	20,309	23.00

51	San Fernando	19.00	1,512	40.00	Vola 1	13.10	20,620	26.50
52	San Clemente	19.50	1,512	40.00	Asano Excelsior	13.60	20,872	19.30
53	San Isidro	19.60	1,512	40.00	Sakar	13.50	21,591	25.70
54	San Lorenzo	19.70	1,512	40.00	Gretke Oldendor	14.00	21,702	21.40
55	Mercosul Palometa	19.70	1,512	40.00	Dorthe Oldendor	14.00	21,711	21.40
56	Asia Star	19.70	1,512	48.00	Kita Dake	14.00	21,955	22.20
57	San Felipe	19.60	1,512	51.00	VTC Light	14.00	21,964	22.20
58	San Cristobal	19.70	1,512	51.00	BBC Barranqui	14.00	22,051	22.00
59	TS Shanghai	19.00	1,519	56.00	Yasmin O	14.00	22,056	22.00
60	London Tower	19.00	1,525	45.70	Beatriz	14.00	22,145	21.40
61	Kota Wangsa	19.00	1,550	41.50	Koper	14.00	22,150	21.40
62	Kota Wajar	19.00	1,550	41.50	Elisabeth Olden	14.00	22,154	21.90
63	Kota Waris	19.00	1,550	41.50	Lucy Olden	14.00	22,160	21.90
64	Al Shamiah	19.50	1,550	52.80	Ching Ho	13.50	22,256	16.00
65	Hansa Narvik	19.50	1,550	52.80	Bellatrix Id	13.50	22,273	16.00
66	YM Izmir	20.50	1,550	67.00	VTC Star	13.50	22,273	16.00
67	Bar'zan	19.10	1,560	45.70	Jin Jin	13.50	22,273	16.00
68	Sinar Sunda	19.10	1,560	45.70	Ever Regal	13.90	23,468	21.00
69	CMA CGM Colibri	19.50	1,561	57.00	Marion Star	14.10	23,492	20.40
70	CMA CGM Quetzal	19.50	1,561	57.00	J. Marion Sun	14.00	23,527	20.40
71	Kmtc Pusan	19.70	1,585	51.00	Global Triumph	14.10	23,604	19.80
72	Kmtc Ulsan	19.70	1,585	51.00	World Ace	14.00	23,693	19.40
73	Kmtc Keelung	19.60	1,585	57.00	Lark	14.00	23,723	19.00
74	Conti Jork	17.70	1,599	45.00	Tharinee Naree	13.90	23,724	19.80
75	Aka Bhum	17.70	1,599	45.00	Pacoda	13.90	23,726	18.80
76	Tiger Sky	17.70	1,599	45.00	Naxos	14.00	23,825	46.00
77	Conti Sydney	18.00	1,599	45.00	William	14.00	23,829	22.60
78	Conti Asia	18.00	1,599	48.30	Spring Accord	13.80	23,986	20.50
79	YM Xingang I	18.50	1,599	48.30	Voge Katja	13.80	23,994	20.50
80	Dal Reunion	21.00	1,600	60.50	Elsa Oldendorff	13.80	24,021	20.20
81	Pacific Trader	19.50	1,608	56.00	Trans Friendship	13.80	24,021	20.50
82	Ocean Trader	19.50	1,608	56.00	Addu Star	13.80	24,034	20.50
83	MOL Agility	19.50	1,608	56.00	Milos	13.80	24,045	20.50
84	Atlantic Trader	19.00	1,608	60.00	Great Harmony	14.20	24,159	28.00
85	Trave Trader	21.00	1,608	60.50	Great Concord	14.30	24,159	28.00
86	Imari	20.00	1,613	49.30	Seven Seas	14.00	24,290	20.20
87	Ipanema	20.00	1,613	52.80	Ocean Phoenix	14.10	24,318	20.90
88	Iga	20.00	1,613	52.80	Global Nextage	14.30	24,830	22.20
89	Izu	20.00	1,613	59.90	Addu Sun	14.00	24,838	24.00
90	Ikoma	20.00	1,613	59.90	Polarqueen	14.00	24,993	23.00
91	Izumo	20.00	1,613	59.90	Shin Chuetsu	14.00	25,331	19.80
92	Iwaki	20.00	1,613	59.90	Pantokrator	14.00	25,398	21.20
93	Uni-Phoenix	18.70	1,618	41.60	Harriett	14.10	25,565	26.50
94	Uni-Pacific	18.70	1,618	44.40	Kavo Maleas	14.00	25,739	24.40
95	Uni-Patriot	18.70	1,618	44.40	Rubin Pearl	14.40	26,054	18.70
96	Uni-Perfect	18.70	1,618	44.40	Ziemia Gorno	14.00	26,209	24.50
97	Uni-Prosper	18.70	1,618	44.40	Ziemia Lodzka	14.00	26,264	24.50
98	Uni-Popular	18.70	1,618	44.40	Ziemia Cieszy	14.00	26,264	24.50
99	Uni-Promote	18.70	1,618	44.40	African Wildcat	14.00	26,391	25.00
100	Uni-Premier	18.70	1,618	44.40	Progress	14.20	26,411	22.00
101	Uni-Probity	18.70	1,618	44.40	Golden Star	14.20	26,444	19.00
102	Uni-Prudent	18.70	1,618	44.40	Ambassador	14.40	26,465	22.10
103	Hatsu Prima	19.30	1,618	54.00	African Leopard	14.00	26,467	24.00
104	Sean Rickmers	19.00	1,620	63.00	Sea Bailo	14.30	26,611	25.50
105	Mapocho	19.00	1,620	63.00	Sea Baisen	14.30	26,613	25.50
106	Kmtc Singapore	20.30	1,626	60.00	Mandarin	13.50	26,735	25.00
107	Maersk Marseille	19.00	1,645	49.00	Greenwing	13.00	26,747	21.50

108	Triumph	19.50	1,645	53.90	Bluewing	13.00	26,747	22.00
109	Harmony	19.50	1,645	56.90	Lingue	13.50	26,973	18.60
110	Rhoneborg	18.00	1,646	45.90	Diamond Star	13.50	27,000	18.60
111	Orion	21.00	1,647	72.00	Abbot Point	14.00	27,000	25.00
112	Sirius	21.00	1,647	72.00	Great Gain	14.00	27,140	27.00
113	Maersk Hong Kong	21.00	1,648	72.00	Great Success	14.00	27,172	27.00
114	Safmarine Amazon	21.00	1,648	72.00	Baltic Frontier	13.50	27,293	18.60
115	Alianca Patagonia	21.00	1,651	64.50	Scan Bulker	14.10	27,308	19.80
116	TS Kobe	21.00	1,651	64.50	Idas Bulker	14.10	27,321	19.80
117	Alianca Andes	21.00	1,651	64.50	Great Motion	13.80	27,338	24.00
118	Wan Hai 233	21.00	1,660	59.90	Ocean Premier	14.00	27,348	25.00
119	Wan Hai 235	21.00	1,660	60.00	Hanjin Calcutta	14.50	27,365	25.80
120	Wan Hai 231	21.00	1,660	61.00	Great Creation	14.00	27,383	24.00
121	Wan Hai 232	21.00	1,660	61.10	Flinders Island	14.00	27,407	25.00
122	Manuela	20.20	1,661	52.00	Port Pirie	14.00	27,407	25.00
123	Kollmar	20.30	1,661	52.00	Clipper Lis	14.00	27,609	22.00
124	Maersk Venice	21.20	1,678	70.00	Wu Chang Hai	14.00	27,635	23.30
125	Maersk Vancouver	21.20	1,678	75.00	Nan Chang Hai	14.00	27,635	23.30
126	Maersk Valletta	21.20	1,678	75.00	Atlantic Fortune	14.40	27,776	27.00
127	Maersk Vigo	21.20	1,678	75.00	Federal Mattawa	14.00	27,779	24.00
128	Marcalabria	19.20	1,684	45.00	Federal Mirami	14.00	27,781	24.00
129	Dorian	19.00	1,684	47.00	Federal Manitou	14.00	27,783	24.00
130	Buxhill	18.50	1,684	48.00	Atlantic Laurel	14.40	27,797	27.00
131	Nordsea	20.00	1,684	48.80	Ocean Falls	14.00	27,827	24.50
132	Marcampania	18.00	1,684	50.00	Andre	14.40	27,836	22.10
133	Ibuki	19.40	1,684	52.90	Patagonia	14.00	27,860	20.80
134	Cala Pilar	20.00	1,684	54.00	Pacific Bulker	14.00	27,865	20.80
135	Hans Schulte	19.50	1,684	54.60	Eastgate	14.00	27,877	20.40
136	Cala Puebla	19.50	1,684	65.00	New Alliance	14.20	27,904	23.30
137	Marcatania	18.20	1,687	47.00	ClipperLancaster	14.00	28,249	24.50
138	Buxmoon	18.00	1,687	47.50	Lake Joy	14.20	28,251	24.50
139	Teng Yun He	20.00	1,702	70.00	PAC Star	14.00	28,255	21.00
140	Rui Yun He	20.00	1,702	70.00	Sujitra Naree	14.00	28,290	20.30
141	Port Said	19.00	1,709	46.10	Hope Star	14.00	28,294	20.90
142	Northern Happiness	19.20	1,709	46.50	Queen Asia	14.00	28,350	22.20
143	Northern Delight	18.00	1,709	49.20	Kali	14.00	28,355	20.70
144	Calapadria	20.40	1,716	65.00	Rubin Stella	14.00	28,379	22.50
145	Wehr Koblenz	19.70	1,726	51.00	Global Young	14.00	28,387	21.70
146	Mercosul Pescada	19.70	1,728	50.00	Tpc Auckland	13.70	28,451	20.70
147	Deike Rickmers	19.70	1,728	50.20	Makarios	13.70	28,452	20.70
148	Wehr Altona	19.70	1,728	51.00	Tasman Sea	14.00	28,456	21.00
149	Delmas Suffren	19.70	1,728	51.00	Cape Nelson	14.00	28,456	21.00
150	Nordstar	19.60	1,728	55.00	Jin Sha Ling	13.70	28,457	20.70
151	German Senator	20.00	1,728	58.00	J. Lucky	14.00	28,460	20.80
152	Lissy Schulte	20.00	1,728	58.20	Pontonostos	13.70	28,470	20.70
153	Dorothea Rickmers	19.70	1,730	45.00	Fonthida Naree	14.00	28,484	21.00
154	Camilla Rickmers	19.70	1,730	50.20	Mount Adams	14.00	28,487	23.00
155	Denderah Rickmers	19.70	1,730	50.20	Allstar	13.70	28,493	20.70
156	CSAV Manzanillo	19.80	1,730	50.20	Moon River	14.00	28,494	23.00
157	E. R. Durban	20.00	1,730	51.00	Ace Bulker	14.00	28,498	21.90
158	Elqui	19.60	1,730	53.20	Orient Sunrise	14.00	28,513	23.00
159	CSAV Montreal	19.60	1,730	53.20	Santa Pacifica	14.00	28,520	21.70
160	CMA CGM Licorne	19.00	1,730	54.00	Ja Sunrise	14.00	28,542	20.40
161	Cala Positano	19.70	1,730	54.00	Sea Honesty	14.00	28,564	21.00
162	Dal Madagascar	19.70	1,730	54.00	Saranya Naree	13.70	28,583	22.60
163	Helene Rickmers	19.70	1,730	55.00	New Guardian	14.00	28,615	20.20
164	YM Santos	19.50	1,730	58.00	Yinxiu	14.30	28,730	23.50

165	CMA CGM Azteca	19.70	1,730	59.40	Cape Scott	14.10	28,747	19.80
166	CMA CGM Paulista	19.60	1,730	61.00	Cape Spencer	14.30	28,799	19.80
167	Perth	23.00	1,733	100.00	Darya Sur	14.00	28,814	25.00
168	Hertford	23.00	1,733	100.00	Wichita Belle	14.00	28,843	19.70
169	CSAV Rotterdam	19.50	1,740	58.00	Darya Taal	14.00	28,892	25.00
170	Cap Arnauti	19.50	1,740	60.00	Darya Raag	14.00	28,968	25.00
171	Cap Maleas	19.50	1,740	60.00	Fortune Express	14.20	30,109	33.40
172	Maersk Varna	20.50	1,740	63.50	Yucatan	14.10	30,838	28.30
173	Sea Beta	20.00	1,740	65.50	New Laurel	14.00	31,024	23.60
174	Clan Gladiator	18.60	1,742	40.00	New Mariner	14.00	31,024	23.60
175	Santa Rosa	19.00	1,742	40.00	Leo Forest	14.00	31,764	24.10
176	Kapitan Afanasyev	19.80	1,748	50.00	Papua	14.00	31,817	25.00
177	X-Press Resolute	19.00	1,806	44.50	Lavieen Rose	14.00	31,824	24.20
178	Safmarine Memling	21.00	1,835	75.00	Patriarch	14.00	31,842	25.00
179	Maersk Valparaiso	21.30	1,835	75.00	Pacific Logger	14.20	31,877	25.00
180	Maersk Itajai	21.30	1,835	75.00	Patriot	14.00	31,880	25.00
181	Pegasus	21.30	1,835	85.00	Angel Arrow	14.00	32,355	25.50
182	Rithi Bhum	22.00	1,858	85.00	C. S. Star	14.20	32,873	22.00
183	APL Mumbai	22.00	1,858	85.00	Federal Maas	14.00	34,197	30.00
184	Satha Bhum	22.00	1,858	85.00	Orsula	14.00	34,198	30.00
185	APL Kobe	22.00	1,858	85.00	Federal St. Laurent	14.00	34,372	30.00
186	Kmtc Port Kelang	21.50	1,860	65.00	Federal Saguenay	14.00	34,372	30.00
187	Indira Gandhi	17.70	1,869	40.50	Federal Rhine	14.00	34,372	30.00
188	Lal Bahadur Shastri	17.80	1,869	40.50	Austyn Oldendorff	14.00	34,655	28.40
189	Rajiv Gandhi	17.90	1,869	44.30	Victory	14.00	34,676	28.40
190	Santa Maddalena	20.00	1,895	50.70	Miltiadis Junior II	14.00	34,682	28.30
191	Clan Legionary	20.00	1,895	51.50	Apostolos II	14.00	34,699	28.30
192	Tiger Shark	19.00	1,923	65.00	Isa	14.20	34,939	27.00
193	Maersk Maryland	18.00	1,928	52.50	Isadora	14.20	34,948	24.00
194	Maersk Maine	18.00	1,928	52.50	Isolda	14.30	34,949	27.20
195	Maersk Vermont	18.00	1,928	53.00	New Blessing	14.20	35,287	25.80
196	MOL Niger	20.00	2,011	66.00	Orient Carp	14.40	35,366	27.70
197	MOL Mono	20.00	2,011	66.40	Federal Oshima	14.00	35,750	28.70
198	Cap Finisterre	18.50	2,023	49.70	New Creation	14.20	35,823	25.80
199	Jolly Platino	18.00	2,026	53.00	Federal Asahi	14.00	36,563	30.20
200	Clan Tangun	19.00	2,061	41.50	Eider	14.00	37,193	32.00
201	CMA CGM Tema	20.00	2,061	50.70	Barbara	13.00	38,858	23.70
202	Santa Giulietta	20.00	2,061	50.70	Alam Selamat	13.00	39,110	24.70
203	Cala Palamos	20.00	2,061	50.70	Diana	14.00	41,180	31.00
204	CMA CGM Lagos	20.00	2,061	50.70	Delia	14.00	41,185	33.00
205	Safmarine Tugela	19.50	2,063	74.00	Daria	14.00	41,260	33.00
206	Cap Sunion	19.50	2,063	74.00	Balgarka	12.80	41,327	34.00
207	Maersk Novazzano	21.00	2,064	76.00	Furtrans Bulk	14.20	41,675	31.00
208	Tuscany Bridge	21.00	2,064	76.00	Kolocep	14.50	41,712	28.50
209	Sydney Express	19.50	2,070	79.30	Glykofiloussa	14.00	41,712	30.00
210	Marivia	21.00	2,078	15.90	Tpc Wellington	14.00	42,004	23.00
211	Cala Pintada	21.00	2,078	15.90	Pacific Wisdom	14.00	42,010	25.30
212	Magnavia	19.50	2,078	74.00	Sea Miror	14.00	42,025	24.20
213	Acx Jasmine	20.70	2,078	74.00	Ming Zhou 25	14.00	42,025	24.20
214	Master I	21.00	2,080	78.00	Sunny Success	14.00	42,203	24.20
215	Champion	21.00	2,080	78.00	Yakima	14.00	42,475	24.20
216	Jolly	18.60	2,098	44.00	Norsul Camocim	13.50	42,488	29.00
217	Safmarine Oranje	18.20	2,098	50.00	Split	14.00	42,584	30.00
218	CMA CGM Aguila	20.00	2,105	59.00	Don Frane Bulic	13.80	42,584	30.50
219	CMA CGM Carioca	20.00	2,105	59.00	Batu	14.20	42,648	26.50
220	CMA CGM Colombie	20.00	2,105	59.00	Hokuetsu Hope	14.30	42,692	27.70
221	MOL Sassandra	20.00	2,135	64.90	Oji Pioneer	13.90	42,730	27.70

222	MOL Volta	20.00	2,135	64.90	Dubai Fortune	14.20	42,850	26.00
223	Santa Francesca	20.00	2,169	43.80	Channel Ranger	14.40	43,108	25.60
224	Santa Felicita	20.00	2,169	47.60	Delta Ranger	14.00	43,108	27.00
225	Hyundai Vladivostok	21.50	2,181	71.00	Full Rich	14.30	43,217	23.80
226	Hyundai Stride	21.50	2,181	71.00	Sea Globe	14.30	43,246	29.00
227	Hyundai Highway	21.50	2,181	71.00	Pacific Vigorous	14.30	43,354	25.30
228	Hyundai Bridge	21.50	2,181	71.00	Pacific Endeavor	14.30	43,366	29.90
229	Hyundai Advance	23.10	2,181	71.00	Pacific Embolden	14.00	43,396	25.30
230	Hyundai Progress	22.30	2,181	74.00	Pacific Career	13.70	43,415	29.90
231	MSC Manaus	18.00	2,206	53.00	Prabhu Mihika	14.00	43,469	27.00
232	Alice Rickmers	21.00	2,226	83.00	Great Ocean	14.00	43,473	26.80
233	Aenne Rickmers	20.50	2,226	85.00	Alberto Topic	14.00	43,473	27.00
234	CMACGM Bueno Air	20.50	2,226	85.00	Thor Dynamic	14.00	43,497	27.00
235	Willi Rickmers	21.00	2,226	85.00	Krateros	14.00	43,595	25.60
236	Alexandra Rickmers	20.50	2,226	86.00	Zenovia	14.00	43,595	27.00
237	Albert Rickmers	20.50	2,226	86.00	Prabhu Yuvika	14.00	43,648	24.50
238	Marfret Provence	20.50	2,226	86.00	Steven C	14.00	43,665	27.00
239	Delmas Brazzaville	20.50	2,226	86.00	Peng Zhong	14.00	43,692	27.00
240	Andreas	21.00	2,226	86.00	You Xuan	14.00	43,697	27.00
241	CSAV Shanghai	21.00	2,226	86.00	Grand View	14.00	43,980	26.50
242	CSAV Ningbo	21.00	2,226	86.00	United Stars	14.00	43,991	30.00
243	MSC Fremantle	18.20	2,228	53.00	Grand Way	14.00	44,006	26.50
244	CMA CGM Utrillo	20.50	2,262	86.00	Sveti Nikola I	14.50	44,314	31.50
245	Aquitania	20.50	2,262	86.00	Dixie Monarch	14.30	44,679	27.70
246	MSC Zrin	18.50	2,275	75.00	Grandis	14.30	44,711	27.70
247	Cape Race	20.00	2,275	75.00	Ryu Yoh	14.30	44,733	29.80
248	Acx Lavender	20.00	2,280	70.00	Raku Yoh	14.30	44,776	27.70
249	Milan Express	20.00	2,330	75.00	Union Leader	14.20	44,809	29.00
250	MSC Jemima	20.00	2,394	68.50	Yantian Sea	14.20	44,821	29.00
251	Maersk Niigata	18.00	2,440	74.00	Zui Yoh	14.30	44,840	27.70
252	Cap Ortegal	21.00	2,442	63.50	Orana	14.30	44,849	27.70
253	Alianca Shanghai	21.00	2,442	63.50	Maria C	14.30	45,205	29.90
254	CSCL Lianyungang	21.00	2,442	65.00	Energy Ranger	14.40	45,219	32.40
255	Cap Frio	21.30	2,468	65.00	Stargold Trader	14.30	45,228	29.50
256	Cap Egmont	21.00	2,468	75.00	Reliance Ocean	13.90	45,262	24.90
257	CSAV Chicago	21.00	2,468	75.00	Gundulic	14.00	45,269	29.00
258	CCNI Guayas	21.00	2,468	75.00	CSL Asia	14.40	45,279	29.90
259	MSC Caracas	21.00	2,470	68.00	Getaldic	14.00	45,300	30.00
260	Ute Oltmann	20.90	2,470	68.30	Ioannis Theo	14.30	45,320	25.80
261	MOL Dream	22.00	2,470	74.00	Nikkei Eagle	14.30	45,347	28.00
262	Valparaiso Express	21.00	2,474	66.50	Nikkei Tiger	14.30	45,363	28.00
263	CSCL Fuzhou	21.60	2,474	83.00	Nordtide	14.50	45,406	22.50
264	CCNI Cartagena	20.00	2,478	76.50	Sea Luck	14.00	45,429	27.50
265	Iran Zanjan	20.00	2,478	88.00	Orpheus Island	14.50	45,513	31.80
266	Libra Niteroi	22.00	2,478	88.00	Spirit	14.00	45,526	27.50
267	CMA CGM Romania	21.50	2,478	92.50	Qin Hai	14.00	45,569	26.50
268	APL Jeddah	21.00	2,478	97.60	Aristea M	14.00	45,584	30.00
269	Jandavid S	20.80	2,483	83.20	Yuehai	14.00	45,632	26.40
270	Maersk Newark	22.10	2,496	80.00	Atoyac	14.00	45,642	24.90
271	Safmarine Zambezi	22.10	2,496	87.90	Jag Reena	14.00	45,659	27.00
272	Maersk Newcastle	22.10	2,496	87.90	Ozge Aksoy	14.00	45,664	24.90
273	Maersk Norfolk	22.10	2,496	87.90	C. Friend	14.00	45,675	28.00
274	Santa Alexandra	22.60	2,506	101.90	Talisman	14.00	45,693	24.00
275	Santa Annabella	22.80	2,506	101.90	Ayse Aksoy	14.00	45,694	24.00
276	Callao Express	21.70	2,524	74.00	Giorgos B	14.00	45,697	24.00
277	MOL Satisfaction	22.00	2,526	78.00	Amulet	14.00	45,700	25.50
278	Hanjin Dubai	22.00	2,526	98.20	Obc Anna	14.00	45,708	25.00

279	Clan Intrepid	21.00	2,546	70.50	Sunny Gloria	14.00	45,713	25.00
280	MOL Sprint	21.00	2,546	70.50	Sea Banian	14.00	45,724	25.30
281	Thekla Schulte	22.00	2,556	102.00	Nicolas S	14.00	45,736	27.00
282	Susanne Schulte	21.90	2,556	102.10	New Eternity	14.50	45,741	28.20
283	Thomas Mann	22.70	2,586	103.00	Tamil Nadu	14.00	45,792	28.00
284	MSC Mediterranean	19.50	2,604	63.00	New Eminence	14.20	45,830	29.10
285	MSC Canberra	19.50	2,604	63.00	Matira	14.20	45,863	21.20
286	Merkur Sky	20.00	2,604	76.00	Great Prestige	13.60	46,193	35.60
287	Cap Roca	21.00	2,640	103.00	Great Majesty	13.50	46,194	35.60
288	ANL Australia	18.80	2,668	62.00	Alfred Oldendor	14.30	46,489	25.80
289	Sci Vijay	18.80	2,668	67.00	Paradise Island	14.30	46,513	28.30
290	MSC Basel	19.00	2,680	63.00	Isolde	14.30	46,570	29.10
291	MSC Palermo	19.70	2,680	63.00	Glen Mooar	14.30	46,570	29.20
292	Zim Alabama	19.70	2,680	63.00	Glen Helen	14.30	46,570	31.00
293	Zim Texas	19.70	2,680	63.00	Hulk	14.50	46,601	29.00
294	MSC America	19.70	2,680	63.00	Bahama Spirit	14.00	46,606	26.00
295	CSCL Genoa	21.60	2,681	89.00	Griffon	14.00	46,635	28.00
296	CSCL Barcelona	22.20	2,681	89.00	Bianco Zealand	14.50	46,637	27.70
297	CMACGM Dardanell	21.80	2,682	120.00	Alex A	14.10	46,640	26.00
298	Pu He	19.00	2,716	68.70	Konkar Georgios	14.50	46,670	25.50
299	Iran Ilam	22.10	2,724	80.00	Ancash Queen	14.40	46,673	30.20
300	Iran Ardebil	22.10	2,724	80.00	Mathios	14.50	46,678	28.40
301	Alexandra P	22.50	2,732	89.00	Pacific Eternity	14.30	46,683	29.00
302	Heike	22.50	2,732	89.00	Gang Qiang	14.50	46,790	27.50
303	Meta	22.50	2,732	89.00	World Swan	14.30	46,799	28.10
304	Safmarine Ikapa	22.50	2,732	89.00	Jian Qiang	14.00	46,807	26.30
305	Gdynia 8184/21	22.50	2,732	166.00	New Oji Pioneer	14.30	46,832	30.00
306	Gdynia 8184/23	22.50	2,732	166.00	Cos Cherry	14.50	46,840	27.50
307	Gdynia 8184/22	22.50	2,732	166.00	Cos Bonny	14.50	46,864	27.00
308	YM Ibiza	21.00	2,758	98.00	Daio Robin	14.00	46,914	26.00
309	CMA CGM Alabama	21.00	2,758	100.00	Sky Pacific	14.20	46,968	30.30
310	OOCL Melbourne	22.60	2,762	108.00	Nord Ace	14.30	47,000	27.50
311	Marmara Sea	22.00	2,797	90.40	VOC Rose	14.00	47,183	28.00
312	Black Sea	22.00	2,797	90.40	VOC Daisy	14.00	47,183	28.00
313	Cimbria	21.80	2,824	95.00	Weser Stahl	12.70	47,257	18.80
314	Tatiana Schulte	22.00	2,824	100.00	Dubai Guardian	14.30	47,271	25.00
315	Patricia Schulte	22.00	2,824	115.00	Alam Aman II	14.00	47,301	24.00
316	Manukai	21.80	2,831	125.00	Turicum	14.30	47,639	26.30
317	Maunawili	21.80	2,831	125.00	Daio Excelsior	14.20	48,181	31.00
318	Norasia Tegesos	22.40	2,890	120.00	Tango Glory	14.30	48,193	26.50
319	Norasia Telamon	22.80	2,890	120.00	Crimson Jupiter	14.00	48,205	31.00
320	Conti Harmony	22.80	2,890	120.00	Pindos	14.00	48,218	34.00
321	Zim Mumbai	21.50	2,908	95.50	Pilion	14.00	48,218	34.50
322	Amasis	21.50	2,908	95.50	Max Oldendorff	14.20	48,225	28.30
323	CMA CGM Elbe	22.50	2,932	80.00	Amber K	14.30	48,282	27.70
324	Livorno Express	21.70	2,954	97.00	China Trader	14.50	48,320	29.50
325	Maersk Peterhead	21.50	2,959	85.50	Taiho Maru	14.20	48,817	26.40
326	Maersk Petersburg	21.50	2,959	85.50	Miraflores	14.30	48,977	30.00
327	YM Hiroshima	22.00	2,959	85.50	Pacific Emerald	14.50	49,016	29.80
328	Kota Ekspres	22.00	2,959	85.50	Pacific Mercury	14.50	49,016	29.80
329	Maersk Pittsburg	22.00	2,959	85.50	Pacific Dolphin	14.50	49,047	29.90
330	Grand View	22.00	2,986	90.40	Pacific Scorpio	14.50	49,061	30.40
331	CMA CGM Sapphire	22.00	2,986	90.40	Pacific Primate	14.50	49,061	33.10
332	LT Genova	21.00	2,987	79.00	Daio Discovery	14.40	49,970	29.00
333	LT Trieste	21.00	2,987	79.00	Darya Dhyan	14.00	50,149	28.50
334	MSC Hailey	21.50	2,987	104.00	Violet	14.00	50,326	31.00
335	Wadi Alrayan	21.60	3,013	108.00	Favorita	14.00	52,292	27.00

336	Tabuk	20.50	3,017	85.00	Akili	14.00	52,301	27.00
337	Zim Japan	21.00	3,029	80.00	Nord Ocean	14.30	52,441	29.20
338	Zim Hong Kong	21.00	3,029	80.00	Tigris	14.00	52,454	34.00
339	Zim Italia	21.00	3,029	80.00	Sinin	14.30	52,466	30.10
340	Zim Korea	21.00	3,029	80.00	Ekavi I	14.00	52,808	31.00
341	Santa Monica	23.40	3,054	129.60	Sanko Galaxy	14.10	52,980	31.00
342	Santa Barbara	23.40	3,054	129.60	Port Melbourne	14.00	53,260	34.00
343	MOL Renaissance	22.30	3,091	4.00	Spar Lyra	14.00	53,565	36.00
344	CSAV Paranagua	22.50	3,091	85.00	Arya Payk	14.00	53,565	36.00
345	Norasia Balkans	22.50	3,091	85.00	Pearl Venus	13.00	53,679	26.50
346	CSAV Moema	22.50	3,091	85.00	Dynastar	14.00	53,793	29.20
347	CSAV Sao Paulo	22.00	3,091	97.50	Wadi Alarish	13.50	64,214	29.00
348	Norasia Alya	22.50	3,091	97.50	Wadi Sudr	13.50	64,214	29.00
349	Emirates Marina	22.50	3,091	97.50	Wadi Alarab	13.00	64,214	31.20
350	Emirates Freedom	22.50	3,091	97.50	Li Shan Hai	14.40	65,029	35.90
351	Emirates Liberty	22.50	3,091	97.50	Despina	14.00	65,644	32.50
352	CCNI Antofagasta	22.50	3,091	97.50	Kiran Asya	14.00	66,832	37.00
353	Widukind	22.50	3,091	97.50	Ocean Prelude	14.20	68,541	33.00
354	Santa Cruz	23.40	3,103	126.40	Hellenic Sky	14.10	68,591	29.10
355	CP Everglades	20.40	3,237	109.70	Sunny Ocean	13.90	68,621	27.50
356	CP Shenandoah	21.60	3,237	110.00	Navios Gemini	14.00	68,636	27.20
357	Washington Express	22.50	3,237	110.00	Yun Tong Hai	14.00	68,788	32.00
358	Philadelphia Express	22.50	3,237	110.00	Maratha Explorer	13.90	68,849	29.80
359	St Louis Express	22.50	3,237	110.00	Lavadara	14.50	69,091	32.50
360	E. R. Sydney	22.00	3,359	116.50	Seaflower	14.50	69,128	32.80
361	MSC Korea	23.30	3,398	109.50	Johanna Olden	14.50	69,146	36.40
362	MSC Alabama	23.30	3,398	109.50	Paiute	14.00	69,183	30.70
363	Indamex Cauvery	22.00	3,400	116.50	Aristides N.P.	13.50	69,268	30.00
364	NYK Prestige	23.00	3,424	102.50	Joyous Age	14.00	69,271	30.80
365	MSC Christina	23.00	3,424	110.00	Pacific Pioneer	14.00	69,279	29.00
366	Zim Atlantic	21.00	3,429	90.00	Joyous Land	14.50	69,283	34.80
367	Zim Asia	21.70	3,429	90.00	Dongfangsheng	13.50	69,306	28.50
368	Zim Pacific	21.70	3,429	90.00	Angele N	13.50	69,315	28.50
369	Zim Jamaica	21.70	3,429	90.00	Citrawati	14.00	69,332	28.50
370	Fowairet	24.00	3,431	136.00	Panagiotis D	14.50	69,337	28.50
371	Maersk Ipanema	22.50	3,467	92.20	Genco Trader	13.50	69,338	28.50
372	MSC Johannesburg	23.50	3,467	107.00	Far Eastern Silo	14.50	69,338	28.50
373	Empress Phoenix	22.50	3,494	135.00	Marina Wave	14.00	69,451	30.00
374	CMA CGM Vernet	22.00	3,538	88.50	Santa Esmeralda	13.50	69,458	31.60
375	Northern Faith	22.00	3,538	88.50	Full Sources	14.00	69,573	31.20
376	CMA CGM Capella	22.00	3,538	93.60	Theareston	14.00	69,637	30.00
377	Northern Reliance	22.00	3,538	94.00	Fivos	14.10	69,659	29.90
378	YM Europe	20.50	3,604	78.10	Fu Zhou Hai	14.40	69,967	32.30
379	Nedlloyd Europa	21.50	3,604	116.00	Gao Zhou Hai	14.40	69,967	35.80
380	Nedlloyd Africa	21.50	3,604	116.00	Deng Zhou Hai	14.40	69,967	35.80
381	Nedlloyd Asia	21.50	3,604	116.00	De Zhou Hai	14.40	69,968	32.30
382	Nedlloyd America	21.50	3,604	116.00	Four Coal	13.60	69,997	32.90
383	Nedlloyd Oceania	21.50	3,604	116.00	Formentera	14.20	69,997	35.00
384	Northern Divinity	23.50	3,607	114.50	Clipper Joy	14.50	70,044	33.70
385	Indamex Godavari	23.40	3,607	130.00	Clipper Jade	14.50	70,046	33.70
386	NYK Springtide	23.40	3,608	121.90	Clipper Jasmine	14.50	70,109	33.70
387	Katsuragi	23.40	3,613	120.20	Balsfjord	13.50	70,120	31.50
388	Chang Jiang Bridge	24.00	3,720	115.30	Renuar	13.80	70,155	33.30
389	YM East	22.50	3,725	122.00	North Princess	14.50	70,164	29.90
390	YM West	22.50	3,725	122.00	Themis P	14.00	70,165	27.00
391	YM Zenith	22.50	3,725	125.00	Bestore	14.00	70,181	26.80
392	Zhong He	24.00	3,764	130.00	Full Comfort	14.00	70,181	27.10

393	MOL Elbe	23.90	3,796	110.00	Maja Vestida	14.00	70,213	28.90
394	Shan He	24.00	3,801	157.50	Peoria	14.00	70,293	29.20
395	Zhen He	25.00	3,801	157.50	Bakra	13.50	70,456	31.50
396	Abu Dhabi	24.40	3,802	116.50	Xinshi Hai	14.00	70,728	30.00
397	Deira	24.10	3,802	130.00	MarathaMessenger	14.00	71,252	26.20
398	River Wisdom	24.00	3,802	134.40	Rubin Camellia	14.30	71,332	27.80
399	Al-Abdali	23.70	3,802	137.70	C. Iris	14.50	71,393	30.40
400	Al Noof	24.10	3,802	138.00	Great Luck	14.00	71,399	34.00
401	Al-Sabahia	24.00	3,802	139.00	Anangel Loyalty	14.00	71,550	33.50
402	Al-Mutanabbi	22.50	3,802	140.00	Konstantinos A	14.00	71,550	33.50
403	MOL Thames	23.00	3,807	138.70	Esna	14.30	71,598	31.50
404	NYK Kai	24.90	3,808	153.80	OinoussianLegend	14.00	71,662	32.00
405	APL Almandine	23.00	3,821	135.00	Transgiant	14.00	71,665	28.40
406	APL Alexandrite	25.20	3,821	146.00	Happy Day	14.00	71,694	32.00
407	APL Amazonite	24.50	3,821	147.50	Pelagia	14.00	71,741	26.10
408	Hanjin Marseilles	24.00	4,024	140.00	Panormos	14.50	71,747	32.60
409	Hanjin Malta	24.00	4,024	140.00	Santa Markela	13.50	71,749	28.00
410	Dalian Express	22.70	4,038	141.50	New Leader	14.50	72,072	32.70
411	MSC Diego	23.00	4,056	120.00	C. S. Queen	14.20	72,465	34.00
412	MSC Aniello	22.50	4,056	128.00	Global Triumph	14.50	72,870	34.00
413	MOL Ingenuity	23.90	4,082	110.00	King Coal	14.50	72,873	34.00
414	Sea-Land Racer	24.40	4,082	145.00	Luise Oldendorff	14.50	72,873	46.00
415	Sea-Land Mercury	24.00	4,082	148.00	Deep Seas	13.50	72,891	29.00
416	Sea-Land Eagle	24.00	4,082	150.00	Proteus	14.00	73,018	31.50
417	Sea-Land Intrepid	24.00	4,082	150.00	Songa Anina	14.50	73,018	31.50
418	Sea-Land Lightning	24.00	4,082	150.00	Corviglia	14.00	73,035	32.50
419	Maersk Denia	25.00	4,112	185.00	Celerina	14.00	73,035	32.50
420	Maersk Denton	25.00	4,112	185.20	General Guisan	14.00	73,035	33.50
421	MSC Ulsan	23.00	4,132	138.00	Nyon	14.00	73,035	33.50
422	MSC Donata	24.30	4,132	138.00	Avalon	13.50	73,080	32.50
423	CMA CGM Vega	24.30	4,132	144.00	Drin	14.00	73,087	33.00
424	Maersk Doha	23.10	4,158	156.50	Tai Profit	14.20	73,105	35.40
425	Maersk Dundee	23.10	4,158	156.50	Great Jade	14.00	73,192	36.00
426	Ever Dainty	25.00	4,211	186.00	Castillo De SP	14.50	73,205	33.70
427	Ever Decent	25.00	4,211	186.00	Eleranta	14.50	73,222	34.00
428	Ever Delight	25.00	4,211	186.00	Castillo De Vigo	14.50	73,236	33.00
429	Ever Devote	25.00	4,211	200.00	Great Bright	14.00	73,242	37.00
430	Ever Diadem	25.00	4,211	200.00	Great Bless	14.00	73,251	36.00
431	Ever Divine	25.00	4,211	200.00	Great Glory	14.00	73,251	36.00
432	Ever Develop	25.00	4,211	200.00	Nueva Union	14.50	73,350	38.10
433	Ever Diamond	25.00	4,211	200.00	Spar Vega	14.50	73,350	38.10
434	Ever Dynamic	25.00	4,211	200.00	Happy Clipper	13.50	73,414	34.20
435	Ever Reward	23.20	4,229	113.70	Fearless I	14.00	73,427	36.70
436	Sun Road	23.00	4,229	124.50	Polska Walczaca	13.70	73,505	32.20
437	Sun Right	23.00	4,229	124.50	Iran Bojnoord	14.40	73,518	37.00
438	Sun Round	23.00	4,229	124.50	Elbe Max	14.00	73,548	34.00
439	Ever Renown	23.20	4,229	131.80	Padre	14.00	73,601	37.00
440	Ever Racer	23.20	4,229	131.80	Pacific Prospect	13.80	73,630	34.70
441	Maersk Dalton	22.50	4,230	117.80	Pacific Paradise	14.00	73,645	33.00
442	Maersk Darlington	22.50	4,230	117.80	Thetis	14.00	73,653	30.00
443	Maersk Dauphin	22.50	4,230	117.80	Maritime Wisdom	13.80	73,657	34.70
444	Maersk Delano	22.50	4,230	117.80	Maritime Dignity	13.80	73,657	34.70
445	Maersk Delmont	22.50	4,230	117.80	Great Loyalty	14.00	73,659	31.30
446	Jervis Bay	23.40	4,230	117.80	Rodon	14.00	73,670	30.00
447	CSCL Ningbo	23.30	4,253	146.00	Great Prosperity	14.00	73,679	33.30
448	CSCL Hamburg	23.30	4,253	146.00	Great Ambition	14.00	73,725	32.00
449	CMA CGM Nilgai	23.30	4,253	146.00	Great Century	14.00	73,747	34.80

450	CMA CGM Yantian	23.30	4,253	146.00	Asahi Maru	14.50	73,914	37.90
451	CSCL Vancouver	23.30	4,253	146.00	Bruno Salamon	14.50	73,965	33.50
452	CMA CGM Kingston	23.30	4,253	146.50	Carl Mesem	14.10	74,001	33.50
453	Maersk Merlion	24.50	4,281	167.00	Spring Fortune	14.30	74,063	32.00
454	Maersk Malacca	24.50	4,281	167.00	Cos Intrepid	14.40	74,119	35.00
455	Maersk Dresden	24.20	4,306	100.00	Alpha Flame	14.50	74,545	32.00
456	MSC Sandra	23.50	4,315	120.00	Miden Max	14.00	74,696	32.00
457	MSC Ingrid	23.00	4,400	144.30	Cinzia D'amato	14.00	74,717	37.50
458	Norasia Valparaiso	24.60	4,444	166.00	Danae	14.00	75,106	35.20
459	Norasia Enterprise	25.00	4,444	166.00	Dione	14.00	75,172	35.20
460	MSC Florida	25.00	4,444	166.00	Fujian	14.00	75,264	35.00
461	Bunga Pelangi Dua	23.50	4,469	135.00	Ever Mighty	14.50	75,265	34.50
462	Maersk Diadema	25.00	4,542	166.00	Solana	14.00	75,275	35.90
463	Hijaz	25.00	4,542	166.00	Hainan	14.00	75,300	32.00
464	Pusan Senator	23.70	4,545	150.60	Petka	14.50	75,460	32.00
465	Penang Senator	23.70	4,545	150.60	Waikiki	14.00	75,473	32.00
466	Pudong Senator	23.70	4,545	150.60	Pessada	14.50	75,484	34.00
467	Peking Senator	23.70	4,545	150.60	Arabella	14.00	75,563	30.50
468	Punjab Senator	23.70	4,545	150.60	Kavo Sapphire	14.00	75,574	33.00
469	Pugwash Senator	23.70	4,545	150.60	Anna	14.00	75,592	33.00
470	Portland Senator	23.70	4,545	150.60	Carol	14.50	75,608	33.00
471	Pohang Senator	23.70	4,545	150.60	Star Of Nippon	14.00	75,611	34.50
472	CMA CGM Asia	23.70	4,545	151.00	Salvatore Cafiero	14.00	75,668	34.00
473	ANL Hong Kong	23.70	4,545	151.00	Shinyo Brilliance	14.00	75,707	30.50
474	MOL Encore	24.50	4,578	185.00	Marvellous	14.00	75,746	30.50
475	London Express	24.00	4,612	137.40	Loch Long	14.00	75,785	30.50
476	Kobe Express	24.00	4,612	138.80	Navios Cielo	14.00	75,834	30.50
477	Dusseldorf Express	24.00	4,612	143.30	Orange Tiara	14.00	75,846	30.50
478	Hannover Express	23.00	4,639	150.40	Alma Ata	13.00	76,008	49.00
479	Leverkusen Express	23.00	4,639	150.40	Pacific Breeze	14.00	76,343	35.00
480	Dresden Express	23.00	4,639	150.40	Oinoussian Lady	14.00	76,704	35.00
481	Hoechst Express	23.00	4,639	150.40	Betis	14.00	76,801	37.80
482	Ludwigshafen Expre	23.00	4,639	150.40	Achilles	14.00	76,878	32.00
483	APL Qingdao	23.50	4,706	149.00	Ascanius	14.00	76,878	32.00
484	APL Ningbo	23.50	4,706	175.00	Corona Ace	13.80	77,447	36.00
485	MOL Velocity	24.50	4,729	185.00	Bernhard Oldendorff	14.00	77,499	37.80
486	MSC Napoli	24.10	4,734	16.30	Konyo	14.30	77,561	34.00
487	APL Dubai	24.50	4,743	111.00	Genyo	14.30	77,561	35.00
488	Sandra Blanca	23.50	4,743	149.10	Shirouma	14.30	77,739	33.50
489	Sandra Azul	23.50	4,743	170.20	Alam Penting	14.00	87,052	38.00
490	Antwerpen Express	24.00	4,890	140.70	Kurotakisan Maru	14.50	87,890	46.00
491	Tokyo Express	24.00	4,890	140.70	Shoho	14.00	87,996	36.60
492	Bremen Express	24.00	4,890	140.70	Double Progress	14.00	88,000	47.30
493	Rotterdam Express	24.00	4,890	140.70	Taipower Prosperity	14.50	88,018	36.00
494	APL Arabia	24.00	4,890	155.00	Ikan Kedewas	14.00	88,279	47.30
495	APL Egypt	24.00	4,890	155.00	Chubu Maru	14.20	91,384	43.20
496	APL Malaysia	24.00	4,890	155.00	Haramachi Maru	14.20	91,437	41.00
497	APL Iolite	24.50	4,918	181.70	Sekiyo	14.30	91,439	43.80
498	Maersk Darmstadt	23.80	4,992	164.00	Lily Fortune	14.30	91,439	44.70
499	APL Cyprine	24.30	5,020	180.00	Noshiro Maru	14.30	91,439	45.60
500	APL Agate	24.50	5,020	180.00	Kamishima	14.00	91,443	43.90
501	APL Pearl	24.50	5,020	180.00	Shin-Sakaide	14.30	91,625	43.50
502	APL Coral	24.50	5,020	180.00	Hokuriku Maru	14.00	94,274	37.80
503	APL Korea	24.50	5,108	183.00	Fernie	14.00	122,292	47.50
504	APL China	24.50	5,108	183.00	Grafton	14.00	122,292	47.50
505	APL Singapore	24.50	5,108	183.00	Duhallow	14.00	122,774	47.50
506	APL Thailand	24.50	5,108	183.00	Eridge	14.00	122,792	47.50

507	APL Philippines	24.50	5,108	183.00	Hanjin Port Kembla	13.40	126,267	36.30
508	Bellavia	25.00	5,117	166.00	Tien Shan	13.50	128,826	40.60
509	Octavia	25.00	5,117	166.00	Suzaku	14.20	148,535	51.00
510	OOCL Britain	24.60	5,344	160.00	Savina	14.50	148,657	52.00
511	OOCL Hong Kong	24.90	5,344	180.00	Ocean Master	14.40	148,723	49.30
512	OOCL China	24.60	5,344	186.80	Matsura Maru	13.70	148,884	45.20
513	OOCL America	24.60	5,344	190.00	POS Challenger	13.90	148,914	50.00
514	OOCL Japan	24.60	5,344	220.00	POS Harvester	13.90	148,918	50.00
515	Ever Ultra	25.00	5,364	201.00	Tiger Lily	13.50	149,190	45.10
516	Ever United	25.00	5,364	201.00	POS Ambition	13.90	149,330	50.00
517	Ever Unison	25.00	5,364	201.00	Pacific Enterprise	14.00	149,363	56.80
518	Ever Unique	25.00	5,364	201.00	Carouge	13.50	149,383	47.00
519	Ever Union	25.00	5,364	201.00	Julian N	13.30	149,391	47.00
520	YM Plum	25.90	5,512	197.80	Montego II	13.90	149,391	47.00
521	YM Orchid	25.90	5,512	197.80	Dong-A Saturn	14.10	149,396	42.50
522	YM Cosmos	25.90	5,512	197.80	Goodwill	14.20	149,401	50.00
523	YM Cypress	26.00	5,512	197.80	Netadola	14.10	149,475	47.00
524	Copiapo	25.60	5,527	198.00	Ocean Comfort	13.90	149,477	47.00
525	YM Pine	26.00	5,548	197.80	Cologny	14.00	149,477	47.00
526	YM Bamboo	26.00	5,548	197.80	Amazon	13.90	149,495	38.00
527	Hanjin Cairo	25.90	5,551	230.00	Ocean Queen	13.50	149,498	44.00
528	Hanjin Taipei	25.90	5,551	230.00	Champel	13.90	149,505	47.00
529	Hanjin Gothenburg	25.90	5,551	230.00	Celigny	13.00	149,507	47.00
530	Monte Pascoal	23.30	5,552	170.00	Cape Australia	13.90	149,512	38.00
531	Alianca Maua	23.30	5,560	170.00	Waterford	12.60	149,513	38.00
532	Monte Cervantes	23.30	5,560	170.00	York	13.50	149,513	38.00
533	Monte Olivia	23.30	5,560	170.00	Cape America	13.90	149,515	38.00
534	Monte Rosa	23.30	5,560	170.00	C. Koreana	14.30	149,516	38.00
535	Monte Sarmiento	23.30	5,560	170.00	Chenebourg	12.60	149,518	38.00
536	Nedlloyd Barentsz	25.30	5,618	220.00	Bulk Leher	13.50	149,532	42.00
537	Nedlloyd Hudson	25.30	5,618	220.00	Cape Africa	13.90	149,533	38.00
538	Nedlloyd Tasman	25.30	5,618	220.00	La Paloma	12.60	149,571	38.00
539	Nedlloyd Mercator	25.30	5,618	220.00	Go Patoro	13.50	150,108	47.00
540	Nedlloyd Drake	25.30	5,618	220.00	Chs Star	13.50	150,149	47.00
541	Ever Unity	25.00	5,652	190.00	Cape Venture	14.50	150,393	54.00
542	Ever Uberty	25.00	5,652	201.00	Blazing River	14.00	150,809	48.10
543	Ever Unific	25.00	5,652	201.00	Chikuzen Maru	14.00	150,842	48.00
544	Ever Uranus	25.00	5,652	201.00	Chs Moon	14.00	151,040	50.50
545	Ever Ursula	25.00	5,652	201.00	Ocean Dragon	14.00	151,049	52.10
546	Ever Useful	25.00	5,652	201.00	Kamisu Maru	14.20	151,102	50.00
547	Ever Urban	25.00	5,652	201.00	Ianthe	14.50	151,143	49.60
548	Ever Utile	25.00	5,652	201.00	Stellar Fortune	14.50	151,283	52.00
549	Ever Ulysses	25.00	5,652	201.00	Nymphe	14.00	151,300	42.90
550	Ever Unicorn	25.00	5,652	201.00	Nautical Dream	14.10	151,439	45.20
551	LT Usodimare	25.00	5,652	201.00	Southern Galaxy	14.00	151,511	50.50
552	OOCLSan Francisco	25.00	5,714	189.00	Hanjin Capetown	13.50	151,525	42.30
553	OOCL Chicago	25.20	5,714	189.00	Empress	13.50	151,662	51.80
554	OOCL Malaysia	24.90	5,762	228.00	Shin Ondo	14.20	151,833	40.10
555	OOCL Los Angeles	24.90	5,762	228.00	China Fortune	13.90	152,011	42.50
556	OOCL Germany	24.90	5,762	228.00	Creciente	14.00	152,065	50.80
557	OOCL France	25.00	5,762	228.00	Santa Isabel	14.50	158,387	48.00
558	APL India	25.00	5,762	228.00	Aquabella	14.50	161,010	55.30
559	APL Canada	25.00	5,762	228.00	Aquadonna	14.50	161,010	55.30
560	APL Denmark	25.00	5,762	228.00	Anangel Legend	14.50	161,059	59.00
561	OOCL New York	25.10	5,762	228.00	Martzoukos A.	14.50	161,175	53.00
562	OOCL Shanghai	25.10	5,762	228.00	Iron Queen	14.50	161,183	57.50
563	CSCL Kobe	26.10	5,762	228.00	Alpha Friendship	14.50	161,524	53.50

564	CSCL Los Angeles	26.10	5,762	228.00	Anangel Pride	13.50	161,643	55.00
565	APL Sweden	26.10	5,762	228.00	Anangel Solidarity	13.50	161,643	55.00
566	E. R. London	25.80	5,762	237.60	Anangel Splendour	13.50	161,643	55.00
567	E. R. Amsterdam	26.10	5,762	237.60	Iron Beauty	14.00	164,218	53.20
568	E. R. Felixstowe	26.10	5,762	237.60	Kirmar	14.00	164,218	53.20
569	NYK Sirius	23.00	6,148	183.00	Thalassini Kyra	14.20	164,218	53.20
570	NYK Castor	23.00	6,208	183.00	Cape Flora	14.30	164,361	53.30
571	NYK Canopus	23.00	6,208	210.00	Thalassini Axia	14.50	164,796	55.00
572	NYK Antares	23.00	6,214	190.60	B Duckling	14.10	165,133	54.00
573	Hatsu Excel	24.50	6,332	219.00	A Duckling	14.10	165,239	53.00
574	Hatsu Ethic	24.50	6,332	219.00	C. Oasis	13.50	165,693	56.00
575	Hatsu Elite	24.50	6,332	219.90	Irfon	13.50	165,729	56.00
576	Hatsu Eagle	25.00	6,332	219.90	Heythrop	13.50	165,729	58.00
577	MSC Barbara	24.80	6,402	240.00	Rubin Grace	14.50	166,939	67.50
578	Hyundai Kingdom	26.40	6,479	248.00	Pantelis Sp	14.00	169,883	60.00
579	Hyundai Republic	26.40	6,479	248.00	Saraji Trader	14.30	169,907	59.50
580	Hyundai National	26.40	6,479	248.00	Iron Yandi	14.00	169,963	53.90
581	Hyundai Dominion	26.40	6,479	248.00	Iron Baron	14.00	169,981	60.00
582	Hyundai Patriot	26.40	6,479	248.00	Cape Ocean	14.50	170,631	56.00
583	CMA CGM Balzac	26.30	6,627	280.00	NSS Bonanza	14.50	170,907	53.00
584	CMACGM Baudelair	26.30	6,627	280.00	Anangel Dynasty	14.50	171,101	63.10
585	Los Angeles Express	25.60	6,732	213.00	Anangel Eternity	14.50	171,176	63.10
586	Bangkok Express	25.60	6,732	213.00	Cape Azalea	14.50	171,846	50.30
587	SanFrancisco Expre	25.60	6,732	213.00	Cape Wakaba	14.50	171,978	55.80
588	MSC Flaminia	25.50	6,732	235.00	Cape Jupiter	14.30	172,480	49.70
589	MSC Alessia	25.60	6,732	235.00	Giuseppe Lembo	13.20	172,639	58.00
590	MSC Ilona	25.60	6,732	235.00	Cape Breeze	13.10	172,972	52.50
591	Maersk Kiel	24.50	6,930	240.00	NSS Advance	14.50	173,246	54.30
592	Maersk Kingston	24.50	6,978	200.00	Castillo De San Jua	13.80	173,329	46.50
593	Maersk Kampala	24.50	6,978	270.00	Mineral Belgium	14.00	173,806	60.00
594	Hamburg Express	25.30	7,506	231.00	Mineral Shanghai	14.00	173,880	60.00
595	Shanghai Express	25.30	7,506	231.00	Quorn	14.50	179,869	53.10
596	Hong Kong Express	25.30	7,506	231.00	Buccleuch	13.50	182,675	52.80
597	Berlin Express	25.30	7,506	231.00	Ocean Castle	13.80	182,711	51.50
598	MSC Maeva	25.40	8,034	256.00	Yamato	13.60	184,349	48.00
599	MSC Lucy	25.40	8,034	256.00	Ocean Vanguard	13.00	206,258	53.00
600	MSC Rita	25.40	8,034	256.00	Sg Prosperity	14.50	211,201	69.00
601	Kyoto Express	24.50	8,749	248.80	Bergeland	14.50	322,941	93.00

Source: Lloyd's Register: Fairplay. (2006). *World Shipping Encyclopaedia*. WMU library software (Ships).

Appendix F - Development of Fuel Oil Supply, World Tonnage and Bunker Price (1990 - 2006)

Year	Fuel Oil Supply ('000 barrels daily)	World Tonnage (million dwt)	Bunker Price (US$/ton)
1990	2,201	658.4	112
1991	2,175	642.1	95
1992	2,119	665.3	88
1993	2,070	688.5	78
1994	2,020	711.7	88
1995	1,983	734.9	100
1996	1,952	758.1	112
1997	1,895	775.8	104
1998	1,967	788.7	72
1999	1,856	799.0	113
2000	1,720	808.4	161
2001	1,724	825.7	135
2002	1,740	825.6	153
2003	1,700	844.2	176
2004	1,668	857.0	186
2005	1,670	895.8	272
2006	1,694	960.0	321

Sources: bunker price in Singapore: compiled by author from various issues of Drewry Monthly from 1990 to 2007 (see Appendix A). **Fuel oil supply**: compiled from BP Plc. (2007). BP statistical review of world energy, June 2007: quantifying energy. London: BP Plc. **World Tonnage**: compiled from various issues of Review of Maritime Transport from 1990 to 2006, UNCTAD.

Appendix G - Bunker forwards and swaps contracts traded at IMAREX (2005-2007)

Month	Trades	Lots	Trade Value ($)	Average Lot/ Trade	Average Value /Trade ($)
Dec-05	23	260	57,000,000	11	2,478,261
S.Total	**23**	**260**	**57,000,000**	**11**	**2,478,261**
Jan-06	43	333	96,000,000	8	2,200,000
Feb-06	70	432	130,000,000	6	1,860,000
Mar-06	67	586	181,000,000	9	2,700,000
Apr-06	47	197	64,000,000	5	1,362,000
May-06	34	406	138,645,000	12	4,078,000
Jun-06	49	339	101,579,000	7	2,073,041
Jul-06	50	341	113,355,500	7	2,267,110
Aug-06	51	436	138,891,500	9	2,723,363
Sep-06	90	701	203,700,000	8	2,263,962
Oct-06	105	665	192,000,000	6	1,828,571
Nov-06	68	734	200,000,000	11	2,941,176
Dec-06	47	760	174,000,000	16	3,702,128
S.Total	**721**	**5,930**	**1,733,171,000**	**104**	**2,499,946**
Jan-07	60	640	15,700,000	11	2,600,000
Feb-07	52	820	18,900,000	16	3,600,000
Mar-07	42	417	11,400,000	10	2,700,000
Apr-07	28	307	9,300,000	11	3,300,000
May-07	60	865	285,000,000	14	6,000,000
S.Total	**242**	**3,049**	**340,300,000**	**62**	**3,640,000**
G.Total	**986**	**9,239**	**2,130,471,000**	**177**	**2,160,721**

Source: Retrieved and compiled by author June 19, 2007 from World Wide Web: http://www.imarex.com/about_imarex/volume_statistics/fuel_oil_swaps.

Appendix H – Composition of shipping routes of Baltic Freight Index from 1985 to 2007

Route	Vessel Size (dwt)	Cargo	Route Descriptions	1/1/85-11/3/88	11/4/88-8/3/90	8/6/90-2/4/91	2/5/91-2/4/93	2/5/93-11/2/93	11/3/93-5/5/98	5/6/98-10/29/99	From 1/11/99
1	55,000	Light grain	US Gurf to ARA	20%	20%	10%	10%	10%	10%	10%	10%
1A	70,000	T/C	Trans-Atlantic round (duration 45-60 days)	No	No	10%	10%	10%	10%	10%	20%
2	52,000	HSS	US Gurf to South Japan	20%	20%	20%	10%	10%	10%	10%	12.5%
2A	70,000	T/C	Skaw Passero a to Taiwan-Japan (50-60 days)	No	No	No	10%	10%	10%	10%	12.5%
3	52,000	HSS	US Pacific Coast to South Japan	15%	15%	7.5%	7.5%	7.5%	10%	10%	10%
3A	70,000	T/C	Trans-Pacific round (35-50 days)	No	No	7.5%	7.5%	7.5%	10%	10%	20%
4	21,000	HSS	US Gurf to Venezuela	5%	5%	5%	5%	5%	No	No	No
5	35,000	Barley	Antwerp to Jeddah (Saudi Arabia)	5%	5%	No	No	No	No	No	No
	38,000	T/C	South America to Far East	No	No	5%	5%	5%	No	No	No
6	120,000	Coal	Hampton Roads (US) to South Japan	5%	7.5%	7.5%	7.5%	7.5%	7.5%	No	No
7	65,000	Coal	Hampton Roads (US) to ARA	5%	5%	5%	No	No	No	No	No
	110,000	Coal	Hampton Roads (US) to ARA	No	No	No	5%	5%	7.5%	7.5%	No
8	130,000	Coal	Queensland (Australia) to Rotterdam	5%	5%	5%	5%	5%	7.5%	No	No
9	55,000	Coke	Vancouver (Canada) to Rotterdam	5%	5%	5%	5%	No	No	No	No
	70,000	T/C	Japan-Korea to Skaw Passero (50-60 days)	No	No	No	No	5%	10%	10%	15%
10	90,000	Iron ore	Monrovia (Liberia) to Rotterdam	5%	5%	5%	No	No	No	No	No
	150,000	Iron ore	Tubarao (Brazil) to Rotterdam	No	No	No	5%	5%	7.50%	7.50%	No
11	25,000	Pig iron	Vitoria (Brazil) to China	5%	No	No	No	No	No	No	No
	25,000	Phosphate	Casablanca (Morocco) to West Coast India	No	2.5%	2.5%	2.5%	2.5%	No	No	No
12	20,000	Potash	Hamburg (Germany) to West Coast India	2.5%	No	No	No	No	No	No	No
	14,000	Phosphate	Aqaba (Jordan) to West Coast India	No	5%	5%	5%	5%	No	No	No
13	14,000	Phosphate	Aqaba (Jordan) to West Coast India	2.5%	No	No	No	No	No	No	No
14	140,000	Iron ore	Tubarao (Brazil) to Beilun and Baoshan (China)	No	No	No	No	No	No	7.5%	No
15	140,000	Coal	Richards Bay (US) to Rotterdam	No	No	No	No	No	No	7.5%	No

Notes: ARA-Amsterdam, Rotterdam and Antwerp area. HSS is heavy grain, soya, and sorghum. T/C is time chater routes. Skaw Passero is the range that extends from Cape Skaw in Denmark to Cape Passero in Sicily (Italy). The countries of the remaining ports are in parentheses. The following minor amendments of the Index are not presented: as of May 6, 1998, routes 2 and 3 refer to a 54,000dwt Panamax vessel; routes 1A, 2A, 3A and 9 were based on a 64,000 dwt Panamax vessel for the period up to February 2, 1996; route 5 was 20,000 dwt vessel Barley from Antwerp to Red Sea for the period January 4, 1985 to February 4, 1986; route 7 was based on a 100,000 dwt vessel for the period February 5, 1991 to February 4, 1993; route 8 was based on a 110,000 dwt vessel for the period January 4, 1985 to February 5, 1992; route 10 was based on a 135,000 dwt vessel for the period February 5, 1991 to August 2, 1995; route 11 was 20,000 dwt sugar from Recife (Brazil) to US East Coast for the period January 4, 1985 to May 8, 1986.

Source: Compiled by the author from Kavussanos & Nomikos (2000b, pp. 783-784).