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Forecasting the dry bulk freight market

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FORECASTING THE DRY BULK FREIGHT MARKET

By

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DECLARATION

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

Title of Dissertation: **Forecasting the dry bulk freight market**

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

This dissertation is a study of the dry bulk freight market and ultimately in the forecasting of the freight rates in this market in view of the examinating of the determinants of supply and demand.

A literature review of the bulk shipping market is examined. Particularly, the market model and freight rate model have been scrutinised. Based on this foundation, forecasting work can be done.

The characteristics and overview of the dry bulk freight market are described and determinants which affect the demand and supply of the market are identified and analysed.

Linear regression, time series analysis and demand/supply models are examined to identify the appropriate methods for forecasting freight rates in the market. Practical work is done by applying identified forecasting methods to forecast the freight rates of the dry bulk freight market in 2005 and 2006.

The concluding chapter identifies the limits of the dissertation with regard to data, methods and approaches. Recommendations are put forward to tackle the problems arising.

KEYWORDS: dry bulk freight market, **m**arket models, freight rate models, determinants, demand, supply, linear regression, time series analysis.

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LIST OF ABBREVIATIONS

BDI	Baltic Dry Index
BRS	Barry Rogliano Salles
EU	European Union
IEA	International Energy Agency
IMF	International Monetary Fund
ISL	Institute of Shipping Economics and Logistics
GDP	Gross Domestic Product
LDT	Light Displacement Ton
MAE	Mean Absolute Error
MDO	Marine Diesel Oil
MSE	Mean Square Error
OECD	Organization for economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
UNTACD	United Nations Conference on Trade and Development

CHAPTER 1 INTRODUCTION

Shipping is certainly one of the most interesting industries in the world. There are a certain number of arguments to support this statement. To begin with, shipping became the first global industry long before the current globalisation process started. In fact the ships, shipping companies and other relevant organisations operate in an international environment. Moreover, the complexity of industry and its dependence on world economy requires huge skills and knowledge to deal with the day-to-day operation as well as events which make routine way. Further, the shipping environment is characterised by a high degree of uncertainty such as the cyclical nature of international trade, the forces of nature and especially the volatile nature of freight rates. The core of this volatility is the dry bulk shipping market.

The volatile nature of the dry bulk freight market is due to the highly competitive characteristics of the dry bulk freight market where the freight rate depends on the balance of demand and supply (Ma, 2004, p. 107). In addition to this, demand and supply are affected by various factors which have different weightings.

The complexity and uncertainty in shipping, especially the volatile nature of the freight rates have urged scholars to discover the secrets of the freight market. In fact, right from the start in the early thirties, shipping communities have always expressed a strong interest in quantitative analysis of freight rates. Market models, and particularly freight rate modelling, have been of primary interest in research in bulk shipping. Once the model is formulated, it can be used for forecasting purposes. Even though a large amount of research into bulk shipping, has been done, “there is no example of a successful freight rate forecasting model" (Veenstra, 1999, p. 42). This is the reason why freight rate forecasting is still a fascinating topic for researchers.

1.1 Objectives

The overriding objective of this dissertation is to suggest an approach for selecting the appropriate methods in forecasting rates in the dry bulk freight market. There are many forecasting methods available; only proper methods will be put forward to forecast freight rates. Forecasting can, however, be done by a careful examination of the factors which affect the freight rates. Therefore, another aim of this dissertation is to provide an economic analysis of the determinants of the dry bulk freight market.

Forecasting requires large data sets of variables of the market. In fact, the shipping sector maintains a huge information industry that makes a large volume of market data, trade flow information, fleet statistics and so on available. This results in careful attention being given to obtaining appropriate data used for the measurement of the variables.

Since there are a large number of factors influencing the dry bulk freight market, a review of past literature can be an effective way to identify the economic relationship among these factors. In general, economic research in shipping has been relatively extensive. This dissertation, however, focuses on reviewing the remarkable work which serves for the purpose of forecasting.

Forecasting is difficult. The reason is that there are many constraints to each forecasting method, the volatile nature of the dry bulk market, the quality of data and so on. All of these elements will be examined in order to improve forecasting work.

Lastly, practical work will be carried out where the freight rates in 2005 and 2006, will be forecasted based on all the theoretical work which has been scrutinized before.

1.2 Methodology

In order to obtain the dissertation's objectives, it was decided to use quantitative methods in carrying out the studies for this dissertation.

The research methodology is divided into two phases; the first phase involves secondary research; whereas the second phase involves primary research.

In phase one, secondary research comprises the acquisition of knowledge of the shipping market in general and the dry bulk shipping market in particular. Beenstock & Vergottis' (1993) Economic Modelling of World Shipping and Albert Veenstra's (1999) Quantitative Analysis of Shipping market provided a deep analysis of previous work on the topic. In addition, the archives of Lloyd's Shipping Economist, Fairplay, Lloyd's List together with market reports from major shipbrokers such as Clarkson, Galbraith and research firms like the Institute of Shipping Economics and Logistic (ISL) provide an update on the current issues relating to the topic as well as an insight into the ideas of shipping professionals.

In phase two, primary research includes data collection and analysis. Shipping related data (fleet, delivery, orderbook, lay-up, scrapping, freight rates, trade volumes) was collected from various publications of shipping newspapers and magazines, major shipbrokering companies and research institutions including Lloyd's List, Fairplay, Drewry, Fearnleys, ISL. In addition, the research also includes the ideas of professionals from the industry so that the broader views of the subject would be gained. Those ideas were obtained from shipowners, shipping companies, shipbrokering houses companies in Greece, Denmark, and England during author's field studies as well as from shipping periodicals.

1.3 Structures of the dissertation

This dissertation provides an econometric analysis of the dry bulk shipping market to serve for the objective of forecasting freight rates. The structure of the dissertation includes 6 chapters.

Chapter 1 sets the scene by introducing the dissertation's objectives. Also, research methodology is mentioned in this chapter to achieve the dissertation's objectives.

Chapter 2 describes developments in bulk shipping research. This chapter starts with a literature review on bulk shipping from the start by Tinbergen in the beginning of the thirties. From there, it introduces various market models especially the freight rates model which will be used for forecasting purposes in latter parts. In addition, this chapter also presents the shipping cycles and their causes.

Chapter 3 contains the analysis of influential factors of the dry bulk freight market. In addition, the correlational research method is used to examine the relationship between factors influencing rates in the dry bulk market.

Chapter 4 is devoted to forecasting the dry bulk freight market by using linear regression. This chapter presents both simple and multiple regression analysis for forecasting the freight rate. Evaluation of forecast results is also done to test the accuracy of the method.

Chapter 5 presents a demand/supply model and time series analysis for forecasting freight rates. Each method is tested to find out its suitability for different types of forecasting. At the end of this chapter, the application of different methods is done to forecast the freight rates for 2005 and 2006.

Finally, Chapter 6 contains the conclusion of works presented in the dissertation together with the direction for further research relating to this topic.

CHAPTER 2 DEVELOPMENTS IN BULK SHIPPING RESEARCH

2.1 Literature review

Shipping plays a vital role in world trade and economy. Nowadays, although a certain amount of the world trade is transported by truck, rail, airplane etc, most is carried by ships. It was estimated that 90 per cent of world trade goods in volume are shipped by sea (Ma, 2004, p. 11). It could be said that shipping is a bridge between world trade and industrial production. Consequently, the demand for international maritime transport is derived from the trade of goods. As the characteristics of world trade fluctuate and are cyclical, this feature is also present in the shipping market. To avoid large risks with a huge investment in expensive ships, shipowners are in a great need of forecasting information on the shipping market. Not only shipowners but many other organisations from shipbrokers to charterers, farmers to industrialists etc. require information on the development of the shipping market for making decisions which affect the future of their organisations.

There have been many attempts to investigate, analyse and model various aspects of shipping markets. The early efforts were made by Tinbergen (1959) who investigated the influence of total demand and supply of tonnage on the sensitivity of freight rates. This is one of the earliest econometric applications in shipping. Timbergen used the seaborne trade to quantify the demand which is considered to be perfectly inelastic with respect to freight rates. On the other hand, the supply determinants are the size of the fleet and the price of bunkers. An increase in the size of the fleet increases the supply. In contrast, an increase in the price of bunkers will cause the supply at a given freight rate to contract because ships find that it is more economical to slow down. The supply and demand model of Tinbergen has the following structure:

$$q^s = f^s (fr, K, p^b,\ldots) \quad (2.1)$$

$$q^d = q \quad (2.2)$$

$$q^d = q^s \quad (2.3)$$

This function could be changed into the expression of freight rate:

$$fr= f (K, q^s, p^b, \ldots) \quad (2.4)$$

where q^s is the quantity supply, q^d is the quantity demand, fr is the freight rate, K is the fleet size (dwt), p^b is the bunker cost and q is the amount of trade.

In addition, Tinbergen also estimated the supply elasticises (the supply equation) as follows:

$\alpha = 0.94$, $\beta= - 0.23$, $\gamma= 0.59$

α, β, γ is the elasticity of supply with respect to the fleet, bunker cost and freight rate. From this, it is obvious that the elasticity of supply with respect to the fleet is close to the value of unity. In contrast, the supply is moderately inelastic with the bunker cost and freight rate (Veenstra, 1999, p. 21).

In the same period, Tjalling Koopman (1939) introduced the idea that "the proper demand analysis in shipping quickly moves outside the scope of shipping market analysis". Furthermore, he also argued that total demand for tank shipping services is rather inelastic to freight rates. This argument is commonly translated into the bulk market. He is also one of the pioneers to 'note the peculiar shape of the supply curve in shipping' (Veenstra, 1999, p. 22).

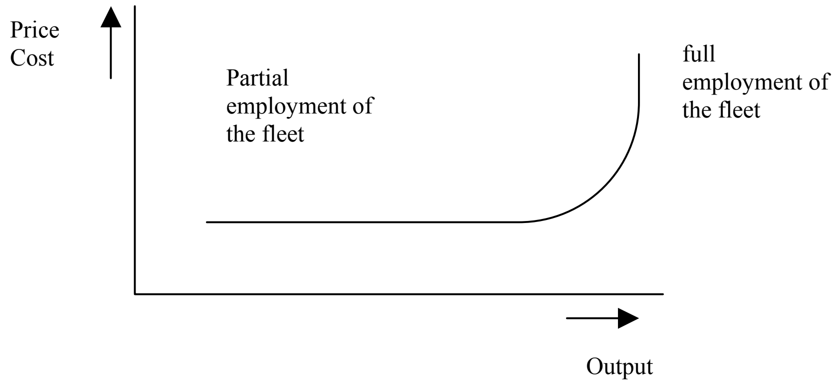

Figure 2.1 Supply curve

Source: Veenstra, A.W. (1999). *Quantitative Analysis of Shipping Market*. Delft: Delft Uniersity Press Postbus.

The shape of the supply curve is important to understand the fluctuation of freight rates. When the fleet is partially active, the demand curve intersects with the flat section (elastic section of supply curve), which means that the increase or decrease in demand hardly affects the freight rate, because the fleet can easily adjust to the changes in demand (Figure 2.1). Nevertheless, when the whole fleet is actively operating, the supply cannot easily meet the increase in demand. Consequently, the freight rate rises sharply.

Arnljot Stromme Svendsen (1958) made a contribution to the quantitative analysis of bulk shipping by publishing his " Sea Transport and Shipping Economics". Swendsen introduced the demand and supply of maritime transport and the determinants for each. The demand determinants comprises of amount of goods to be shipped, transport distance and political measures affecting trade and shipping. The supply determinants are total tonnage in operation, the average life of a ship and the efficiency of ships' operation (Veenstra, 1999, p. 24).

Thorburn (1960) published “Demand and Supply of Water Transport” which investigates freight rate formation. With the assumption that shipping markets are perfectly competitive, the freight rate will be equal to costs in the long run. Consequently, this would enable the investigation of freight markets through the identification and evaluation of the actual individual costs of the shipowners (Veenstra, 1999, p. 27)

In 1966, Zenon Zannetos published ‘The Theory of Oil Tankship Rates’ which was considered ‘the most cited work in maritime economics’ (Veenstra, 1999, p. 27). His main idea dealt with the role of expectation in price determination. He observed that the expectation is significantly affected by the voyage charter rate which is determined by short-term demand and supply in the shipping market. Through an analysis of the supply and demand in the tanker market, Zannetos also discovered the relationship between the voyage charter rate and the number of idle ships. The relationship between voyage charter and time charter rate was also extensively investigated.

Many researchers have paid great attention to the market model since the start work of Tinbergen in the early thirties. One of them is Howdon (1978) who explained the determination of freight rates in the short and long run. His work was very much based on the one of Zannetos. Hawdon carries out the simulation experiments with his model which comprises the exogenous variables including tanker size, steel prices, bunker costs, average of tanker size, oil trade, the closing of the Suez canal and endogenous variables such as voyage charter, orders, deliveries and scrapping (Veenstra, 1999, pp. 30-34). These variables are still used by analysts and researchers for market forecast and analysis.

The Center for Applied Research of Norwegian School of Economics and Business Administration has performed a great volume of theoretical and empirical work on the shipping market. Wergeland (1981) has a study of the aggregate demand for freight. He estimated an aggregate model of the world dry bulk freight market (Norbulk). The equation of demand and supply are:

$$Q = 1.379T - 0.077F \quad (2.5)$$

$$Q^s = 0.486K + 0.266F - 0.120P_b \quad (2.6)$$

where

Q^s is the quantity supply, Q is the quantity demand, F is the freight rate, K is the fleet (dwt), P_b is the bunker cost, T is world seaborne trade (ton-mile) (Beenstock & Vergottis, 1993, pp. 76-77).

In contrast to the high elasticity of demand for world trade (T), the demand for freight is very inelastic. The price elasticity of demand with respect to freight is minus 0.077. The supply is also estimated to be moderately inelastic with the freight and bunker price. As compared to the calculation of Tinbergen and others, coefficients which were estimated by Wergeland are not considerably different.

Strandenes (1984) announces the results of a study on the determinants of time charter rates and second hand prices. The determinants of time charter rates are expressed in the following equation (Beenstock & Vergottis, 1993, p. 79-80).

$$H^i_t = p[a\pi + b\pi^L] \quad (2.7)$$

where

H^i_t: time charter rate on a year i arranged at time t

π : current short term time charter equivalent

π^L : expected long term time charter equivalent

p() is a risk premium factor that might vary with the duration of the contract

If p=1 and a + b =1 then there is risk neutrality

If p() <1 means that the owners are prepared to accept lower profits on a safe time charter than the expected profit to be earned on the more risky spot market.

Indeed, the longer the time charter is, the less time the charter rate is. The twelve-month time charter rate for Panamax was fixed at USD 38,000 in March which is much higher than the 36 month time charter of USD 25,500 (Lloyd's Shipping Economist, April 2005, p. 39).

The freight market models Norbulk and the study of Strandenes (1984) as well as other research into the ship building and scrapping markets have been incorporated into an integrated model of the bulk shipping markets (Norship).

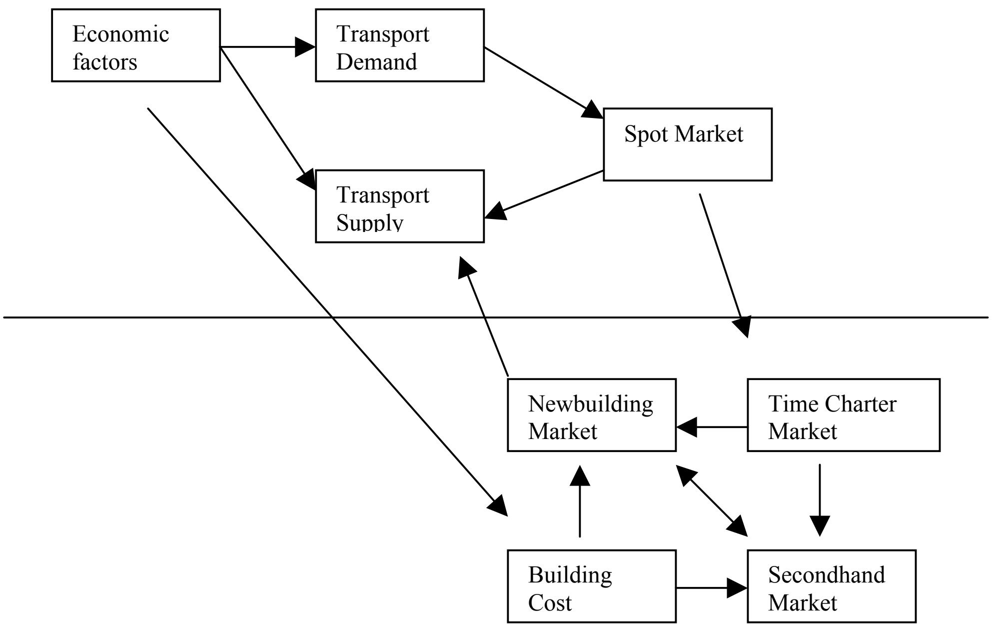

Figure 2.2 Structure of the Norship model

Source: Veenstra, A.W. (1999). *Quantitative Analysis of Shipping Market*. Delft: Delft Uniersity Press Postbus.

The demand and supply model mentioned above the horizontal line (Norbulk) (Figure 2.2) is specified as follows:

$Q = f^T (c_1, y^p , y^a)$ (2.8)

$Q^d = f^d (c_2, q, fr^p)$ (2.9)

$Q^s = f^s (c_3, fr^p , K, p^b)$ (2.10)

$Q^s = Q^d$ (2.11)

where y^p and y^a are the potential industrial production and the level of economic activity respectively; c_1 , c_2 , c_3 are constants; the other variables are mentioned above. Norbulk estimates of variables are illustrated in Table 2.1.

Table 2.1 Norbulk estimates of variables

Supply and demand model	fr^p	q	K	p^b
Q^d	-0.40	1.38	1	
Q^s	0.27		1	-0.24

Source: Veenstra, A.W. (1999). *Quantitative Analysis of Shipping Market*. Delft: Delft Uniersity Press Postbus.

Beenstock & Vergottis (1993) introduce a comprehensive model for the dry bulk. They first distinguish four main markets in the shipping industry which are the freight, secondhand, newbuilding and scrap markets. According to Beenstock & Vergottis, the freight market is characterised by a supply and demand framework for the voyage charter rate. Beenstock & Vergottis also incorporate the variables q and K in the voyage charter equation in the form (q-K) which is the supply and demand balance, p^b, AH being the average haul of a contract. They assume that demand is inelastic to the freight rates and the theoretical supply elasticity of the fleet is unity (Veenstra, 1999, p. 37). Their estimation results of the freight market for dry bulk carriers are shown in Table 2.2.

Table 2.2 Beenstock & Vergottis's estimiate; freight market

Freight market block	C	q-K	p^b	AH
fr^s	6.05	4.22	1	-6.60

Source: Beenstock & Vergottis (1993). *Econometric Modelling of World Shipping.* London: Chapman & Hall.

2.2 The freight rate model

There has been a significant consensus about the structure of the reduced form freight rate equation between researchers over years. The estimation of the reduced form freight rate relations performed by some typical researchers is presented in Table 2.3. Another thing is that all the functions contain the same variables q, K and p^b. Moreover, there is a significant similarity in the estimated coefficients.

$$fr = f(K, q, p^b, \ldots) \quad (2.12)$$

Table 2.3 Estimation results reduced form freight rate

	C	q	K	p^b	Other variables
					AH
Tinbergen					
Pre-war		1.7	-1.6	0.4	
Post war		0.5	-3.3		
Hawdon					
Dry bulk carriers	-0.85	0.81	-6.25		
Norbulk		3.87	-1.28	0.42	
Beenstock & Vergottis					
Dry bulk carriers	6.05	4.22	-4.22	1	-6.60

Source: Veenstra, A.W. (1999). *Quantitative Analysis of Shipping Market*. Delft: Delft Uniersity Press Postbus.

In conclusion, it appears that the bulk shipping market in general and dry bulk shipping market in particular have always been considered as competitive markets in which the prices are driven by the forces of the market. It is significant to implement supply and demand analysis to understand the development and forecast of the market. Furthermore, there is a common consensus on some elements in the structure of the shipping industry including price inelastic demand, the form of the supply curve, the interrelation of freight and ship markets, for example, secondhand and newbuilding market.

2.3 Shipping cycle and forecasting

Cycles are one of phenomena which have occurred in many industries. The shipping industry is no exception. Economists have devoted a lot of effort to analyzing shipping cycles. Martin Stopford is one person who has analyzed the characteristics of shipping cycles as well as clarifying the mechanisms and the causes of cycles.
This section will focus firstly on a brief history of dry cargo market cycles; secondly examine the causes of cycles and thirdly, present the forecasting of dry cargo market cycles.

2.3.1 Brief history of dry cargo market cycles 1975-2000

Cycle 1: 1974 –1980

After the remarkable boom in the dry cargo market in 1974, it started to collapse. This downturn resulted from the recession in the world economy which followed the oil crisis in 1973. In 1976 the market remained depressed. It is estimated that 5 million deadweight tons of dry cargo vessels and 6 million deadweight of combos were laid up (Stopford, 2002, p. 213). The market had started to recover with the upturn of the steel industry and coal trade in 1977. The market continued to increase in 1979 and reached a peak in 1980 which was triggered by a strong steel industry and a tight supply of tonnage together with heavy congestion in ports in Continent (Europe) and the United States.

Cycle 2: 1981 – 1990

From 1981, the dry bulk shipping market fell again after a few years of recovery due to the deep recession in the world economy. The demand plunged for two consecutive years in 1982 and 1983. The new vessels which were delivered during the shipping boom in 1980 contributed to the negative effects. By 1983 the one-year time charter rate for a Panamax bulk carrier fell to $4,700 a day (Stopford, 2002, p. 213). In 1987, the market recovered after a series of years of severe depression. By 1990 the rates were back to the level of 1980.

Cycle 3: 1991-1995

The world economy moved into recession in 1992 which lead to a downturn in the dry bulk market. However, “the bulk carrier investors had become so conservative in their ordering activity” which result in low delivery during this period. This explains why the cycle 3 was “unusually shallow“ (Stopford, 2002, p. 213). The freight rates reached a new peak in 1995 (Stopford, 2002, pp. 214-215).

Cycle 4: 1996 –2000

The Asian currency crisis in late 1997 resulted in the downturn in the global economy which had a major impact on the movement of dry cargo. The Baltic dry index (DBI) dropped to under 1000 points. However, the conservative investment policy during 1991-1995 did not exist in this cycle. The bulk carrier deliveries increased from 15 to 20 million deadweight tons per annum. The reason could be that shipowners were able to order cheap vessels and expected those ships would be delivered into an upswing (Stopford, 2002, p. 215). Consequently, the increase of deliveries caused a relatively weak dry bulk market. In 2000, the DBI recovered to the level of about 1500 points.

Four cycles between 1975 and 2000 had an average length of 6 years. Meanwhile, according to Stopford (2000), the average shipping cycle had a frequency of 7.1 years from peak to peak. The average cyclical length of 6 years over the period 1974-2000 was 18.3% less than the 7.1 years average between 1872 and 2000. However the longest cycle was 9 year during 1974-2000 and the shortest 4 years. This is a very big difference so using cycles analysis for market prediction is not much help. As each cyclical had its own length and volatility, it is important to study each cycle as a distinctive event.

2.3.2 Causes of cycles

One of the popular ways to find out the causes of cycles is through the supply/demand model. The shipping market is driven by the interaction between supply and demand which determine freight rates. The changes in demand and supply will result in the shortage or surplus of tonnage in the market which in turn drive the increase or decrease in freight rates. When demand exceeds the supply, freight rates are driven up and shipowners tend to invest in more new ships to meet the demand. However, it usually takes about 1 to 2 years to build a ship so the supply cannot adjust immediately to the demand. In contrast, when the supply exceeds the demand, competition drives freight rates down and uneconomic ships start to be scrapped.

The shipping market is driven by exogenous and endogenous factors (Stopford, 2002, p. 217). Endogenous factors are events within the shipping market namely the interaction of four shipping markets: the freight, newbuilding, demolition and second-hand market which trigger the market. Meanwhile, exogenous factors are event outside the shipping market such as a business cycle in the world economy, seaborne trade, the world political situation etc., which trigger a cyclical pattern. This will be discussed in more detailed below.

2.3.3 Shipping cycles and forecasting

The statistical analysis of shipping cycles provided convincing evidence that the rule of a regular seven-year cycle from 1986 until now or 6-year cycle of dry bulk market during the period 1974-2000 has little value for forecasting the future market. In fact, the cycles are sometimes 9 years or 3 years. It is a quite too big difference to be accepted as a forecasting tool. The supply demand models are a helpful way to analyze the shipping cycles. Economic conditions, trade growth and the ordering and scrapping are the main variables which can be analyzed. It is essential to take into consideration the “wild cards” which triggered the extravagant market (Stopford, 1997, p. 72). Closure of the Suez Canal, the Asian currency crisis, the China phenomenon and port congestion are some examples. Careful analysis of these variables will help to reduce the risks which decision makers are taking. However, it is very complicated to analyse these factors. The world economy, for instance, is complex and difficult to predict. Nevertheless, historical analysis tells us that it is important to be alert to the possibility of the world economy recession which leads to a decline in demand. The shipping industry depression coinciding with major depression in world economy in 1983 can be given as an example. Economists and statisticians have developed economic indicators which help them to recognize the turning points of an economy in advance.

OECD’s leading indicator index, for instance, are based on a wide range of indicators including stocks, the number of workers laid off, orders, the amount of overtime as well as financial statistics such as company profits, money supply. Such information is very important for analyzing short-term market trends (Stopford, 2002, p. 223), then based on them, we can forecast, to a certain extent the possible trends in the shipping market.

CHAPTER 3 INFLUENTIAL FACTORS OF THE DRY BULK FREIGHT MARKET

3.1 Dry bulk freight market

The dry bulk freight market concerns the transportation of dry bulk including the five major bulks of iron ore, coal, grain, bauxite & alumina, phosphate rock as well as other minor bulks such as steel products, sugar, fertilizer etc. These commodities are vital to various industries and human life.

"God must have been a shipowner. He placed the raw materials far from where they were needed and covered two thirds of the earth with water" (Erling Naess) (Stopford, 1997, p. 291). Indeed, car and steel industry are usually located in the industrialized countries while iron ore is in mines thousands of miles away. This emphasizes the importance of dry bulk shipping in the world economy.

In order to analyse or forecast a freight market, it is very important to understand its nature. As regard to the dry bulk freight market, there is much work and various types of research to support the perfect competition hypothesis of the dry bulk freight market. However, it is meaningful to examine the conditions for perfect competition of the dry bulk freight market. These conditions are profit maximization, perfect knowledge, homogeneous service, large number of buyers and sellers, free entry and exit. To begin with, like other industries, profit maximisation is a driving force where that shipping operators try to optimise their operations. Besides, there is a large amount of information on the dry bulk shipping industry, for instance, market reports, analyses reported by different kinds of organisations such as the Baltic Exchange, Institute of Shipping Economics and Logistics (ISL), Fairplay, Lloyd's

List etc. All parties can obtain information on the market such as freight rates and fixtures. Furthermore, the dry bulk freight market has a homogeneous service. It is argued that the transportation of different cargo, on different routes, by different vessels is different services. Nevertheless, at the higher level of aggregation, the service which the shipowners offer is “the space in a ship times the distance travelled” (Veenstra, 1999, p. 17). Moreover, there are around 5975 dry bulk carriers operating in the market (Drewry Monthly – April 2005). Likewise, the number of charterers, brokers and trade houses etc is also large. Consequently, it can be said that this condition is satisfactory. Lastly, as compared to other industries, maritime transport in general and dry bulk shipping in particular is recognised as one of the most contestable (Ma, 2004, p. 5). A new company is free to enter into the market; similarly, an existing one is able to exit the market. Thanks to the existence of an active secondhand market, shipowners can easily buy or sell ships.

In conclusion, the dry bulk shipping markets fulfil all the conditions of the perfect competitive market. The support by many researchers for the perfect competition model in bulk shipping makes sense (Veenstra, 1999, p. 18).

As the dry bulk freight market is a highly competitive market, the identification of determinants in freight rate analysis can be based on a supply and demand framework. The following section will discuss the influential factors on the dry bulk freight market.

3.2 Influential factors of the dry bulk freight market

3.2.1 Influential factors of demand for dry bulk transport

3.2.1.1 World economy

Shipping does not create demand, its demand is derived form trade (Ma, 2004, p. 5). Without doubt, the world economy is the most important influence on ship demand. The world economy generates the demand for sea transport through the trade of the input for the manufacturing industry such as raw materials and manufactured products. As regards the dry bulk shipping market, the demand is mainly coming from the trade in raw materials, for instance, iron ore, coal etc. As a result, when the world economy fluctuates, sea trade and transport demand also fluctuate. In addition, Prof. Dr. Berthold Volk from Fachhochschule (University of Applied Sciences) notes that small changes in the economic development might have a substantial consequence for the demand for sea transport (Volk, 2002, p. 7).

However, the relationship between sea trade and world economy is not simple and direct. “There are three different aspects of world economy that may lead to change in demand for sea transport business cycle, trade elasticity and the trade development cycle” (Stopford, 1997, p. 118).

Examining the relationship between the rate of economic growth and the seaborne trade, it can be seen that that there is a close correlation between them (correlation coefficient is approximately 0.8). It is the fact that the growth rate of trade in value is usually higher than world economic growth (Figure 3.1).

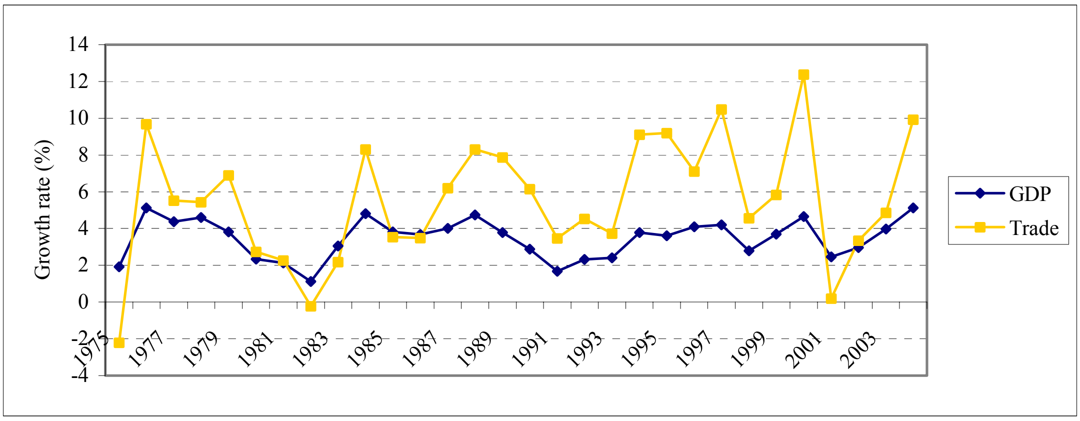

Figure 3.1 World GPD and World trade growth (1975-2004)

Source: IMF. (2005). World Economic Outlook. Retrieved July 15, 2005 from the World Wide Web: http://www.imf.org/external/pubs/ft/weo/2005/01/index.htm

The ratio between the growth rate in world trade and the rate of economic growth is defined as the elasticity of world trade. For the last 30 years trade elasticity has been positive at an average of 1.58 (IMF, 2004). In other words, world trade grew 58 per cent faster than world GDP. However, the elasticity was 1.87 between 1990 and 2000 due to the high growth rate of world trade.

There are two remarkable years as seen in Figure 3.1 in the last decade. In 2001 the United States was embarking on a long and uncertain war against terrorism after the September 11 event; the price of oil spiked above $30 a barrel. The global economy fell into deep recession which was mirrored by the recession in world trade. However the recovery of the world economy coincided with the increase in world trade in 2003.

In addition, because of the high international nature of the shipping industry and the complex mechanism through which the freight rates are determined by the interaction of demand and supply, it is interesting to examine the dry cargo freight market on a macroeconomics level. There are several global macroeconomic factors influencing the shipping industry in general and the dry cargo freight market in particular. Two of the most important factors are the foreign exchange rate and global inflation.

To begin with, since demand for sea transport heavily depends on the international trade, the foreign exchange rate volatility may have a substantial impact on the shipping industry. In his book "Economics of Maritime Transport: Theory and Practice", Mc Conville (1999) identifies the direct and indirect effect on the shipping. Since most freight rates are quoted in USD, the appreciation of the dollar relative to other currencies will probably increase freight rates. Dollar depreciation, on the contrary, will effectively decrease freight rates. On the other hand, from the macroeconomic perspective, the fluctuation in exchange rates may affect the shipping industry indirectly by increasing the level of international trade which makes the exports of the countries cheaper (or more expensive) and, consequently, increases (or reduces) the demand for sea transport. Moreover, Leggate (1999) attempted to quantify the impact of foreign exchange rate movement on the operating result of the shipping industry. She found that the risks of a volatile foreign exchange market might have a positive or negative effect on expenditure denominated in USD, depending on the direction of movement in the exchange rate. As a result, operating profits can rise or fall sharply because of such movements (Grammenos & Arkoulis, 2002).

Inflation is another potential source which affects the dry cargo freight market because of the repercussion it has on the world economy and international trade. High inflation is a signal of world economy uncertainty affecting consumers, and consequently influencing international trade.

3.2.1.2 The impact of political disturbance on ship demand

Stanford (1997) noted that the discussion on sea transport demand would not be complete without reference to the impact of politics. There are various political events which result in a sudden and unexpected change in maritime transport demand including wars, political alliance or even a strike. The Korean War in the early 1950s lead to a stockbuilding boom in Western countries. Later, the Six-Day War between Israel and Egypt in 1967 resulted in the closure of the Suez Canal which caused a great impact on trading through this canal. Recently, the event of September 11 and war on Iraq had an influence on the world economy and international trade in 2001. Not only wars but also political alliance has a significant impact on shipping. In May 1, 2004, the European Union celebrated the ceremony of its expansion as the existing 15 countries were joined by 10 new ones. This expansion not only adds 75 million people to EU and increases the area of territory by 34% but also facilitate EU internal trade. The traditional trade pattern EU countries may be given up and replaced by EU internal trade.

It is obvious that any investigation and analysis of the shipping market should take into consideration potentially important facts of a political nature. These factors are often "outside the experience of market analysts" (Stopford 1997, p. 127).

3.2.1.3 Seaborne commodity trade

In 2004, the world seaborne trade was 6540 million tons of which 38% or 2487 million tons were dry bulk trade (ISL, Jan/Feb 2005). During the last ten years, seaborne dry bulk trade increased on average by 3.8 per cent yearly. Particularly, the increase was 5.5% in 2003 and 6.3% in 2004 (ISL, Jan/Feb 2005). As compared to the world seaborne trade in the same period, the growth rate of dry bulk trade is similar. This means that the dry bulk trade has maintained its considerable share as compared to other cargoes. In 2004, nearly 64% or 1592 million tons could be attributed to the 5 major dry bulk cargoes (iron ore, coal, grain, bauxite & alumina and phosphate).

Table 3.1 Five major bulk commodities, 1975-2004 (Mt)

Commodity	1975	1985	1995	2000	2004
Iron ore	292	321	399	454	590
Coal	127	272	403	523	655
Grain	137	181	184	230	250
Bauxite & alumina	41	40	49	53	67
Phosphate	38	43	28	28	30
Total	635	857	1063	1288	1592

Source: Compiled from many publications of Fearnleys Review.

From Table 3.1, it is clear that each of five major bulk commodities has its own distinctive growth pattern. From 1975 to 1985 iron ore grew slowly, after which the trade has grown rapidly. Especially, the iron ore trade increased by 30 per cent between 2000 and 2004. Coal grew rapidly from 1975 to 2004. It nearly increased by 2.5 times between 1985 and 2004. At present, coal is the largest of the dry bulk trade.

Grain grew gradually during 1975 and 2004. Bauxite grew steadily between 1975 and 1995, then stagnated and recently increased sharply. Phosphate has fluctuated during the last 30 years; growing for some years then decreasing.

Understanding the changes in the pattern of growth of 5 major dry bulk commodities trade are very important for analysing the dry bulk freight market.

Iron ore

Iron ore is the raw material of steelmaking. Consequently, any analysis of the iron ore trade must include the world steel production.

Steel is a basic material for sustained development in a modern industrial society. Almost all important sectors of industry use steel as an essential input for such products as cars and machinery manufacturing, industrial and domestic buildings, merchant ships and the great majority of industrial products. Steel production comes from two main sources: crude steel and pig iron.

Crude steel production primarily follows three types of process which are the reduction of iron ore mainly via blast furnaces (BF steel) and the melting of steel scrap in the electric arc furnace (EAF steel) and steel.

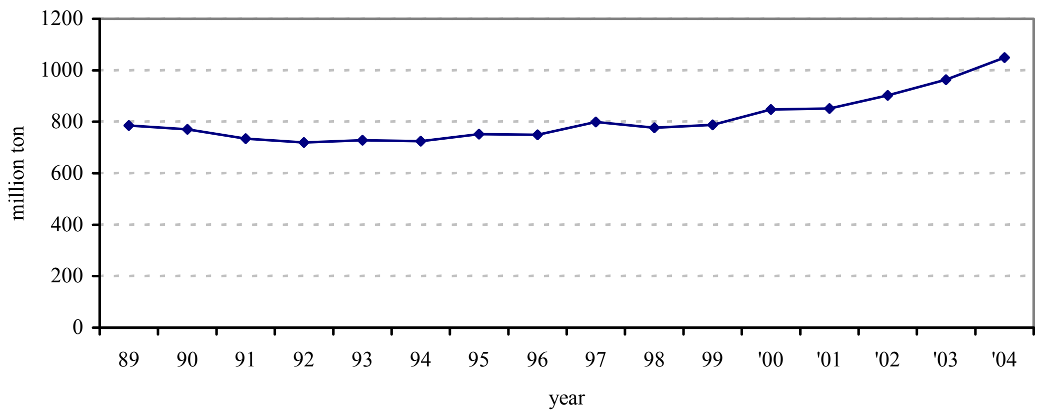

Figure 3.2 World crude steel production

Source: http://www.issb.co.uk/?p=keystatistics

Crude steel production deceased slightly during 1989 and 1994. After then, production grew by 5 per cent per year (Figure 3.2). In 2004, world steel production increased by 8.9 per cent to 1,055 million tons representing a very strong demand in Asia as well as moderate to strong demand elsewhere in the world (Fearnleys Review, 2004). East Asia including China, Japan, South Korea and Taiwan, is leading in crude steel production (44 % of world steel production). China was a leader in steel production which reached 272.5 million tons in 2004, up 23%. At the same time, crude steel output for the rest of the world increased 4.6 per cent to 763 million tons.

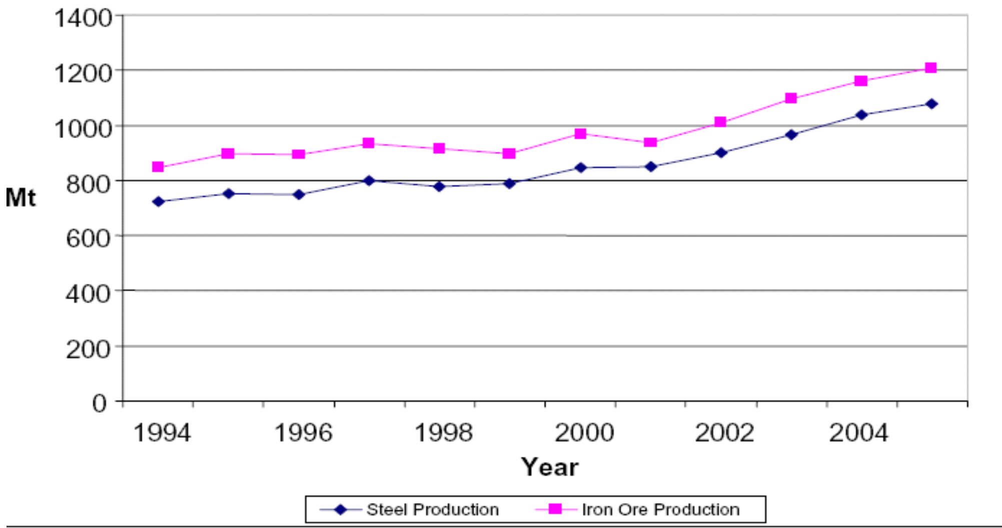

Figure 3.3 World production of iron ore and steel.
Source: UNCTAD, IISI, Merrill Lynch, Deutsche Bank. (2005). Retrieved July 10 2005 from World Wide Web:
http://www.baffinland.com/investors/pdf/050510-iron-ore-industry-review-update.pdf

The above Figure 3.3 illustrates the close correlation between steel production and iron ore production. As a result, the movement of steel production has a considerable consequence on iron ore production.

World pig iron production is another important demand for the iron ore trade. The raw materials for pig iron production are iron ore and coking coal. As a result, for forecasting iron ore demand, the growth of pig iron is of principal interest (Svenning, 2005, p. 21). World pig iron production including direct reduced iron (DRI) increased by 10.8 per cent to 753.9 million tons in 2004 (Figure 3.4).

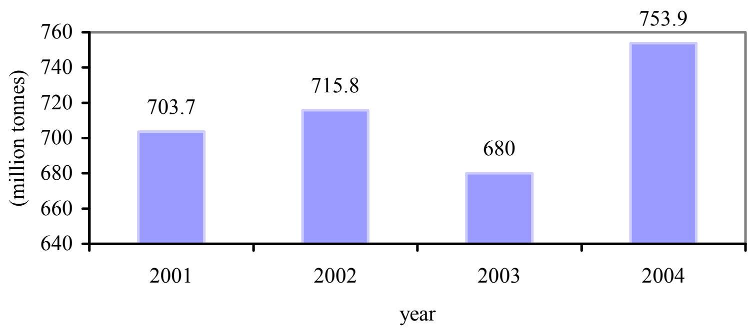

Figure 3.4 World pig iron production
Source: Fearnleys review, 2004

Iron ore is the second largest of the five major dry bulk commodity trades. Between 1985 and 2000, the iron ore trade fluctuated. Since then it has increased by 7.6% per year on average (Figure 3.5). The seaborne trade in iron ore was approximately 590 million tons in 2004.

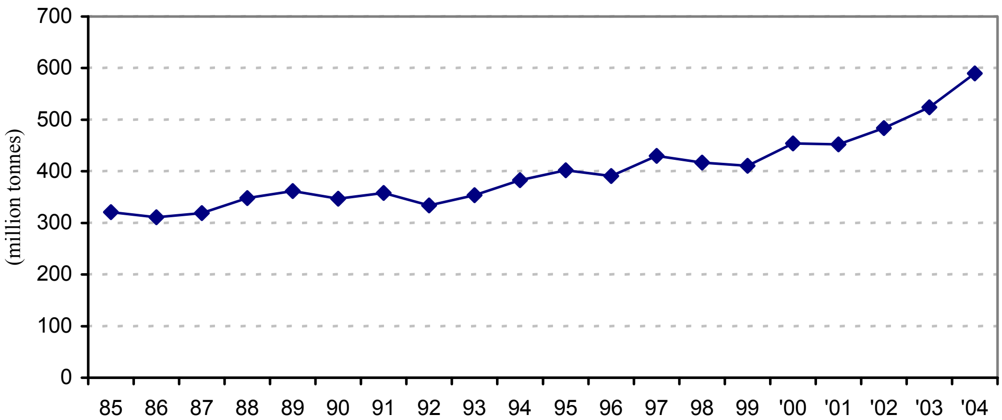

Figure 3.5 World iron ore trade

Source: ISL January/ February 2005

In the iron ore trade, the four major exporters including Australia, Brazil, Canada and Sweden accounted for around 77 per cent of the seaborne trade in iron ore. Australia is a leading iron ore exporter with the volume rising to 210.4 million in 2004, up 12.8 per cent from 2003. Brazilian iron ore exports which ranked second reached 202.7 million tons, up 8.2 per cent from 2003. Together, Australia and Brazil account for approximately 70 per cent of world iron ore trade (Table 3.2).

Table 3.2 Major Iron Ore Exporters

(Mill. Mt)	2003	2004	Change	Change %
Australia	186.5	210.4	23.8	12.8%
Brazil	187.3	202.7	15.3	8.2%
Canada	26.3	28.1	1.8	7.0%
Sweden	16.1	17.3	1.2	7.2%
Total	416.3	458.5	42.1	10.1%

Source: Fearnleys Review 2004

As far as iron ore import is concerned, the largest importing countries were China (208 million tons), EU15 (145 million tons) and Japan (135 million tons) in 2004. Three major importers account for close to 75 per cent of world iron ore seaborne trade. There is a miracle story in iron ore seaborne trade. Ten years ago China imported about 37.4 million tons of iron ore. Five years ago, this number had grown to 55.4 million tons, around half of the EU or Japanese import. In 2004, China became the biggest iron ore importer with a volume 208 million tons; in other words, an increase of 152 million tons, or 275%, in five years. Two thirds of this increase has occurred just in the last two years (Figure 3.6). This is one of the substantial factors which contributed to the unexpected high freight rate in 2003 and 2004.

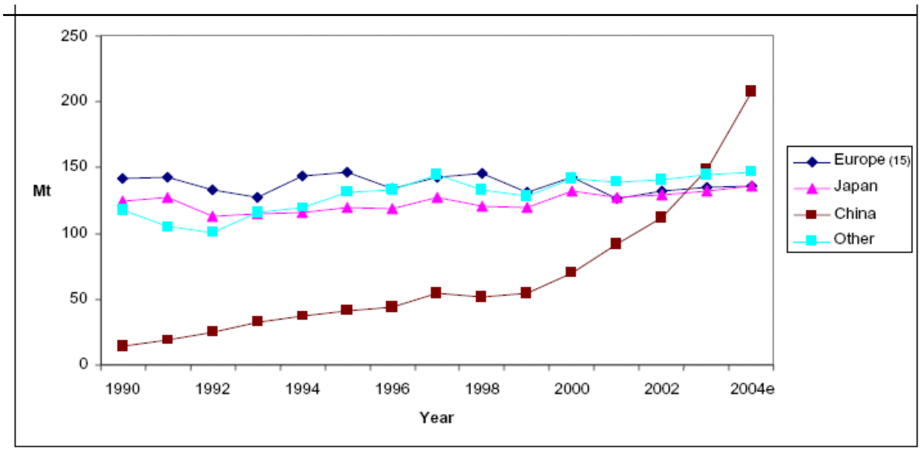

Figure 3.6 World iron ore imports by principal destination, 1990-2004 (Mt)

Source: UNTACD, Deutsche Bank, Merrill Lynch. (2005). Retrieved July 10 2005 from World Wide Web:
http://www.baffinland.com/investors/pdf/050510-iron-ore-industry-review-update.pdf

Coal

Coal is the world's most abundant, safe and secure fossil fuel. It is the single largest fuel source for the generation of electricity worldwide. Over 23% of primary energy needs worldwide are met by coal and 39% of global electricity is generated from coal. Moreover, 66% of global steel production depends on coal feedstock. All of these figures raise the important role of coal in the global economy (Fearnleys Review, 2004).

Coal is the largest of the dry bulk trades with a seaborne trade volume of 650 million tons in 2004 (ISL, Jan/Feb 2005). The coal seaborne trade can be divided into two different markets including the trade of raw material for steelmaking, called coking coal, and fuel for the power generating industry, called thermal coal.

The coal seaborne trade has grown rapidly since 1985 with an average growth rate of 7.3 % per annum (Figure 3.7). As compared to the seaborne trade of five major dry bulk commodities, the coal trade accounted for approximately 41 per cent in 2004. Coal shipments increased around 7 per cent and reached an all-time record 610 million tons in 2003. Thermal coal made up 70 per cent of the world coal seaborne trade, and in 2003 thermal coal shipments grew at the rate of 8.4 per cent to reach 430 million tons. The seaborne coking coal trade increased by almost 4 per cent (Fearnleys Review, 2004). Consequently, seaborne coal trade has been affected largely by the steel production industry and especially the power generating industry.

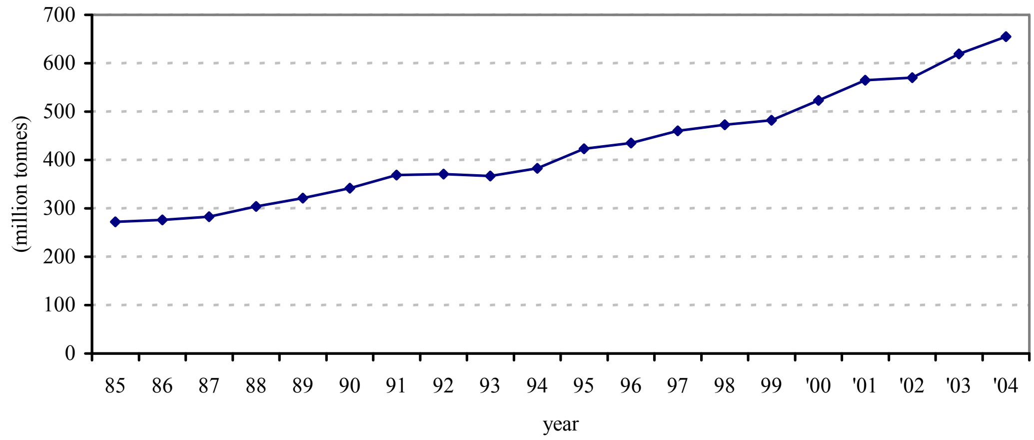

Figure 3.7 World seaborne coal trade
Source: Fearnleys Review 2004

Australia, is by far the largest coal exporter of both thermal and coking coal in nearly equal amount with around 70 per cent of the world coal trade. Australia's total coal trade amounted to 211 million tons in 2003, an increase of 7 per cent. China, Indonesia and South Africa mainly exported thermal coal, accounting for about 33 per cent of world thermal coal exports. The main coal importers are the EU with around 30 per cent of the world import and Japan which accounts for approximately a quarter of the world import, (UNTACD, 2004).

China also exerts an influence over the coal market. China's role as the world's blast furnace has been the driver behind the coking coal trade. In 2003, China's net trade in coking coal was about 9.5 million tons (UNTACD, 2004).

Grain

Grain is an agricultural commodity. According to Fearnleys (2004), the term grain used for statistics comprises wheat, maize, soybeans, barley, sorghum, rye and oats. The world production of these commodities in 2003 amounted to 1468 million tons. The international seaborne grain trade in 2004 reached around 250 million tons which ranked it third among the major dry bulk commodities, accounting for around 16 per cent. Fearnleys estimated that world seaborne grain trade will be 260 million tons in 2005 and 270 million tons in 2006. Examining the development of the grain trade between 1985 and 2004 (Figure 3.8), although seaborne grain trade has fluctuated, the steady upward trend in seaborne grain trade volume can be recognised. Especially, the trade has grown from 196 million tons in 1995 to 250 million tons in 2004 with an average growth rate of 7.8 per cent. The world grain trade is influenced by many factors including production and consumption. While the production is largely influenced by the weather, the consumption is impacted by taste, population, income growth, agriculture and trade policy. As far as the agriculture and trade policy is concerned, the issue of genetically modified agricultural commodities has a great impact on the seaborne grain trade. For example, the decision by Brazil to legalize the genetically modified soya is expected to increase the export substantially.

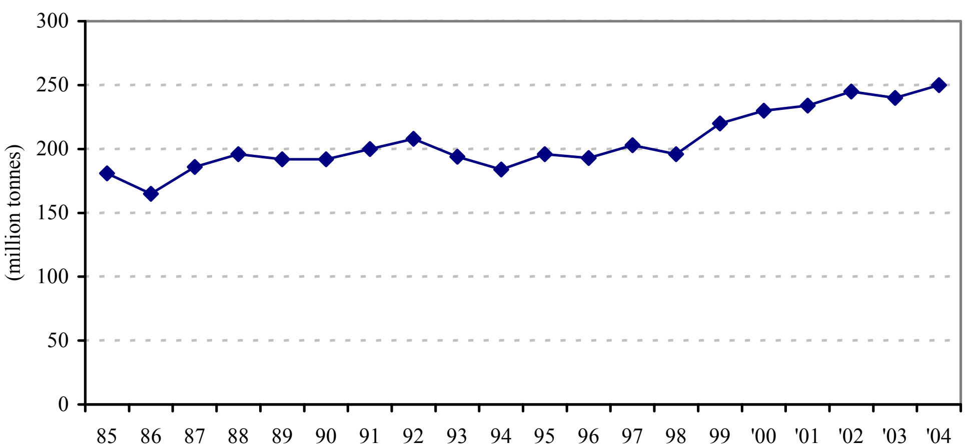

Figure 3.8 World seaborne grain trade
Source: Fearnleys Review 2004

North America, including the USA and Canada, is the largest grain exporter, accounting for approximately 47 per cent of the world grain trade in 2003. South America was the second largest exporter accounting for 22 per cent. Australia came after and making up 4.7 per cent. The Far East and Japan are the biggest grain importers, totally accounting for about 36 per cent of world seaborne grain trade in 2002. Africa and the Americas were the second and third importers accounting for 18% and 17% respectively. There is a potential growth of grain demand in Asia, especially China and Africa, where the income growth and population are increasing (Fearnleys Review, 2004).

The seaborne bauxite and alumina trade

Bauxite ore and alumina is a primary input for the aluminium industry. While bauxite ore is the raw material of aluminium making, alumina is the semi-refined product. The world seaborne bauxite and alumina trade reached 63 million tons in 2004 (Fearnleys Review, 2004) which accounted for 4.2 per cent of major dry bulk commodities.

Australia is the largest seaborne bauxite and alumina exporter with a total volume of 18 million tons, accounting for 29% in 2003. At the same time, West Africa ranked second, accounting for almost half of the world total, amounting to 15.8 million tons in 2003 (Fearnleys Review, 2004). Jamaica is a big exporter of bauxite ore and alumina with a volume of 9.1 million tons, accounting for 14% of the world trade of these kinds of commodity. North America and Europe are the two largest bauxite and alumina importers, accounting for 55% and 42% of the total trade in 2003.

The seaborne phosphate rock trade

Phosphate rock is a principal raw material for the fertilizer industry. Total seaborne trade in phosphate rock reached approximately 30 million tons in 2003. The number one producer is the USA. However, Morocco is the largest phosphate exporter with a volume of about 11 million tons in 2003 (Fearnleys Review, 2004). On the importing side, the Americas and other Asia such as Japan received most of the total seaborne volume. Since phosphate is mainly used for the production of compound fertilizers, the seaborne phosphate trade relies on agriculture. All the factors which affect agriculture, such as weather conditions, agricultural policies, urbanisation etc. also influence the phosphate trade.

3.2.1.4 Average haul

The demand for sea transport depends upon not only the volume of cargo transported but also the distance over which the cargo is shipped. From earlier times, many researchers have taken distance into consideration. Swendsen (1958), Eriksen (1977), Beenstock & Vergottis (1993) measured sea transport demand in ton-miles which can be defined as the tonnage of cargo shipped, multiplied by the average distance over which the cargo is transported. Stopford (1997) mentions some changes in average haul which affected ship demand. The closure of the Suez Canal increased the average distance from the Arabian Gulf to Europe from 6,000 miles to 11,000 miles. The result of such an increase lead to a freight market boom on this occasion.

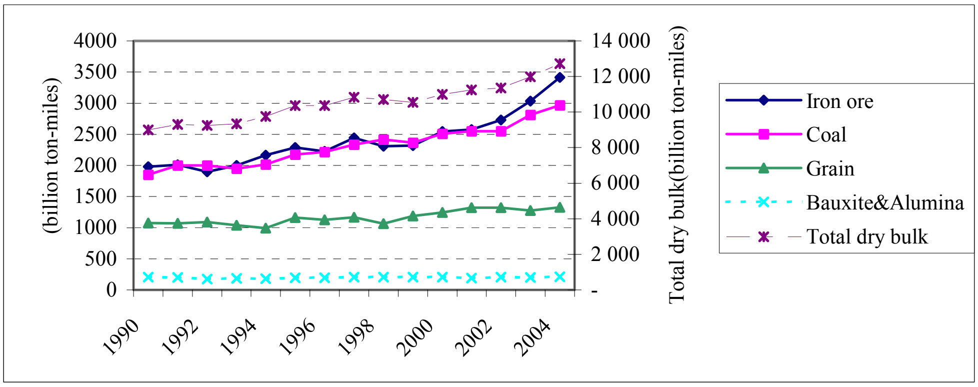

Figure 3.9 Major commodities seaborne trade, 1990-2004

Source: ISL Jan Feb, 2005 (see Appendix 1)

Figure 3.9 illustrates the development of commodity trade (in ton-mile) between 1990 and 2004. Especially, the demand for dry bulk sea transport in ton-miles grew sharply between 2003 and 2004. This also coincided with the freight rate boom period when the Baltic Dry Index reached its highest ever index.

3.2.1.5 Transportation cost

In theory, demand should change inversely with freight rates because the higher freight rates will create an incentive to use other modes of transportation or to import from closer areas. However, in practice, the substitution of modes of transport of dry bulk commodities is very limited or uneconomic. Dry bulk commodities are usually low value cargo. Consequently, it is really difficult for iron ore and coal traders, for example, to find other forms of transport which are economic. Indeed, "we have been unable to discover a negative relationship between demand and freight rates" (Beenstock & Vergottis 1993, p. 162)

3.2.2 Influential factors of supply of dry bulk tonnage

3.2.2.1 Ship types in the dry bulk market and sailing pattern

Vessels operating in the dry bulk market are categorized into four segments: Capesize (80,000+ dwt), Panamax (60-80,000 dwt), Handymax (40-60,000dwt) and Handysize (10-40,000 dwt). Different vessel sizes are more influenced by certain cargo types than others. The "rule of thumb" is that large vessels carry fewer commodities than small vessels.

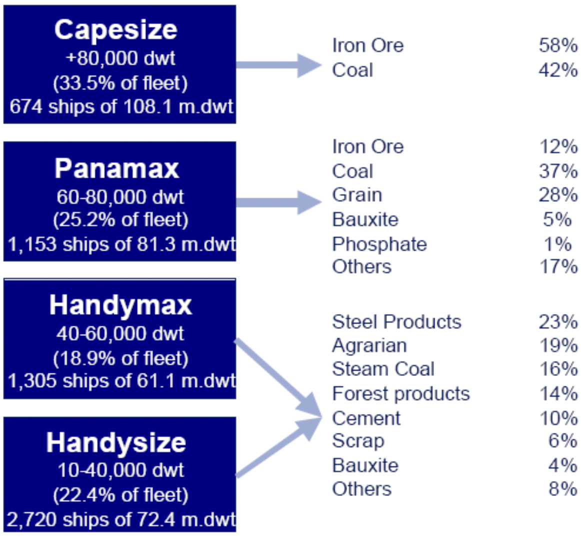

Figure 3.10 Dry bulk fleet overview

Source: Fearnleys, UBS Warburg and DnBNOR Shipping.

Figure 3.10 shows that Capesize vessels rely mainly on two commodities (iron ore and coal). Meanwhile Handymax and Handysize vessels carry at least eight different products. Capesize and Panamax vessels are normally employed in a global sailing pattern, whereas Handymax and Handysize vessels are typically operating regionally such as intra-Asia, intra-Europe.

Among many variables affecting the supply of the shipping service of the dry bulk freight market, five key influences are the world dry bulk merchant fleet, fleet productivity, shipbuilding capacity, scrapping and freight rates.

3.2.2.2 World dry bulk merchant fleet

At the beginning of 2005, the bulk carrier fleet (including Ore/Bulk/Oil carriers – OBO) had, in terms of tonnage, a share of 36 per cent of the world merchant fleet equal to 319.2 million deadweight tons (mdwt) in 2004 (ISL, Jan/Feb 2005). The development of the dry bulk fleet is shown in Figure 3.11.

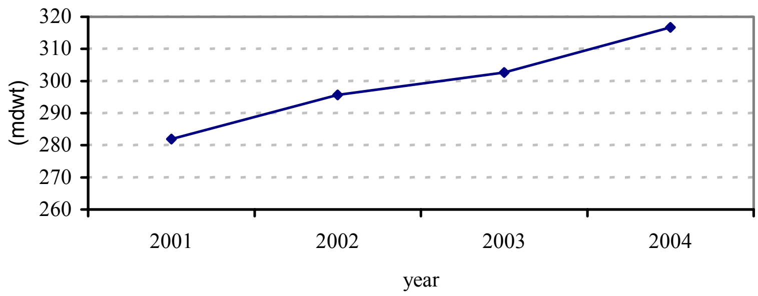

Figure 3.11 World dry bulk carrier

Source: ISL Jan/Feb, 2004

During the period 2000-2004, the dry bulk carrier fleet in terms of deadweight tonnage expanded on average by 3.2 per cent per year. The average age of bulk carriers and OBO carriers was 15.2 years and 19 years respectively at the beginning of 2004. ISL estimate that 22.4 per cent of bulk tonnage was in service for more than 20 years (ISL, May 2005). Moreover, the majority of bulk carriers belong to the Handysize (up to 35,000 dwt) accounting for 46.1 per cent of the total bulk fleet (including OBO carriers) in terms of the number of carriers and 16.5 per cent in terms of tonnage. The Panamax size class, namely 50,000dwt to 80,000dwt, accounts for 21.4 per cent of the number and 30.4 per of dwt of all bulk carriers. Although the Capsize class makes up a small percentage in number of carriers (11 per cent), it accounts for 35.4 per cent of the dwt of total dry bulk carriers.

Tinbergen (1959) estimated the supply elasticity with respect to the fleet (0.9) which is close to unity. This means that when the fleet increases 1 unit, the supply will increase 0.9 unit. As a result, the world dry bulk merchant fleet substantially affects the dry bulk freight market.

3.2.2.3 Fleet productivity

The productivity of a fleet can be defined as the total ton-miles of cargo in the year divided by the deadweight fleet actively employed in carrying cargo. As a result, the productivity of a fleet of dry bulk carriers measured in ton-miles per dwt depends on four main factors: speed, port time deadweight utilization and loaded days at sea (Stopford, 1997, p.133).

Firstly, when the ship sails faster, the time a vessel takes on a voyage becomes shorter. Consequently the productivity of the ship is higher. In other words, the ship's carrying capacity increases. Sail speed is one of the method through which the supply can be adjusted in the short run (Ma, 2004, p.28). However, when the ship increases its speed, the fuel consumption also increases considerably (cube of the increase in speed).

$$C_s = k * S^3 \qquad (3.1)$$

Secondly, the degree of ship capacity utilization affects the ships' carrying capacity and ship productivity. The shipowners do their best to achieve fixtures which secure the next legs with the objective of increasing ship productivity and ship income.

Thirdly, the time in port plays an important role in ship productivity. Port time is considered as the un-productive time of the ship. As a result, the less time the ship stays in port, the more cargo it will carry. The port time depends on the efficiency of cargo handling facilities. Port congestion, especially in Australia, was a major concern of the shipowner in 2003. It results in the shortage of supply of dry bulk sea transport and the increase in freight rate during this period. Between 1980 and 1981, port congestion at Hampton Road also lead to the historical height of bulk carrier freight rates, from some 3,000 USD/day to 14,000 USD/day, which is more than a 4 times increase (Volk, 2002, p. 7).

3.2.2.4 Ship scraping

Ship scraping, which is carried out in the demolition or scrap market, directly affects the supply of maritime transport. The demolition market is the one of four markets namely freight market, secondhand, newbuilding and scrap market which are distinguished and studied by certain researchers such as Hawdon (1978), Beenstock & Vergottis (1993) and Stopford (1997). There is a common agreement that the demand and supply in each market are interconnected. For example, if the demand for sea transport increases and only a few new ships are built, the freight rate will increase. This will affect both the second hand and demolition market. The price for second ships will increase, reflecting the higher potential earnings and fewer ships will be sold for scrapping, also resulting in a decrease in the demolition market.

The scrap market is negatively correlated to the freight market. It can be said that the demolition market plays an essential role as a buffer balancing demand and supply in the freight market. When the global demand for sea transport declines, which results in an overcapacity in the freight market leading to increased scrapping, a balancing out in the demand and supply of the freight market occurs. During the upturn of the freight market, the reverse occurs.

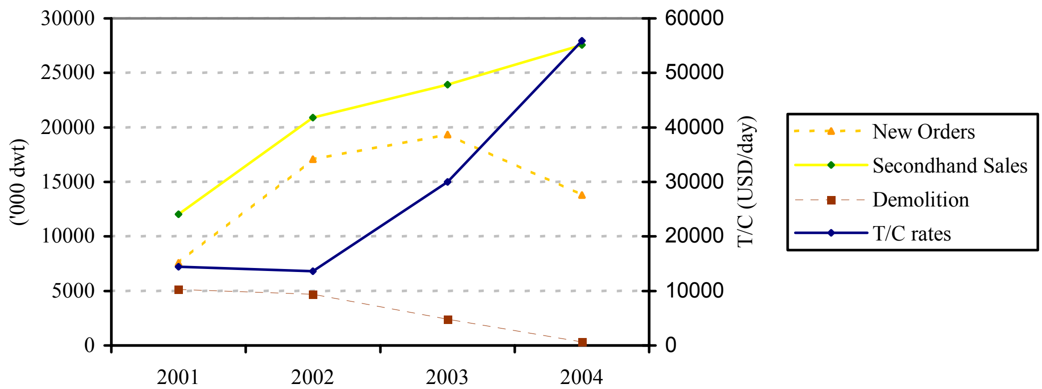

Figure 3.12 Time charter rate, new orders, secondhand sales and demolition in dry bulk shipping market, 2001-2004

Source: Compiled from various publications of Drewry Monthly

3.2.2.5 Shipbuilding

The shipbuilding market is essential to the overall health of the shipping industry, particularly the freight market, as it dictates the supply of tonnage to the market. As far as the supply of dry cargo ships, shipyards' resources can be used not only for building new dry cargo ships but also for constructing other vessels such as tankers, container ships, LNG ships, cruise ships etc. Beenstock & Vergottis (1993) noted that the supply of new dry cargo ships depends positively on the price of dry cargo new buildings and negatively on the costs of shipbuilding inputs, such as materials and labour. In addition, the supply of dry cargo ships will be influenced by the profitability of building other ships like tankers and container ships. If the prices of tankers or container ships increase, shipyards will tend to switch their resources to the construction of these ships and thus affect adversely the dry cargo new building.

Regarding shipyard developments, the Far East is the leading region accounting for 86 per cent of world delivery in 2004; Europe (including East and West Europe) was runner up with 11 per cent world delivery. In terms of countries, Korea surpassed Japan in 2002 and became the leading shipbuilder with shipyards such as Huyndai, Daewoo and Samsung. Japan was the 2nd largest shipbuilding nation in 2004. China's shipbuilding exceeded Germany for the first time in 1995, rising to the 3rd place behind Korea and Japan (ISL, August/September 2004). With the ambition to become the leading shipbuilding country, the Chinese government is paying special attention to this industry. The USD3.6 billion project to build the world's biggest shipyard on Shanghai's Changxin Island, is expected to start in 2007 (Samanthula, 2004).

3.2.2.6 Freight rate and bunker price

Beenstock & Vergottis (1993) estimates the elasticity of supply with respect to freights and fuel prices to be 0.59 and - 0.23 respectively. It can be seen that the supply is fairly inelastic both with respect to freight and bunker. The result does not seem to differ significantly from those estimated by the Norbulk model in which the price elasticity of supply with respect to freight and bunker prices are 0.266 and - 0.120 respectively. The sign of two elasticity figures are also in accordance with expectation. If the freight rates are high, shipowners will tend to increase the supply of tonnage. Moreover, if fuel prices increase ships will save fuel by slow steaming which results in a reduction in supply.

3.3 Correlation between freight rates and some of the main factors

The applications of correlation technique have proved to be limited. Managerial applications of correlation include comparing sales volume with advertising expenditures, comparing bond prices to the GNP growth rate etc. Moreover, correlation analysis is essential to compute and interpret time series analysis and regression analysis which will be used for the forthcoming part of forecasting freight rates.

3.3.1 Correlation between freight rates and the seaborne dry bulk trade

Shipping is a derived demand, acting as a facilitator of world trade. Consequently, seaborne trade determines largely the demand for sea transport. This means the higher the increase in seaborne trade from time to time, the higher the demand for sea transport and thus higher the freight rate. Therefore, freight rates and seaborne trade are positively correlated.

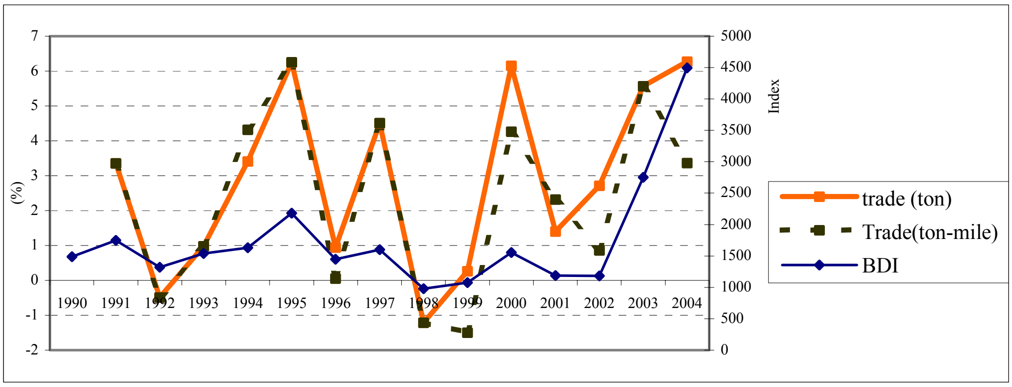

Figure 3.13 World dry bulk seaborne trade (%change year on year) and BDI

Source: Compiled from different publications of ISL (see Appendix 2)

The correlation coefficient between dry bulk trade in ton and in ton-mile and freight rate was only 0.57 and 0.52 respectively. An outstanding example for low correlation between these variables is the market situation during 2000. Although the growth of the seaborne dry bulk trade in 2000 was approximately similar to the number in 2003 and 2004, the freight rate in the latter years was almost 3 times higher than that of the former year (Figure 3.13). The big difference in rate level can be explained as follows. First, the relative fleet growth has an impact. Freight rates are determined by not only the demand for sea transport of dry bulk but also supply. The supply growth between 2003 and 2004 (approximately 3%) was lower than demand in ton-mile growth (around 6%) (SSY, 2005). This is one of the reasons which drove the freight rates up during 2003 and 2004. Second, certain regions regardless of the world growth from time to time are considered as engines of dry bulk demand. In 2003, China is a locomotive for the dry bulk market from 2003 until now. Port congestion in Australia has made a contribution to the positive picture of the dry bulk market in 2003 and 2004.

3.3.2 Correlation between the fleet of dry bulk carriers, bunker price and freight rate

The fleet is one of the variables which affects the supply and thus influence freight rates. When supply exceeds the demand for shipping services, freight rates will fall. Freight rates recover, only after demand can keep up with supply through a combination of an increase in scrapping activities which will remove old ships from the fleet and/or rising shipping demand. Consequently, freight rate and fleet size move in opposite directions.

Another variable affecting the freight rate level is voyage cost which mainly includes fuel costs (bunker costs), cargo handling costs and port charges. The shipowners will normally compensate an increase in voyage cost with a higher freight rate. In voyage costs, fuel cost is the most important items which accounts for approximately 47 per cent of the total (Stopford, 1997, p.166). This is why bunkers are an indicator of voyage cost in many quantitative works concerning the freight market. Therefore, bunkers are positively correlated with freight rates.

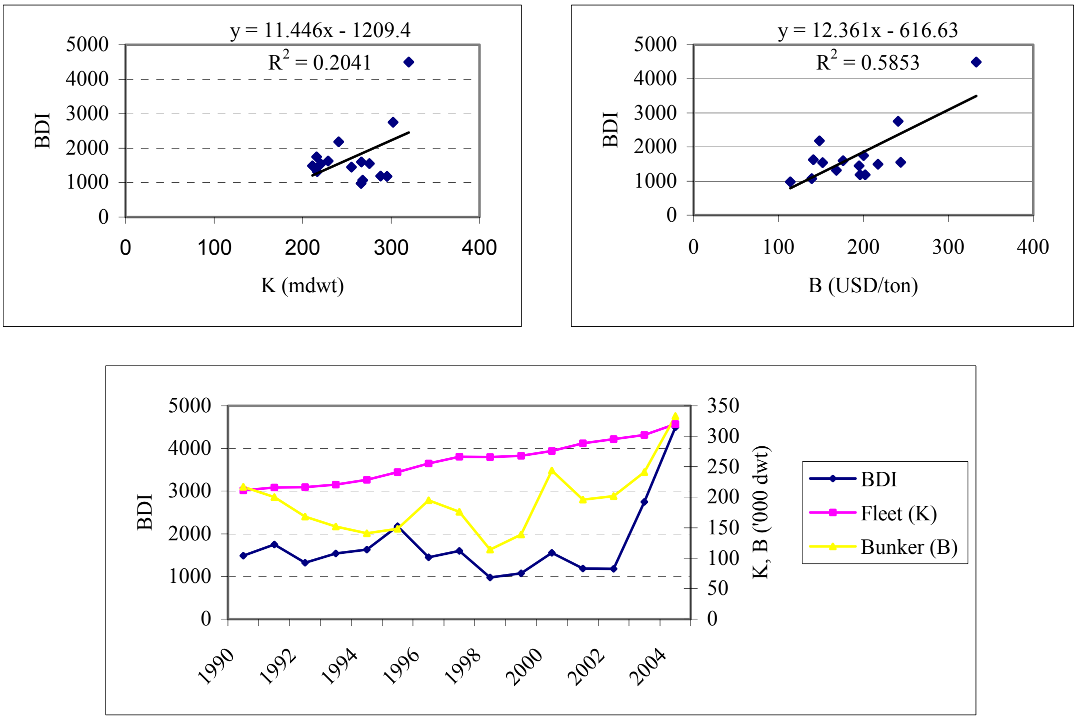

Figure 3.14 Correlation between fleet, bunker price and freight rate

Source: compiled from different source (1990-2004) (see Appendix 3)

However, in reality, things are not always what are described in theory. Figure 3.14 shows that the fleet development is positively correlated with the freight rate. This can be explained as follows. In the shipping market, the supply is not immediately adjusted to demand. According to law of demand and supply, when demand increases, the freight rate will increase. Shipowners tend to order ships to meet the increase in demand. However, it normally takes from one to two years to build a ship. During this period, the demand may increase due to a growth in the world economy and industrial production. Although the new delivery of a ship is added to the existing fleet, the increase in demand may be higher than the increase in supply. Thus the freight rate may increase.

Figure 3.14 illustrates that the correlation coefficient between BDI and Fleet is approximately 0.45. In respect of correlation between freight rate and bunkers, this correlation coefficient is rather high (0.77).

3.3.3 Correlation between demolition, new order, lay-up and freight rates

As mentioned in the previous chapter, the shipping industry consists of four markets: freight sale and purchase, shipbuilding and scrap market. These markets are closely interrelated. This part will examine the relationship between freight rates and some major variables including demolition and new order activities in scrap and the newbuilding market. The reason for analyzing these variables is that they directly affect the level of supply in the freight market. In addition, lay-up analysis is also taken into consideration because the lay-up decision of shipowners is a way to adjust supply.

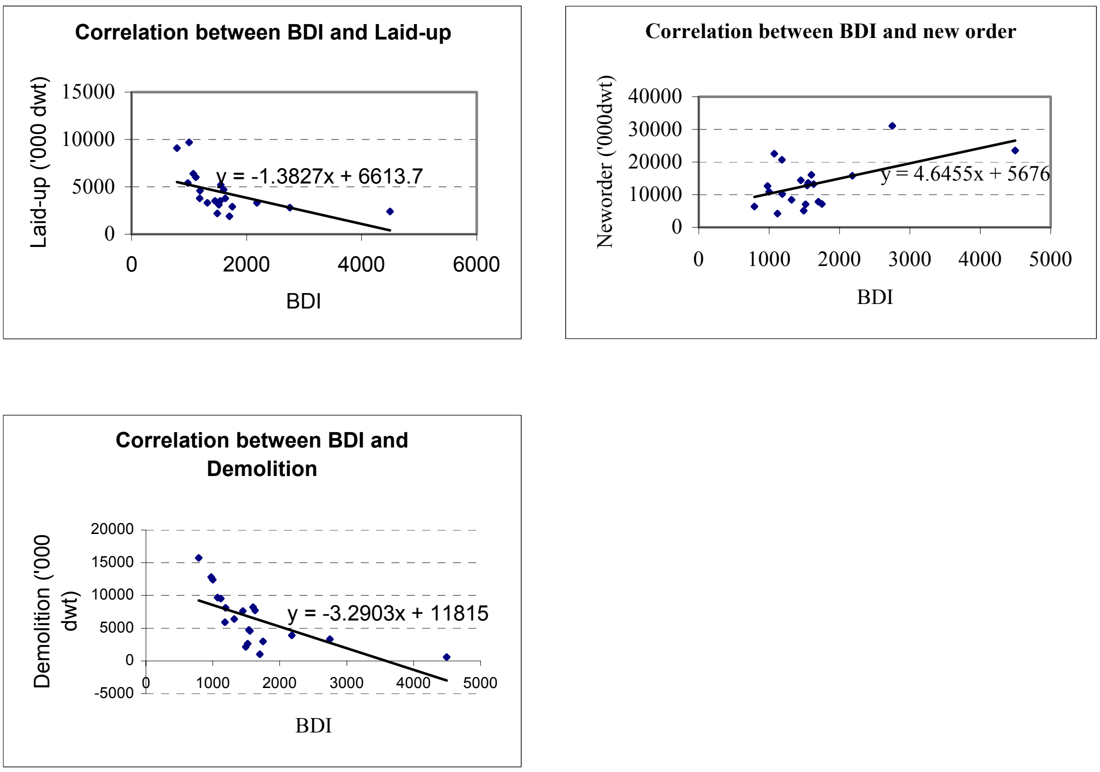

Figure 3.15 Correlation between BDI, laid-up, new order and demolition

Source: compiled from different sources (1990-2004) (see Appendix 3)

The demolition activities depend on the age profile of the fleet and the prevailing freight market conditions are the main drivers of demolition. Since 1995 until 2004, the typical scapping age for dry bulk carriers remained stable at about 25-27 years (DnB Nor Market, 2005). It is apparent that the present strong market has encouraged shipowners to upgrade and postpone demolition as long as possible. In 2004, the age for dry bulk being scrapped was higher than previous years. The average age for Handymax vessels being scrapped, for example, rose to 29 years. Meanwhile, the scrap price reached a very high level at 380 USD/ldt on average due to few scrapping activities (DnB Nor Market, 2005). Consequently, freight rates are negatively correlated with demolition. It is calculated that the correlation coefficient between BDI and demolition is –0.66.

Regarding the relationship between the freight rate and neworder activities, Koopmans observes that when freight rates are high, usually new order for vessels are placed with shipyards. However, that is not always all the case. Between 1991 and 1995, the new order activities increased although the freight rate level was very low. The reason is probably that shipowners were able to order cheap vessels and expected those ships would be delivered into an upswing. Therefore, it is also important to note that the shipowners increase their new order activities when they expect good future developments in the freight market. The correlation coefficient of BDI and new orders is calculated at 0.54 which is rather low.

Svendsen (1958) investigated the lay-up decision which was the point that “it cost money to operate a ship but it also costs money not to operate it”. Svendsen also emphasized that shipowners usually do not decide to lay-up the first time when freight rates are too low to cover voyage costs. Only when the freight rates have been low for several times, does the shipowner make the decision to lay-up. Therefore, freight rates and lay-up have a negative correlation. The correlation coefficient of BDI and lay-up is relatively low (-0.53).

CHAPTER 4 FORECASTING FREIGHT RATES IN THE DRY BULK SHIPPING MARKET USING LINEAR REGRESSION

4.1 Regression Analysis

In the previous part the relationship between two variables was studied. In this part, not only the simple linear regression analysis of two variables but also multiple regression analysis is discussed in order to achieve a more accurate forecast of freight rates. Since a great number of calculations are needed, computer software for the techniques discussed are emphasized.

Regression analysis is concerned with describing and evaluating the relationship between a given variable (usually known as dependent variable) and one or more other variables (usually called independent variable(s)). The objective of this method is to find out the regression line that best fits the data points.

4.1.1 Simple linear regression

Simple linear regression analysis determines the line that best fits a collection of X-Y data points. "That line minimizes the sum of the squared distances from the points to the line as measured in the vertical, or Y, direction". (Hanke & Reitsch,1989, p.162). This line is known as the regression line and its equation is called the regression equation as follows.

$$Y = b + aX \tag{4.1}$$

b is called Y intercept.

a the slope of the straight line

$$b = \frac{n\sum XY - \sum X \sum Y}{n\sum X^2 - (\sum X)^2} \quad (4.2)$$

$$a = \frac{\sum Y}{n} - \frac{b\sum X}{n} \quad (4.3)$$

4.1.2 Standard error of estimate

After finding out the regression line, the next step is to measure the extent to which the data points are dispersed around the line. Such a measurement is called the standard error of estimate.

"The standard error of estimate measures the typical amount by which the actual Y values differ from the estimated values" (Hanke & Reitsch, 1989, p.165).

$$s_{y.x} = \sqrt{\frac{\sum (Y - Y_R)^2}{n-2}} \quad (4.4)$$

The regression analysis has a small standard error involves data points very close to the regression line and one with a large error involves data points widely dispersed around the line (Hanke & Reitsch, 1989, p.165).

4.1.3 Residuals

"A residual is the difference between an actual Y value and its predicted value" (Hanke & Reitsch, 1989, p.175). Since there are both positive and negative residuals, the some of residuals is always zero. One method which has been devised to measure the errors generated by the forecasting is the mean absolute error (MAE). MAE is the average value of the absolute residuals.

Residual is $Y_f - Y$

$$MAE = \frac{\sum |Y_f - Y|}{n}$$

Y_f is the forecasted value.

Y is an actual value.

4.1.4 Result evaluation

The interpretation starts by investigating whether there is enough evidence to conclude that there is a linear relationship between each independent variable and a dependent one among all the population data points. As a result, the following hypothesis is tested

H_o : $\beta = 0$

H_1 : $\beta \neq 0$

where β is the slope of the true population regression line (Y=$\beta_0 + \beta X$)

In this dissertation the hypothesis is tested at the significant level equal to 5%. Consequently, for the coefficient that p-value[1] is bigger than 5%, the null hypothesis is satisfied and for the coefficient that p-value less than 5% the alternative hypothesis is satisfied.

Another parameter used for evaluating the model is the coefficient of determination (R^2). R^2 measures the extent to which the variability of Y and X are related. In other words, this statistic illustrates the percentage of variation of dependent variables that is explained by the variation of the independent variable. R^2 is calculated by following equation:

$$R^2 = \frac{b\sum Y + a\sum XY - n\overline{Y}}{\sum Y^2 - n\overline{Y^2}} \qquad (4.5)$$

$\overline{Y}$ is the average of all Y values

4.2 Multiple regression

The relationship between two variables allows a person to predict accurately the dependent variable from the independent variable. However, most situations are not so simple. Many independent variables affect a dependent variable at the same time.

[1] The p-value is the probability that your sample could have been drawn from the population(s) being tested (or that a more improbable sample could be drawn) given the assumption that the null hypothesis is true. A p-value of .05, for example, indicates that you would have only a 5% chance of drawing the sample being tested if the null hypothesis was actually true (http://www.isixsigma.com/dictionary/P-Value-301.htm)

In order to predict a dependent accurately when more than one independent variable is used, multiple regression analysis is an appropriate selection. The basic concept of multiple regression remains the same compared to simple regression, but more than one independent variable is used to forecast the dependent variable.

In multiple regression analysis the dependent variable is also represented by Y and the independent variables are represented by $X_1, X_2, X_3, ..., X_n$. The regression equation is as follows:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + ... + b_nX_n \quad (4.6)$$

4.2.1 Regression equation measurement

4.2.1.1 Data collection and analysis

In this section, the information is used to measure the regression equation and to forecast freight rates later mainly collected from the following sources

- Freight is the Baltic Dry Index (BDI) which was compiled from various issues of Shipping Statistics and Market Review published by the Institute of Shipping Economics and Logistic (ISL) and other sources.
- Q is the demand for dry bulk sea transport (ton-mile) (q) collected from Fearnleys Review.
- K is the fleet of bulk carriers (dwt) gathered from various issues of Fearnleys Review.
- Bunker prices (B) were compiled from Lloyd's list Bunker 60, The Drewry Monthly and other sources.

Due to the difficulties in collecting data of total dry bulk seaborne trade in ton-mile, the analysis of data which will be used for this in chapters 4 and 5 are implemented between 1990 and 2004.

4.2.1.2 Variable transformation into logarithms

For measuring the multiple regression equation, the time series data were transformed into logarithms. Some reasons are mentioned to justify this. The first reason is that taking logarithms may stabilise a non-stationary variable. Another reason is that the exponential trend in time series becomes linear after transformation, thus making it easier to analyse the time series in detail. The transformation of BDI, Q, K and B into logarithms was displayed in table 4.1.

Table 4.1 Development of BDI, demand for dry bulk sea transport, fleet of bulk carriers and bunker prices

Year	BDI	Q	K	B	ln(BDI)	ln(Q)	ln(K)	ln(B)
1990	1490	9 000	211.1	217	7.31	9.11	5.35	5.38
1991	1750	9 302	215.9	200	7.47	9.14	5.37	5.3
1992	1320	9 257	216.6	168	7.19	9.13	5.38	5.12
1993	1540	9 348	220.6	152	7.34	9.14	5.4	5.02
1994	1630	9 752	228.8	141	7.4	9.19	5.43	4.95
1995	2180	10 362	241	148	7.69	9.25	5.48	5
1996	1450	10 368	255.3	195	7.28	9.25	5.54	5.27
1997	1600	10 836	266.7	176	7.38	9.29	5.59	5.17
1998	977	10 705	266.1	114	6.88	9.28	5.58	4.74
1999	1073	10 545	268.1	139	6.98	9.26	5.59	4.93
2000	1553	10 995	275.7	244	7.35	9.31	5.62	5.5
2001	1188	11 250	288.3	196	7.08	9.33	5.66	5.28
2002	1182	11 347	295.3	202	7.07	9.34	5.69	5.31
2003	2751	11 979	302.4	241	7.92	9.39	5.71	5.48
2004	4494	12 382	320.2	333	8.41	9.42	5.77	5.81

Source: Compiled from different sources

4.2.1.3 Simple regression equation measurement by computer program (Statgraphic)

- **Regression - BDI and Q**

Dependent variable: ln(BDI)

Independent variable: ln(Q)

Linear model: Y = a + b*X

Coefficients

	Least Squares	*Standard*	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
Intercept	-8.14319	8.87921	-0.917109	0.3758
Slope	1.67733	0.959227	1.74863	0.1039

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	0.400144	1	0.400144	3.06	**0.1039**
Residual	1.70124	13	0.130865		
Total (Corr.)	2.10139	14			

Correlation Coefficient = 0.436

R^2 = 0.19

R^2 (adjusted for d.f.) = 0.12

Standard Error of Est. = 0.361

Mean absolute error = 0.277

The output shows the results of fitting a linear model to describe the relationship between ln(BDI) and ln(Q). The equation of the fitted model is

$$\ln(BDI) = -8.14319 + 1.67733 * \ln(Q) \quad (4.7)$$

Although the sign of b is positive as expected, there is no a statistically significant relationship between ln(BDI) and ln(Q) at the 95% or higher confidence level since the P-value in the analysis of variance table is greater at 0.05.

The R^2 statistic indicates that the model as fitted explains 0.19 of the variability in ln(BDI). The correlation coefficient equals 0.43637, indicates a relatively weak relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 0.361. The mean absolute error (MAE) of 0.277 is the average value of the residuals.

- **Simple Regression - BDI and K**

Dependent variable: ln(BDI)

Independent variable: ln(K)

Linear model: Y = a + b*X

Coefficients

	Least Squares	*Standard*	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
Intercept	2.63694	4.2089	0.626514	0.5418
Slope	0.8558	0.758834	1.12778	0.2798

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	0.187273	1	0.187273	1.27	0.2798
Residual	1.91411	13	0.14724		
Total (Corr.)	2.10139	14			

Correlation Coefficient = 0.298

R^2 = 0.089

R^2 (adjusted for d.f.) = 0.019

Standard Error of Est. = 0.383

Mean absolute error = 0.280

The output shows the results of fitting a linear model to describe the relationship between ln(BDI)and ln(K). The equation of the fitted model is

$$\ln(BDI) = 2.63694 + 0.8558 * \ln(K) \tag{4.8}$$

Since the P-value in the analysis of the variance table is greater than 0.05, there is no a statistically significant relationship between ln(BDI)and ln(K) at the 95% or higher confidence level. Furthermore, the sign of b is positive which is not the one expected.

- **Regression - BDI vs. B**

Dependent variable: ln(BDI)

Independent variable: ln(B)

Linear model: Y = a + b*X

Coefficients

	Least Squares	*Standard*	*T*	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
Intercept	2.33454	1.5261	1.52975	0.1500
Slope	0.967474	0.292128	3.31182	0.0056

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	0.961623	1	0.961623	10.97	0.0056
Residual	1.13976	13	0.0876742		
Total (Corr.)	2.10139	14			

Correlation Coefficient = 0.676

R^2 = 0.457

R^2 (adjusted for d.f.) = 0.415

Standard Error of Est. = 0.296

Mean absolute error = 0.229

The output shows the results of fitting a linear model to describe the relationship between ln(BDI)and ln(B). The equation of the fitted model is:

$$\ln(BDI) = 2.33454 + 0.967474 * \ln(B) \quad (4.9)$$

Since the P-value in the analysis of the variance table is less than 0.05, there is a statistically significant relationship between ln(BDI) and ln(B) at the 95% confidence level. The sign of b is positive as expected.

The R^2 statistic indicates that the model as fitted explains 0.457 of the variability in ln(BDI). The correlation coefficient equals 0.676, indicating a moderately strong positive relationship between the variables. The standard error of the estimate shows the standard deviation of the residuals to be 0.296. The mean absolute error (MAE) of 0.229 is the average value of the residuals.

4.2.2 Multiple regression between BDI and Q, K, B

4.2.2.1 Variable identification

Demand for dry bulk sea transport can be expressed as a function of seaborne trade volume (q), and freight rate (fr).

$$Q^D = f(q, fr) \tag{4.10}$$

Supply of dry bulk sea transport can be expressed as a function of fleet (K) and the price of bunker (P_b).

$$Q^S = f(K, P_b) \tag{4.11}$$

Since $Q^D = Q^S$

This function can be converted to obtain the equation of freight rate as follows.

$$Fr = f(q, K, P_b) \tag{4.12}$$

4.2.2.2 Analysis of multiple regression between variables

Dependent variable: ln(freight)

Independent variables: ln(B), ln(K), ln(Q)

Coefficients

		Standard	T	
Parameter	*Estimate*	*Error*	*Statistic*	*P-Value*
CONSTANT	-79.1432	10.079	-7.85232	0.0000
ln(B)	0.659368	0.13864	4.75598	0.0006
ln(K)	-11.2901	1.40952	-8.00988	0.0000
ln(Q)	15.7397	1.92976	8.15632	0.0000

Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	1.93967	3	0.646556	43.98	0.0000
Residual	0.161719	11	0.0147018		
Total (Corr.)	2.10139	14			

$R^2 = 0.923$

R^2 (adjusted for d.f.) = 0.902

Standard Error of Est. = 0.121

Mean absolute error = 0.086

The output shows the results of fitting a multiple linear regression model to describe the relationship between ln(freight) and 3 independent variables. The equation of the fitted model is

$$Ln(BDI)= -79.1432 + 0.659368*\ln(B) - 11.2901*\ln(K) + 15.7397*\ln(Q) \quad (4.13)$$

Since the P is less than 0.05, there is a statistically significant relationship between the variables at the 95% confidence level. Furthermore, all the signs in the equation are the ones expected.

The R^2 statistic indicates that the model as fitted explains 0.923 of the variability in ln(BDI). The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 0.902. The standard error of the estimate shows the standard deviation of the residuals to be 0.121. This value can be used to construct prediction limits for new observations by selecting the Reports option from the text menu. The mean absolute error (MAE) of 0.086 is the average value of the residuals. Since the P-value is greater than 0.05, there is no indication of serial autocorrelation in the residuals at the 95% confidence level.

In determining whether the model can be simplified, notice that the highest P-value on the independent variables is 0.0006, belonging to ln(B). Since the P-value is less than 0.05, that term is statistically significant at the 95% confidence level.

4.2.3 Evaluation of the result estimates

With regard to simple regression analysis, BDIs which are forecasted by simple linear regression between BDI vs Q and BDI vs K are not very accurate due to high Mean Absolute Errors (578 and 591).

With respect to the forecast error resulting from simple linear regression between BDI and B, the forecast result is closer to the real BDI compared to the calculation from simple regression between BDI vs Q and BDI vs K . The MAE is around 447.

For the forecast result done by the multiple regression equation, the forecast error is smallest compared to calculations based on simple regression. The forecast BDI line is relatively close to the real BDI line. MAE is estimated at 332.

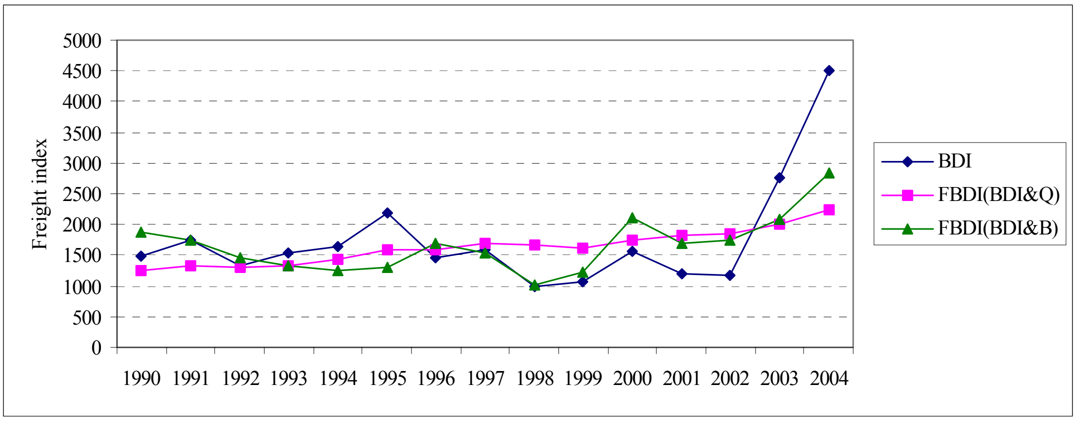

Figure 4.1 BDI and forecasted BDI by simple regression between 1990 and 2004

Source: calculated by the author (see Appendix 4)

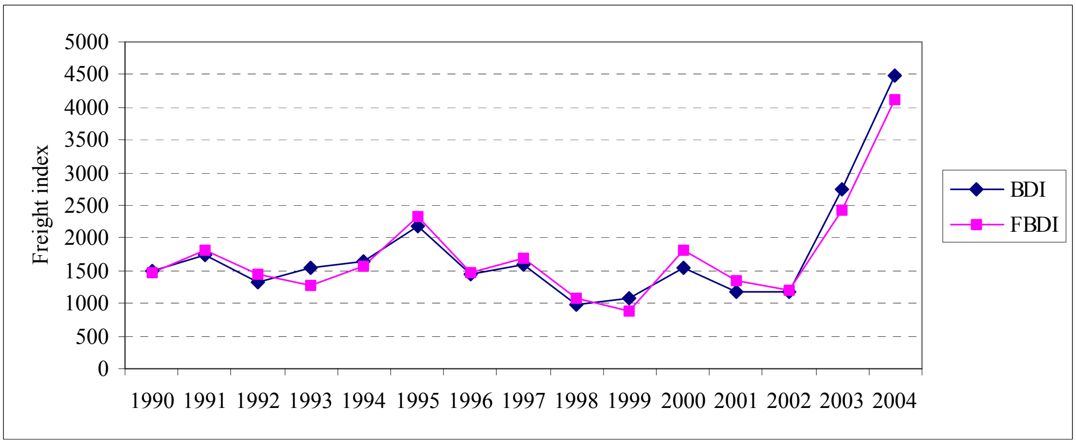

Figure 4.2 BDI and forecasted BDI by multiple regression between 1990 and 2004

Source: calculated by the author (see Appendix 4)

Figures 4.1 and 4.2 illustrate the comparison between the real freight rate and forecast results which are done by simple and multiple regression. Figure 4.2 shows that the BDI forecasted by multiple regression is much more accurate than the BDI forecasted by simple regression.

CHAPTER 5 DEMAND/SUPPLY MODEL, TIME SERIES ANALYSIS AND FORECASTING DRY BULK FREIGHT MARKET IN 2005, 2006

5.1 Supply/demand balance model

This model uses a methodology based on forecasting the supply and demand for merchant ships and using the supply/ demand balance to draw conclusion about development in the freight rates (Stopford, 1997, p. 500). This method includes eight main steps as follows:

Step 1: Economic assumption:
This step determines what assumptions in which world economy will develop during the forecast period. Some major economic assumptions are the growth rate of Gross Domestic Product (GDP), industrial production (IP). The other assumptions are about the political situation, oil prices etc. As mentioned in chapter 3, all of these factors influence strongly the seaborne trade and thus freight rates.

Step2: Seaborne trade forecast
As discussed in chapter 3, seaborne trade is affected by many factors such as GDP, IP, political situation etc. However, IP has the closest correlation with seaborne trade in general and dry bulk seaborne trade in particular. Therefore, one of the simplest methods to forecast dry bulk seaborne trade is to use the regression model as follows.

$ST = f(IP_t)$

where, ST = seaborne trade

IP = industrial production

T = year subscript

Linear equation of this model is $ST_t = a + bX_t$

Where ST is the dependent variable and X (industrial production) is the independent variable. The estimation of a and b, which was implemented by Stopford during the period 1963-1980, is as follows:

a = -307.6, b =22.03 and the linear regression is $ST_t = -307.6 + 22.03X_t$ (5.1)

The regression equation tells us that between 1963 and 1980, for each 1 point increase in the industrial production index, the dry cargo seaborne trade increases by 22.03 million tons.

It is estimated that the correlation coefficient of dry bulk seaborne trade and OECD industrial production is 0.98 between 1963 and 1980. When the equation is used to project seaborne trade through to 1996, the forecast proves to be very accurate. Checking the regression of dry bulk seaborne trade on OECD industrial production in 2003 and 2004, it is found that the accuracy of the forecast of dry cargo seaborne trade is very high. The forecasted trade of 2106 million tons (mt) in 2003 which are very close to the actual 2198 million tons. The projected trade of 2278 million tons in 2004 which are also very similar to the actual 2336 million tons [1].

Step 3: Average haul forecast

The average haul (AH) can be forecasted in two ways. The simple way is to forecast AH based on the historical trend, at the same time, attempting to identify the factors that might affect the AH. The second method is to calculate the AH by analysing the trade matrix for each commodity. However, matrixes of certain major dry bulk commodities such as iron ore, coal grain, phosphate rocks could be collected from some well-known shipbrokers and research institutes.

[1] OECD industrial production growth rate is 1.1% in 2003 and 4% in 2004. Source: OECD.

Step 4: The demand forecast

The total demand for dry bulk sea transport is calculated by multiplying seaborne trade (ton) by the average haul (mile).

Step 5: Dry bulk fleet forecast

The supply of the dry bulk fleet is calculated by adding the predicted deliveries to the existing dry bulk fleet minus the forecast volume of scrapping. As mentioned at the beginning of the chapter, freight rates and scrapping is negatively correlated while freight rates and new order have a positive correlation. In other words, when freight rates go up, shipowners normally start ordering new ships and stop scrapping.

Step 6: Ship productivity forecast

The productivity of a ship is measured by the number of ton-miles of cargo per dead weight of dry bulk capacity per annum. The forecast of productivity of a ship can be done by analysing the statistical series of past productivity of merchant fleet and project this into the future, considering any changes of trend in the series.

Step 7: The supply forecast

The supply is calculated in ton-miles by multiplying the total deadweight tonnage of dry bulk carriers by their productivity.

Step 8: The balance of supply and demand

According to the law of demand and supply, the supply must equal demand at the equilibrium point. In the dry bulk freight market, if supply exceeds demand, the residue is assumed to be laid up; if supply is less than demand, the fleet productivity should increase (Stopford, 1997, p.505).

Step 9: Forecast of freight rates

After the level of surplus tonnage has been calculated, the level of freight rates can be estimated. If there is a very large surplus, it is easy to know the level of freight rates since it will fall to the operating costs. However, it is difficult to forecast freight rates when the market is close to balance, tiny changes in supply or demand will push freight rates up or down (Stopford, 1997, p. 519). The forecast of freight rates is done with regression equations on a simulated model.

5.2 Time-series analysis

Time-series analysis is one of the most popular techniques used in forecasting. The objectives of time-series analysis are to model the behaviour of historical data and to forecast future outcomes (Washington, Karlaftis & Mannering, 2003, p. 169). In this dissertation, two main basic methods are used for forecasting freight rates in the dry bulk freight market including average method and exponential smoothing techniques.

5.2.1 Characteristics of time series

The analysis of time-series data includes the attempt to discover the component factors that influence each of the periodic values in a series. Each component is identified so that the time-series data can be projected into the future and used for forecasting. The process to identify these components is called decomposition. The time-series data is decomposed into trend or long-term movement (L), seasonal movement (S), cyclical movement (C) and irregular movement.

Firstly, trend or long-term movements corresponds to the general direction in a time series. This long-term movement is normally illustrated by a trend line which is identified by some appropriate methods including the moving average method.

Secondly, the cyclical component is a series of wavelike fluctuations. The data swing around a trend curve of a time series. The theoretical reason for shipping cycles has already been examined in chapter 2.

Thirdly, seasonal movement is a time series which follows similar or nearly similar patterns within equal time periods. This seasonal movement will be scrutinised later under the exponential smoothing technique.

Lastly, irregular movements do not follow any pattern or trend. The time series fluctuations are normally caused by unpredictable or nonperiodic events such as war, elections, weather changes and outburst economies occurring in a nation or region.

5.2.3 Methodology

The moving average and exponential smoothing methods will be used in this section to analyze time-series. These methods provide a reasonably good short-term forecast (Washington, Karlaftis & Mannering, 2003, p. 171).

The data used for time-series analysis are the monthly Capesize time charter rates between January 1999 and April 2005 which were collected from different issues of Drewry Monthly.

5.2.3.1 Moving averages method

The moving average is obtained by identifying the mean for a specified set of values and then using it to forecast the next period.

$$M_T = F_{T+1} = \frac{(X_T + X_{T-1} + ... + X_{T-n+1})}{n} \qquad (5.2)$$

where:

M_T : moving average at time T

F_{T+1} : forecasted value for next period

X_T : actual value at period T

n : number of terms in the moving average

The following figure demonstrates the moving average technique with a monthly Capesize time charter rates (130,000-150,000dwt) between January 1999 and April 2005 (see Appendix 5). The number of terms in the moving average is 3 months.

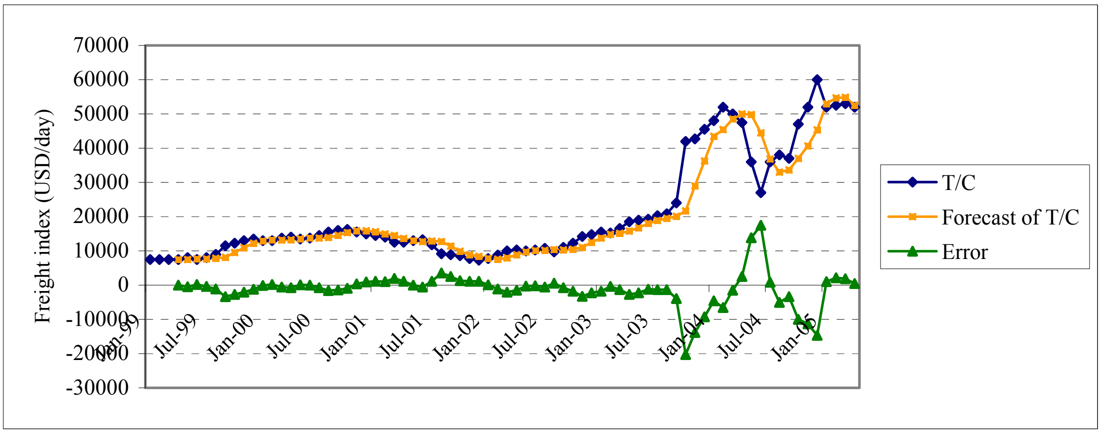

Figure 5.1 Moving average forecast of Capesize's time charter rates between January 1999 and April 2005

Source: compiled by the author

Figure 5.1 illustrates the relatively close gap between real and forecasted time charter rate during January 1999 to September 2003. However residuals (errors) are very high between October 2003 and February 2004 as well as between May 2004 and December 2004. These periods coincided with the extreme fluctuations of the dry bulk market with the Capesize' s time charter rate fluctuating dramatically month by month.

This is one of major limitations of the moving average method, where equal weights for each observation are assigned. This point "contradicts the usual experimental evidence that more recent observations should be closer in value to future ones so they should have an increased importance in the forecasting process" (Washington, Karlaftis & Mannering, 2003, p.172). Another limitation is that this method requires a large number of past observations to provide an adequate prediction. To tackle these two limitations, exponential smoothing methods were developed.

5.2.3.2 Exponential smoothing techniques

Exponential smoothing is a procedure for continually revising a forecast in view of more recent experience. The observations are weighted, with more weight being assigned to more recent observations.

$F_{T+1} = AX_T + (1-A)F_T$

replacing F_T by $F_T = AX_{T-1} + (1-A)F_{T-1})$ we have

$F_{T+1} = AX_T + A(1-A)X_{T-1} + (1-A)^2 F_{T-1}$

By substituting F_i for each i = t, t-1,…, the final equation is

$F_{T+1} = AX_T + A(1-A)X_{T-1} + (1-A)^2 F_{T-1} + A(1-A)^3 X_{T-3} + \dots$

F_{T+1}: forecasted value for next period

A: smoothing constant ($0 \le A \le 1$)

X_T: actual value of series in period T

F_T : forecasted value for last period

From the original equation, we can convert it into

$F_{T+1} = F_T + A(X_T - F_T)$

Exponential smoothing, in other words, is the previous forecast (F_T) plus A times the error $(X_T - F_T)$ in the previous forecast. The value assigned to A is the key to the analysis. If predictions are stable and random variations smoothed, a small A is required. On the contrary, if a rapid response to a real change in the pattern of observations is desired, a large value of A is suitable.

When using exponential smoothing, forecasts always lag behind the actual demand. Although a higher A would reduce the gap, the gap is always there because the large A will have less smoothing. In addition, the time series data sometimes are influenced by seasonal fluctuations. Exponential Smoothing Adjusted for Trend and Seasonal Variation (Winter's Model) should be taken into consideration.

5.2.3.3 Exponential smoothing adjusted for trend and seasonal variation (Winter's Model)

The Winter's model is similar to linear exponential smoothing but attempts also to account for seasonal movements of past data in addition to trends.

The exponentially smoothed series

$$F_T = A\frac{X_T}{S_{T-P}} + (1-a)(F_{T-1} + T_{T-1}) \tag{5.3}$$

The seasonality estimate

$$S_T = B\frac{X_T}{F_T} + (1-B)S_{T-P} \tag{5.4}$$

The trend estimate

$$T_T = C(F_T - F_{T-1}) + (1-C)T_{T-1} \tag{5.5}$$

Forecast for P periods in the future

$$F_{T+P} = (F_T + PT_T)S_T \tag{5.6}$$

A: smoothing constant ($0 \leq A \leq 1$)

X_T : actual value of series in period T

F_T : forecasted value for last period

F_{T-1}: average experience of series smoothed to period T-1

B: smoothing constant for seasonality estimate

S_T : seasonality estimate

S_{T-P} : average experience of seasonality estimated smoothed to period T-P

C: smoothing constant for trend estimate

T_T: trend estimate

T_{T-1}: average experience of trend estimate, smoothed to period T-1

P: number of seasons per year

F_{T+P} : forecasted value for next period

In formulas (5.3), (5.4) and (5.5), A, B and C are the constants that must be estimated in such a way that the error of the forecast is at a minimum. One method of estimating A, B and C is an iterative procedure that minimizes the Mean Percentage Error (MPE) or Mean Square Error (MSE). Based on judgement, the forecasts are computed for A, B and C equal to appropriate numbers. The smaller MPE each combination of A, B and C brings back, the better the forecast is. However, with the development of Information Technology (IT), this procedure is left to good computer software.

5.3 Forecasting freight rates of the dry bulk shipping market in 2005, 2006 using the demand/ supply model

5.3.1 Economic assumption

5.3.1.1 World Economy

According to IMF (2005), world economic growth is forecasted to average around 3.7 percent in 2005 and 2006 compared with a growth of 4.7 percent in 2004. The growth in the United States, the largest economy and in China, the world's fastest growing economy, as well as in other emerging countries, is an impetus for sustainable growth of the world economy in 2006. In the short term, the world economic prospect is closely associated with economic development in the United States and China. The economy of the United States is expected to rise by 3.3 per cent in 2005 and 2006. Meanwhile, the economy remains buoyant in China with a growth of 8.7 per cent in 2005 and 8.2 per cent in 2006.

In contrast, economic growth in Japan and Western Europe is likely to weaken. The economies of Japan and Europe are particular vulnerable to higher oil prices and a significant weaker US dollar. The economic growth in Japan and Europe is expected to rise 1.3 and 1.6 per cent respectively.

In the principal economies of East and South East Asia, relatively strong economy in China is expected to support export and thus economic growth. In other regions, high oil and mineral prices on the world market are likely to support economic growth in the Middle East and Latin America (Figure 5.2).

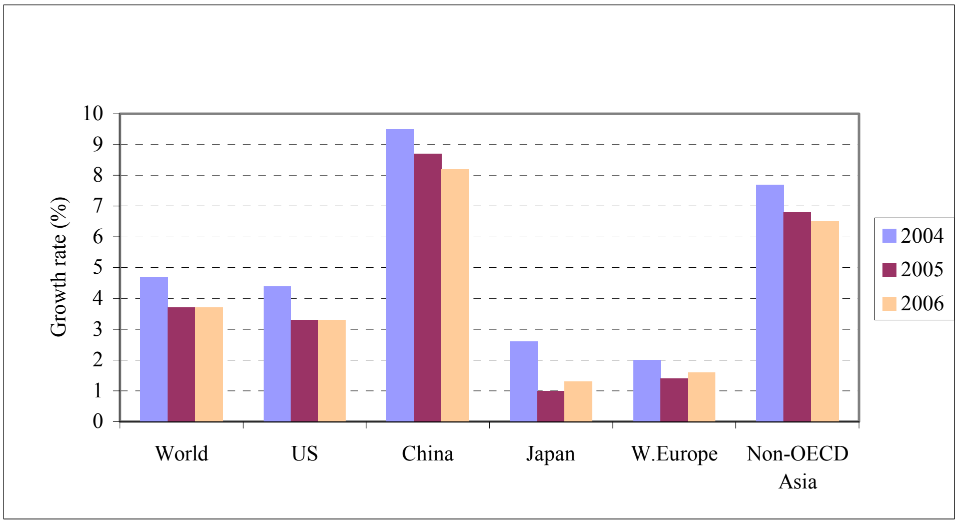

Figure 5.2 Regional economic growth

Source: IMF (2005). *World Economic Outlook*. Retrieved July 15, 2005 from the World Wide Web: http://www.imf.org/external/pubs/ft/weo/2005/01/index.htm

5.3.1.2 Industrial production in OECD

It is estimated that industrial production in the OECD will rise by 2.4 per cent in 2006 and 2.3 in 2007 compared to 3.6 per cent in 2004 (OECD, 2005).

5.3.1.3 Risks to world economic growth

High and volatile oil price

The world oil price has remained high and volatile. After a fall to below US$ 47 a barrel in January 2005, crude oil increased significantly in price to over US$ 55 a barrel in March before easing back in April and May. The oil price increased again in June to US$ 54 a barrel and reached a new record of US$ 64.5 on August 10, 2005 (Williams, 2005). A higher oil price may trigger a rapid fall in consumption and business confidence with a strong negative impact on economic activities. World GDP growth is expected to slow down in 2005 and 2006 relatively to 2004 with the oil price being one of the major contributing factors (OECD, 2005).

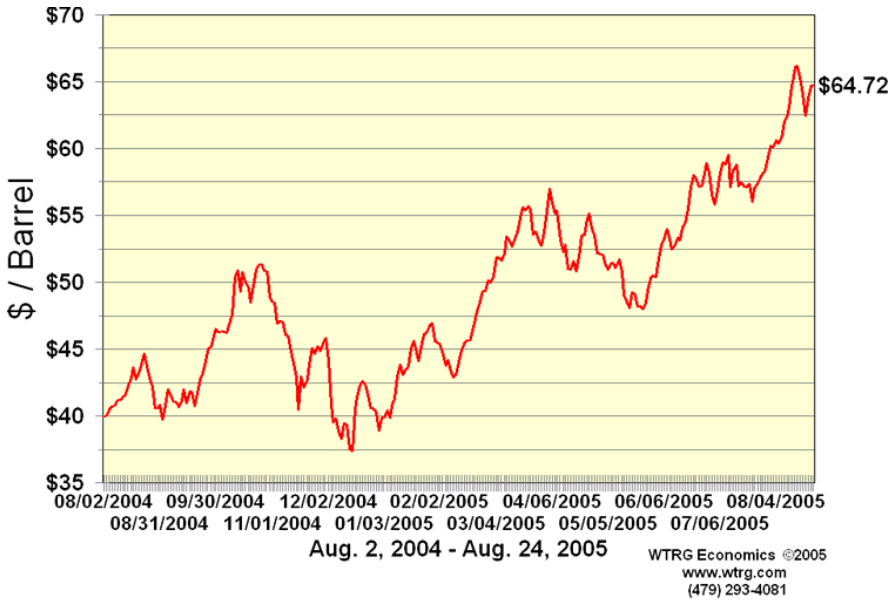

Figure 5.3 Crude oil spot (North Sea Brent)

Source: Williams, J.L (2005). Crude Oil Sport- North Sea Brent. Retrieved July 15, 2005 from the World Wide Web: http://www.wtrg.com/#Crude

The uncertainty of the US dollar

After depreciating against major international floating currencies during 2003 and 2004, the value of the US dollar has recovered. However, IMF forecasted that there remains a significant probability that the US dollar could depreciate in the short term. With the large US trade and current account deficit, the considerable downward pressure on the US dollar is likely to persist. A significant decline in the value of the US dollar could be a threat to world economic prospects. A sharp depreciation of the US dollar places a substantial upward pressure on other international currencies such as the Yen and Euro and poses a risk to export and thus the economic growth in those countries. In contrast, the decrease of the US dollar value can help the US trade and current balance deficits. However, sharp decline in the value of US dollar could also have adverse affects on the US economy. International investors would lose confidence in the US dollar. Consequently, there could be a significant reduction in the capital inflows in the United States. Under this circumstance, the interest rate in the United States would increase substantially, adversely affecting the economic performance. The weakening of the US economy may pose a threat to other economies in the world.

Terrorist attack has not undermined world economic growth

Although the terrorist bombings in London may have an incalculatable impact in politics, the economic impact is likely to be small like those in Madrid and New York.

5.3.2 Forecast of demand for dry bulk sea transport

5.3.2.1 Dry bulk seaborne trade forecast

The forecast of dry bulk seaborne trade can be made by using the regression equation which is estimated by Stopford and the forecast of industrial production (IP) in the OECD. A 6 per cent error over 16 years is very good result when using this equation to forecast dry cargo seaborne trade (Stopford, 1997, p. 502). The equation is as follows:

$$ST_t = -307.6 + 22.03X_t \qquad (5.7)$$

where X_t is OECD industrial production; ST_t is dry cargo seaborne trade.

OECD IP_{2005} = 2.4% and OECD IP_{2006} =2.3%

The regression equation shows that for each one point increase in the industrial production index, dry cargo seaborne trade increases by 22.03 million tons. As a result, the forecasted increase in the dry bulk seaborne trade in 2005 equal 22.03 multiplied by 2.4 which is 52.872 million tons. Similarly, the increase in the dry bulk seaborne trade in 2006 is 51.29.

$$Q_t = Q_{t-1} + \Delta_{t-1}^{t} \qquad (5.8)$$

Where

Q_t : forecast of dry bulk seaborne trade in year t

Q_{t-1} : dry bulk seaborne trade in year t-1

Δ_{t-1}^{t} : forecast of increase in dry bulk seaborne trade in year t compared to year t-1

$Q_{2005} = Q_{2004} + \Delta_{2004}^{2005}$ = 2336 + 52.872= 2388.9 million tons

$Q_{2006} = Q_{2005} + \Delta_{2005}^{2006}$ = 2388.9 + 51.29 = 2440.2 million tons

5.3.2.2 Average haul forecast

Forecasting AH can be made by basing it on the historic trend, at the same time, attempting to identify the factors that might affect the AH. Figure 5.4 illustrates that there was no significant change in AH between 1996 and 2004. In addition, the trade pattern of dry bulk will not change in the short term.

Based on the moving average method, the forecast of AH in 2005 is 5450 miles. Also, it is estimated that AH in 2006 will be approximately 5450 miles.

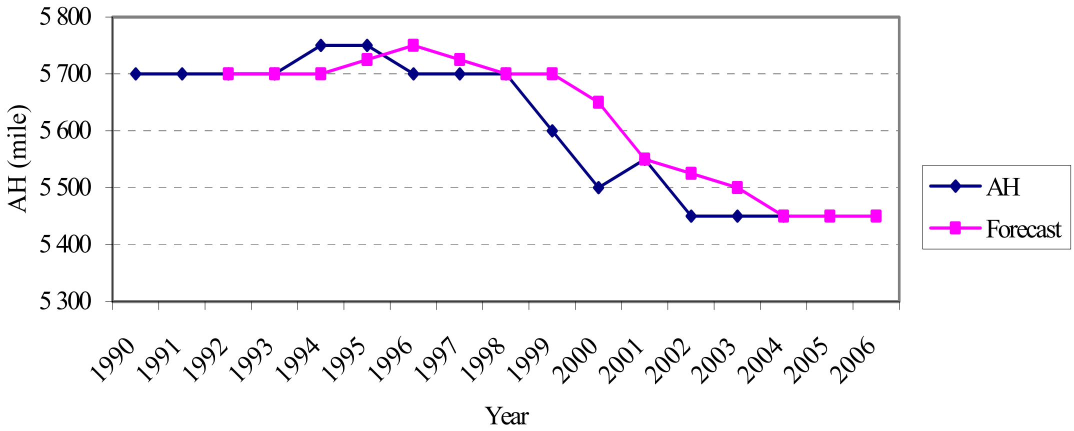

Figure 5.4 Average haul development and forecast

Source: Compiled by the author (see Appendix 6)

5.3.2.3 The demand forecast

The total demand equals dry bulk seaborne trade multiplied by average haul.

$$Q^D = Q * AH \tag{5.9}$$

where

Q : forecast of dry bulk seaborne trade

Q^D : forecast of total demand

Q^D_{2005} = 2388.872*5450/1000= 13019.35 billion ton-mile

Q^D_{2006} = 2440.162*5450/1000= 13298.9 billion ton-mile

5.3.2.4 Supply forecast

Forecast for the fleet of dry bulk carriers

The fleet of dry bulk carriers was approximately 320.2 million dwt (mdwt) in 2004. According to Lloyd's MIU and Lloyd's Register/Fairplay, dry bulk delivery in the period 2005-2006 will be strong in the historic perspective, as 20.41 and 20.91 mdwt is scheduled for delivery in each respective year. As far as demolition is concerned, the scrapping of dry bulk carriers amounted to only 0.2 per cent of the existing fleet in 2004 compared to the average demolition over the last fifteen years of approximately 2 per cent (DnB NOR, 2005). The low scrapping level is mainly due to the strong freight market last year. Since the level of freight rates during the first of half of 2005 is lower than 2004, it is expected that the scrapping environment in 2005 will be relatively lower than what was the case in 2004, thereafter following a more normalised picture. Consequently, the demolition of dry bulk carriers is assumed to be around 1 per cent in 2005 and 2 per cent in 2006.

With the above estimation, the fleet of dry bulk carriers in 2005 and 2006 will be 337.4 and 351.6 mdwt respectively.

Ship productivity forecast

Ship productivity forecasting can be done by analysing the past data series. Using moving average, ship productivity is estimated to be 38,787 ton-miles per annum in 2005 and 38,528 ton-miles per annum in 2006.

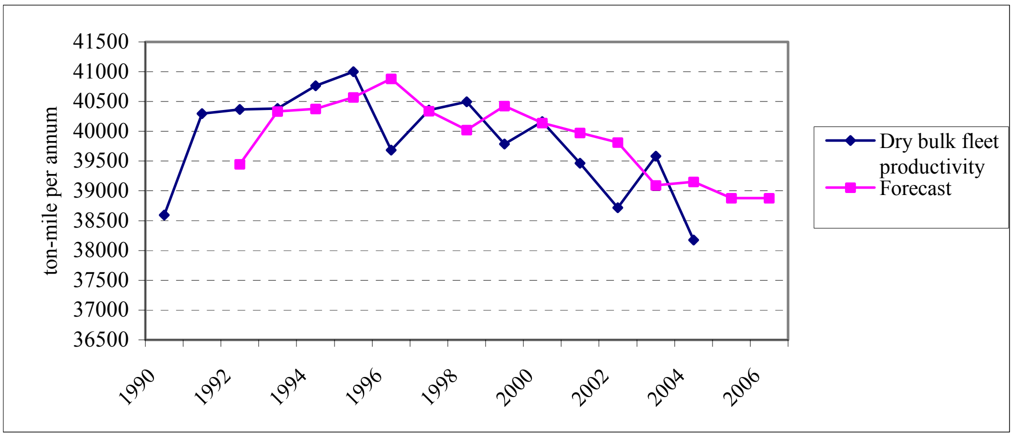

Figure 5.5 Dry bulk cargo fleet productivity and forecast
Source: compiled by the author (see Appendix 6)

Forecast of supply

The supply is calculated in ton-miles by multiplying the total deadweight tonnage of dry bulk carriers by their productivity. The result of forecast of supply is 13,086 and 13,546.4 billion ton-miles in 2005 and 2006 respectively.

5.3.2.5 Balance of demand and supply

The balance of demand and supply in 2005 is measured at 66.6 billion ton-miles[2]. Similarly, the balance in 2006 is estimated at 247.5 billion ton-miles[3]. The balance in ton-mile is equivalent to 1.7 mdwt and 6.4 mdwt[4].

In conclusion, the fleet of dry bulk carriers is rising and exceeds demand in 2005. The gap between supply and demand is even widening in 2006. However, the supply/demand balance is still tight in 2005, therefore the collapse of the freight market back to pre-2003 is unlikely to occur in the short term. In 2006, it is

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[2] $\Delta_{2005} = totalS - totalD$ = 13,086 – 13,019.35 = 66.6

[3] Δ_{2006} = 13,546.4 – 13,546.4 = 247.5

[4] Balance in dwt = balance in ton-mile / ship productivity
Balance in dwt in 2005= 66.6/ 38,878*1000 = 1.7 mdwt
Balance in dwt in 2006= 247.5/ 38,528*1000 = 6.4 mdwt

forecasted that freight rates in dry bulk freight market will be lower than in 2005 due to a higher surplus of supply.

5.4 Forecasting freight rates of dry bulk shipping market in 2005, 2006 using multiple regression

The multiple regression equation to forecast freight rate (BDI) (4.13) is as follows.
Ln(BDI_2005)= -79.1432 + 0.659368*ln(B) - 11.2901*ln(K) + 15.7397*ln(Q)
In order to forecast freight rate, it is important to predict the dry bulk seaborne trade, the fleet and bunker prices.

5.4.1 Dry bulk seaborne trade forecasting

The results of the forecasted dry bulk seaborne trade in 2005 and 2006 have been done in previous section.

Q_{2005} = 12,670.6 btm

Q_{2006} = 12950.1 btm

5.4.2 Dry bulk fleet forecast

Dry bulk fleet forecast had also done in above part. The results are as follows.

K_{2005} =337.4 mdwt

K_{2005} = 351.6 mdwt

5.4.3 Bunker price forecast

Figure 5.6 illustrates the very close correlation between oil prices and bunker prices between Jannuary 1999 and April 2005. Consequently, the bunker price will be forecasted based on the oil price. The forecasted crude oil price in 2005 will stay at US$54.7 a barrel. It is high probability that the crude oil price will remain at a high level of US$ 56 a barrel (AJMA Petroleum Consultant, 2005). Moreover, the International Energy Agency (IEA) also forecasted a higher demand for crude oil from China and the United States. This will result in high crude oil price if OPEC still maintains the same production level.

Based on the regression between dependent variable (bunker price) and independent variable (oil price), the result of the bunker price forecast is as follows.

P_{b_2005} = 9.4831*54.7 – 10.928 = 507.8

P_{b_2006} =9.4831*56 – 10.928 = 520.1

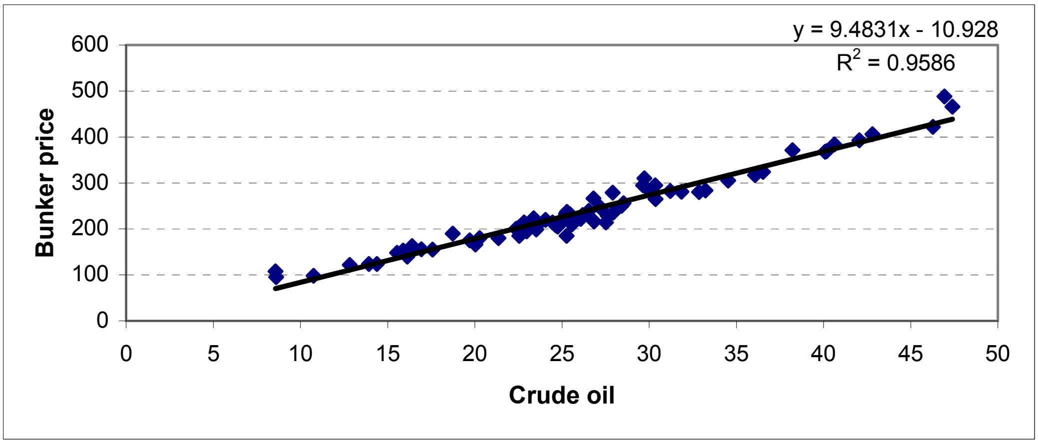

Figure 5.6 Correlation between bunker price and crude oil price

Source: compiled by the author (see Appendix 7)

5.4.4 Forecast result by using multiple regression

Based on the multiple regression between freight rate (BDI) and bunker price (P_b), fleet of dry bulk carriers, dry bulk seaborne trade, the result of the forecast is as follows:

Ln(BDI_2005)= -79.1432 + 0.659368*ln(B) - 11.2901*ln(K) + 15.7397*ln(Q)

= -79.1432 + 0.659368*ln(507.8) - 11.2901*ln(337.4) + 5.7397*ln(13019.35)

= 8.362949

BDI_2005 = 4285.3

Ln(BDI_2006)= -79.1432 + 0.659*ln(520.1) - 11.29*ln(351.6) + 15.7397*ln(13298.88)

= 8.247656

BDI_2006 = 3818.6

It is forecasted that the level of BDI in 2005 and 2006 will be less than that in 2004. This can be explained by a lower demand growth than that in 2004 together with an acceleration of new deliveries. However, since the supply and demand balance is still very tight there will be no collapse of the freight market back to the pre 2003 level.

5.5 The result of freight rates forecasted by exponential smoothing adjusted for trend and seasonal variation method

This method is suitable for the data series which has long term (trend curve) and seasonal movements. When scrutinizing freight rates in the dry cargo freight market, it is found that freight rates of various types of vessels such as Capesize, Panamax, Handymax and Handisize have a seasonal pattern. The freight rates are normally high at the beginning of the year; after that rates fall until June/July, then rise again until the end of the year.

5.5.1 Data collection

Data will be used for forecasting are the iron ore single voyage rates of the West Australia-China route collected from various issues of The Drewry Monthly from January 1999 to April 2005 (see Appendix 8).

5.5.2 Forecast results

The heart of the exponential Smoothing Adjusted for Trend and Seasonal variation method is to estimate the smoothing constant (A), smoothing constant for seasonality (B) and smoothing constant for trend (C). The optimum combination of the value of A, B and C is to minimize the error of forecasting such as Mean Square Error (MSE). Selecting A, B, and C can be done by using experience with this or similar series. The rule is that as the value of A, B and C gets closer to one, more weight is given to recent observations. As the value approaches zero, all observations are given equal weight. Nevertheless, using computer software to find out the optimum A, B and C is very time-effective and accurate. In this part, NCSS, statistical and power analysis software are used to estimate those constants. The number of seasons (P) is four, based on the pattern of Baltic Capsize Index in 2004 and previous years.

Seasonal - Trend Report

Forecast Summary Section

Number of observations	75
Mean	7.826667
R-Squared	0.919879
Mean Square Error	1.970555
Mean |Error|	0.8144587
Mean |Percent Error|	9.925818

Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	180
Search Criterion	Mean Square Error
A	0.9525807
B	0.9999722
C	0.0093531
Season 1 Factor	0.9920059
Season 2 Factor	0.98126
Season 3 Factor	0.9973758
Season 4 Factor	1.029358

Forecasts Section

Date	Rates
Apr-05	16.98805
May-05	16.48124
Jun-05	16.41115
Jul-05	16.7909
Aug-05	17.44309
Sep-05	16.91977
Oct-05	16.84493
Nov-05	17.23181
Dec-05	17.89813
Jan-06	17.3583
Feb-06	17.27871
Mar-06	17.67271
Apr-06	18.35317
May-06	17.79682
Jun-06	17.71248
Jul-06	18.11361
Aug-06	18.80822
Sep-06	18.23535
Oct-06	18.14627
Nov-06	18.55452

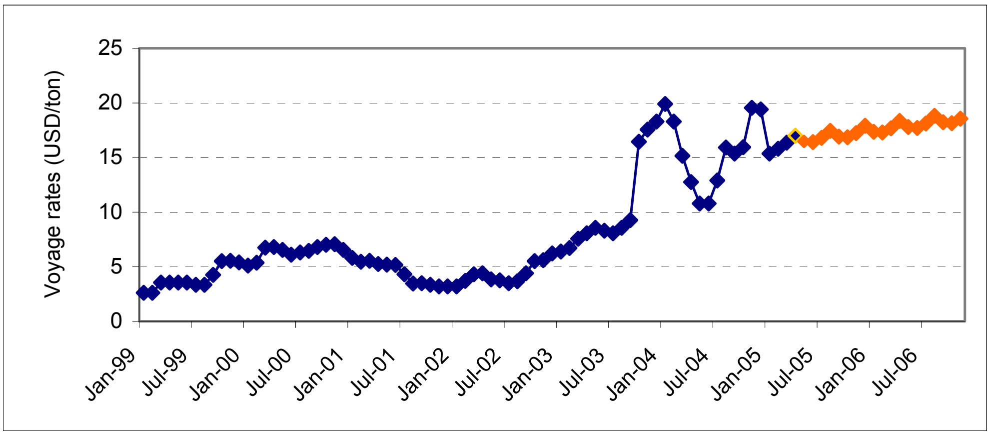

Figure 5.7 Iron ore single voyage rates (West Australia-China) forecast for 2005 and 2006

Source: compiled by the author

5.6 Evaluation of forecast results

The forecast results of BDI performed by the multiple regression method show that although the freight levels in 2005 and 2006 may be lower than 2004 it may still be higher than pre 2003. There are several reasons to explain this. The first one is that there may be a surplus of supply approximately 1.7 mdwt and 6.4 mdwt in 2005 and 2006 respectively, according to the estimation of the demand/supply model. Maritime Strategies International's (MSI) also forecasts that although the total seaborne trade will grow by some 4.5 per cent in the next five years, an increase in the aggregate fleet capacity of 5.2 per cent will result in a weakened freight market (Jessel, 2005, pp. 15-16). Furthermore, since China was one of the main factors behind the shipping boom in 2003 and 2004, the growth of the Chinese seaborne trade will have a great impact on the dry cargo freight market. At the end of 2004, the Chinese government carried out measures to cool the overheated economy for a "soft landing" (Economist, 2005). These measures will affect the world dry cargo seaborne trade. According to the Chinese Association for Ore and Steel (CSIA), the level of ore imports may reach 240 million tons in 2005, with an increase of around 20 per cent compared to the 40 per cent witnessed in 2004 (BRS, 2004).

Regarding the forecast result of iron ore single voyage rates (West Australia-China**),** although the level of the freight rate may be lower than the record level in 2004 (19.99 USD/ton), it may fluctuate at a high level by the end of 2005 and in 2006 (16-18 USD/ton). According to the forecast of Fearnleys, a total of 95 Capesize bulk carriers are due for delivery in 2005-2006 and China's iron ore imports will increase by 58 million tones in 2005 and 23 million tones in 2006. Based on this forecast, Fearnleys estimates that there would be a high demand for Capesize vessels (Svenning, 2005, pp. 21-23). As a result, iron ore single voyage rates may also not collapse in the short run.

There are some opinions from leading shipowners, shipbroking companies supporting the arguments that the freight rates will stay at high level in the short run

(2005 and 2006). Captain Vassilis Constantakopoulos (2004), the president of Costamare – one of the biggest shipowners in the world, implied that although the level of freight rates in 2005 and 2005 might be lower than 2004, it would remained at a high level. In addition, the manager of the dry bulk division of Torm shipping company, one of the world's most respected names in international shipping, was very optimistic about the dry bulk freight market in the short run (2005 and 2006). Furthermore, Dr. Philip Rogers (2004), Group Head of Research at Galbraith's Ltd, implied that freight rates would reduce slightly in the short term. Until now, those opinions about the freight rate forecast are correct (Figure 5.8). There is a high probability that the BDI will stay more or less at level between 2003 and 2004.

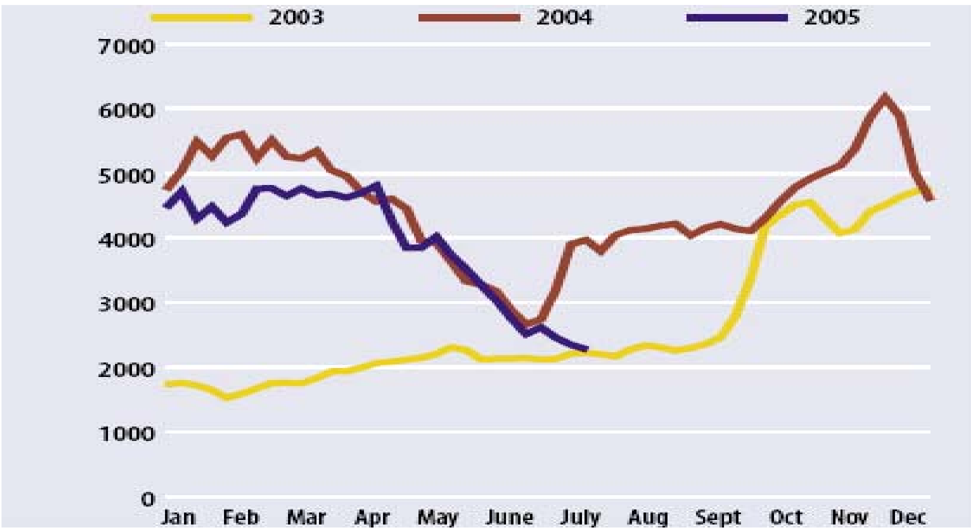

Figure 5.8 Baltic Dry Index (2003-2005)

Source: Fairplay. (11 August, 2005)

CHAPTER 6 CONCLUSION

This dissertation has provided the economic analysis of the dry bulk shipping market and methods of forecasting freight rates namely demand and supply model, multiple regression and time series analysis. A general economic analysis of the market is able to describe the economic relations that are believed to exist between factors. Based on this foundation, appropriate forecasting methods were suggested to ensure the accuracy of forecasting.

Historical developments in the quantitative bulk shipping market have also been scrutinized. Based on examining the remarkable research from early thirties, it was found that there was a significant consensus about the reduced form of the freight rate equation in which variables such as bunker prices, fleets of dry bulk carriers and dry bulk seaborne trade, play a role. Another agreement is that freight rates correlated with shipping markets such as second hand and newbuilding market. Moreover, the shipping cycles, as well as their causes, have also been analysed. This examination answered the reason why the shipping market in general, and dry bulk freight market in particular, are volatile. It was discovered that the causes of the shipping cycles are the inelasticity of supply in shipping market which make supply cannot meet the demand in the short run.

Moreover, this dissertation has described the main features of the dry bulk freight market, one of the biggest markets, accounting for approximately 40 per cent of world seaborne trade. In this market, five major commodities namely iron ore, coal, grain, phosphate and bauxite & alumina play a key role, making up more than 60 per cent of the total market. The dry bulk freight market, a highly competitive market, is influenced by many factors which are divided into two main groups: demand and supply. On the demand side, the world economy, seaborne trade and political disturbance are significant factors. Meanwhile, on the supply side the world dry bulk merchant fleet, fleet productivity, ship scrapping, newbuilding and bunker prices are major factors. These factors are called determinants of the dry bulk freight market. In addition, correlational research has also been done in order to find out the correlation between freight rates and major factors. Among them, only bunker prices are highly correlated with freight rates.

Since low correlation between freight rates and most major factors, the application of the simple linear regression equation for forecasting freight could not meet the requirements of accuracy. Consequently, multiple regression is used to forecast freight rates instead. The examination of this method shows that the result of forecasting is relatively accurate. However, in order to have more a precise result, it is important to quantify the demand and supply surplus in the market. The demand/supply model was an efficient way which should be taken into consideration before forecasting. While the regression method is suitable for long term forecasting, the time series method should be used for the short-term one. In the time series analysis, because of the seasonal movements of freight rates, the exponential Smoothing Adjusted for Trend and Seasonal Variation method is one of the most suitable methods of forecasting freight rate.

Lastly, practical work was done. Forecasting BDI in 2005 and 2006 was carried out. The result shows that freight rates in 2005 and 2006 may decrease compared to the rates in 2004. However, it is unlikely that freight rates will collapse back to the pre-2003 level. This result is somehow logical since the calculated supply/demand surplus was still tight. Moreover, according to many major shipowners, shipping companies, shipbrokers as well as professionals in shipping, there is a high probability that freight rates in 2006 may stay at a high level even though they will be less than that of 2004.

Limitation of analysis

The work done in this dissertation has inevitably its limitations. First, due to the difficulties of data collection, the period of data series were compiled from 1990 on a yearly basis. Moreover, data have been collected from different sources to reduce the accuracy of forecasting. In addition, although it seems that the multiple regression method is suitable for forecasting rates in the dry bulk freight market, there are still many other methods that should be taken into consideration.

Further research

An important area for further research lies in the shortcomings of the data. Once long- term data are collected, the accuracy of the multiple regression and time series method will be improved. A systematic collection of market data should focus on the fleet, seaborne trade and bunker prices since they are major variables of the freight rate equation.

Further elaboration of the work in selecting appropriate forecasting methods should be done. There are still many other methods which are worth taking into consideration; for example, the time-series models of the ARMA family, namely autoregressive (AR) and autoregressive moving average, or so-called Vector Autoregressive (VAR) models. These models require not only a deep knowledge of statistics but also sophisticated computer software.

This dissertation has only carried out the forecasting of DBI which represents the freight rates of the dry bulk freight market as a whole. However, it is significant to forecast rates of different segments of the dry bulk freight market including Capesize, Panamax, Handymax and Handysize vessels since the freight indexes of these segments form the BDI. Once this research is done, it might be more meaningful to the shipping industry.

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Major commodity seaborne trade (1990-2004)

Appendix 1

Year	Iron ore	Coal	Grain	Bauxite & Alumina	Total dry bulk
1990	1978	1849	1073	205	9 000
1991	2008	1999	1069	200	9 302
1992	1896	2001	1091	177	9 257
1993	2001	1949	1038	187	9 348
1994	2165	2014	992	180	9 752
1995	2287	2176	1160	195	10 362
1996	2227	2217	1126	195	10 368
1997	2444	2332	1169	205	10 836
1998	2306	2419	1064	205	10 705
1999	2317	2363	1186	204	10 545
2000	2545	2509	1244	208	10 995
2001	2575	2552	1322	192	11 250
2002	2731	2549	1322	206	11 347
2003	3035	2810	1273	198	11 979
2004	3415	2965	1325	210	12 731

(billion ton miles)

Source: compile by the author from ISL, January/February 2005 and different sources.

World dry bulk trade and BDI

Appendix 2

Year	**Dry bulk trade (in ton)**	**Growth rate (%)**	**Dry bulk trade (in ton-mile)**	**Growth rate (%)**	**BDI**
1990	1 579		9000		1490
1991	1 632	3.4	9302	3.4	1750
1992	1 624	-0.5	9257	-0.5	1320
1993	1 640	1.0	9348	1.0	1540
1994	1 696	3.4	9752	4.3	1630
1995	1 802	6.3	10362	6.3	2180
1996	1 819	0.9	10368	0.1	1450
1997	1 901	4.5	10836	4.5	1600
1998	1 878	-1.2	10705	-1.2	977
1999	1 883	0.3	10545	-1.5	1073
2000	1 999	6.2	10995	4.3	1553
2001	2 027	1.4	11250	2.3	1188
2002	2 082	2.7	11347	0.9	1182
2003	2 198	5.6	11979	5.6	2751
2004	2 336	6.3	12382	3.4	4494

Source: Shipping Statistics Handbook. Retrieved 10 June 2005 from the World Wide Web: http://www.kmi.re.kr/english/stat/html/w_year_2004.html

BDI, fleet, neworder, demolition and laid-up

Appendix 3

Year	BDI	Fleet	Neworder	Broken up	Lay-up
1985	1000	197500	10878	12400	9700
1986	790	196000	6406	15733	9100
1987	1120	193200	4190	9531	6000
1988	1520	195500	7091	2636	3100
1989	1700	202700	7808	1012	1900
1990	1490	211100	5069	2122	2200
1991	1750	215900	7184	2989	2900
1992	1320	216600	8400	6415	3300
1993	1540	220600	12830	4734	3500
1994	1630	228800	13248	7740	3800
1995	2180	241000	15803	3892	3300
1996	1450	255300	14400	7600	3500
1997	1600	266700	16100	8200	4700
1998	977	266100	12600	12800	5400
1999	1073	268100	22500	9700	6400
2000	1553	275700	13600	4600	5200
2001	1188	288300	10200	8100	4600
2002	1182	295300	20700	5900	3800
2003	2751	302400	31100	3300	2800
2004	4494	320200	23500	600	2400

(1000 dwt)

Source: compiled from different publications of Shipping Statistics Yearbook (ISL)

BDI and forecasted BDI by simple and multiple regression between 1990 and 2004

Appendix 4

Year	BDI	Q (btm)	K (mdwt)	B (USD/ton)	ln(BDI)	ln(Q)	ln(K)	ln(B)	ln(FBDI) (BDI&Q)	FBDI (BDI&Q)	ln(FBDI) (BDI&B)	FBDI (BDI&B)	ln(FBDI) (BDI,Q,B)	FBDI (BDI,Q,B)
1990	1490	9000.3	211.1	217	7.31	9.11	5.35	5.38	7.13	1248	7.54	1881	7.29	1460
1991	1750	9302.4	215.9	200	7.47	9.14	5.37	5.30	7.18	1319	7.46	1738	7.50	1804
1992	1320	9256.8	216.6	168	7.19	9.13	5.38	5.12	7.18	1308	7.29	1468	7.27	1435
1993	1540	9348	220.6	152	7.34	9.14	5.40	5.02	7.19	1329	7.20	1333	7.15	1275
1994	1630	9752	228.8	141	7.40	9.19	5.43	4.95	7.26	1427	7.12	1239	7.36	1564
1995	2180	10362	241	148	7.69	9.25	5.48	5.00	7.37	1580	7.17	1299	7.75	2333
1996	1450	10368	255.3	195	7.28	9.25	5.54	5.27	7.37	1582	7.44	1696	7.30	1475
1997	1600	10836	266.7	176	7.38	9.29	5.59	5.17	7.44	1703	7.34	1536	7.43	1685
1998	977	10705	266.1	114	6.88	9.28	5.58	4.74	7.42	1669	6.92	1009	6.98	1072
1999	1073	10545	268.1	139	6.98	9.26	5.59	4.93	7.39	1627	7.11	1222	6.79	886
2000	1553	10995	275.7	244	7.35	9.31	5.62	5.50	7.46	1745	7.65	2107	7.50	1806
2001	1188	11250	288	196	7.08	9.33	5.66	5.28	7.50	1814	7.44	1704	7.21	1355
2002	1182	11347	295	202	7.07	9.34	5.69	5.31	7.52	1840	7.47	1755	7.10	1207
2003	2751	11979	302	241	7.92	9.39	5.71	5.48	7.61	2015	7.64	2082	7.80	2434
2004	4494	12731	320	333	8.41	9.45	5.77	5.81	7.71	2232	7.95	2846	8.32	4117

Source: Compiled from different sources (Baltic Exchange, The Drewry Monthly, Shipping Statistics and Market Review (ISL), Fearnleys Review, Bunker 60 (Lloyd's List)

$$\ln(BDI) = -8.14319 + 1.67733 \cdot \ln(Q)$$

$$\ln(BDI) = 2.33454 + 0.967474 \cdot \ln(B)$$

$$\ln(BDI) = -79.1432 + 0.659368 \cdot \ln(B) - 11.2901 \cdot \ln(K) + 15.7397 \cdot \ln(Q)$$

Capesize time charter rates and forecasting the rates by using moving average method (January 1999 - March 2005)

Appendix 5

Date	CapesizeTC (USD/day) (130-150dwt)	Forecast TC	Error	Date	CapesizeTC (USD/day) (130-150dwt)	Forecast TC	Error
Jan-99	7500			**Mar-02**	10000	7917	-2083
Feb-99	7500			**Apr-02**	10300	8833	-1467
Mar-99	7500			**May-02**	10000	9683	-317
Apr-99	7500	7500	0	**Jun-02**	10250	10100	-150
May-99	8000	7500	-500	**Jul-02**	10750	10183	-567
Jun-99	7500	7667	167	**Aug-02**	9750	10333	583
Jul-99	8000	7667	-333	**Sep-02**	11000	10250	-750
Aug-99	9000	7833	-1167	**Oct-02**	12250	10500	-1750
Sep-99	11500	8167	-3333	**Nov-02**	14250	11000	-3250
Oct-99	12250	9500	-2750	**Dec-02**	14750	12500	-2250
Nov-99	13000	10917	-2083	**Jan-03**	15500	13750	-1750
Dec-99	13500	12250	-1250	**Feb-03**	15250	14833	-417
Jan-00	13000	12917	-83	**Mar-03**	16500	15167	-1333
Feb-00	13000	13167	167	**Apr-03**	18500	15750	-2750
Mar-00	13750	13167	-583	**May-03**	19000	16750	-2250
Apr-00	14000	13250	-750	**Jun-03**	19250	18000	-1250
May-00	13500	13583	83	**Jul-03**	20250	18917	-1333
Jun-00	13750	13750	0	**Aug-03**	20850	19500	-1350
Jul-00	14500	13750	-750	**Sep-03**	24000	20117	-3883
Aug-00	15500	13917	-1583	**Oct-03**	42000	21700	-20300
Sep-00	16000	14583	-1417	**Nov-03**	42750	28950	-13800
Oct-00	16250	15333	-917	**Dec-03**	45500	36250	-9250
Nov-00	15500	15917	417	**Jan-04**	48000	43417	-4583
Dec-00	15000	15917	917	**Feb-04**	52000	45417	-6583
Jan-01	14500	15583	1083	**Mar-04**	50000	48500	-1500
Feb-01	14000	15000	1000	**Apr-04**	47500	50000	2500
Mar-01	12500	14500	2000	**May-04**	36000	49833	13833
Apr-01	12500	13667	1167	**Jun-04**	27000	44500	17500
May-01	13000	13000	0	**Jul-04**	36000	36833	833
Jun-01	13250	12667	-583	**Aug-04**	38000	33000	-5000
Jul-01	11750	12917	1167	**Sep-04**	37000	33667	-3333
Aug-01	9125	12667	3542	**Oct-04**	47000	37000	-10000
Sep-01	8875	11375	2500	**Nov-04**	52000	40667	-11333
Oct-01	8565	9917	1352	**Dec-04**	60000	45333	-14667
Nov-01	7750	8855	1105	**Jan-05**	52000	53000	1000
Dec-01	7250	8397	1147	**Feb-05**	52500	54667	2167
Jan-02	7750	7855	105	**Mar-05**	53000	54833	1833
Feb-02	8750	7583	-1167				

Source: Compiled from various publications of The Drewry Monthly.

Supply/demand model

Appendix 6

	Dry bulk cargo demand					Dry cargo fleet			
Year	**Trade volume mt**	**AH miles**	**Transport required btm**	**Combined Carrier btm**	**Dry cargo demand btm**	**Dry cargo fleet productivity tm/dwt per annum**	**Active dry cargo fleet m.dwt**	**Laid up m.dwt**	**Total bulker fleet m.dwt**
	1	2	3	4	5	6	7	8	9
1990	1 579	5 700	9 000	938	8 062	38594	208.9	2.2	211.1
1991	1 632	5 700	9 302	719	8 583	40298	213	2.9	215.9
1992	1 624	5 700	9 257	646	8 611	40369	213.3	3.3	216.6
1993	1 640	5 700	9 348	581	8 767	40382	217.1	3.5	220.6
1994	1 696	5 750	9 752	580	9 172	40764	225	3.8	228.8
1995	1 802	5 750	10 362	616	9 746	40999	237.7	3.3	241
1996	1 819	5 700	10 368	376	9 992	39683	251.8	3.5	255.3
1997	1 901	5 700	10 836	262	10 574	40358	262	4.7	266.7
1998	1 878	5 700	10 705	147	10 558	40497	260.7	5.4	266.1
1999	1 883	5 600	10 545	132	10 413	39789	261.7	6.4	268.1
2000	1 999	5 500	10 995	131	10 864	40161	270.5	5.2	275.7
2001	2 027	5 550	11 250	53	11 197	39467	283.7	4.6	288.3
2002	2 082	5 450	11 347	60	11 287	38720	291.5	3.8	295.3
2003	2 198	5 450	11 979	121	11 859	39581	299.6	2.8	302.4
2004	2 336	5 450	12 731	250	12 481	39272	317.8	2.4	320.2

Source: Compiled from different sources (Fearnleys Review, Shipping Statistics Yearbook (ISL), The Drewry Monthly)

(2) = (3)/(1)*1,000

(5) = (3) – (4)

(6) = (5)/(7)*1,000

(7) = (9) – (8)

Crude oil and MDO (January 1999- April 2005)

Appendix 7

Date	Crude Oil Domestic First Purchase Price (Cents per Barrel)	MDO (Singapore) USD/ton	Date	Crude Oil Domestic First Purchase Price (Cents per Barrel)	MDO (Singapore) USD/ton
Jan-99	857	108	**Mar-02**	2028	180
Feb-99	860	95	**Apr-02**	2252	203
Mar-99	1076	98	**May-02**	2351	205
Apr-99	1282	122	**Jun-02**	2259	204
May-99	1392	124	**Jul-02**	2351	205
Jun-99	1439	124	**Aug-02**	2476	205
Jul-99	1612	140	**Sep-02**	2608	222
Aug-99	1758	155	**Oct-02**	2529	237
Sep-99	2003	166	**Nov-02**	2338	223
Oct-99	1971	175	**Dec-02**	2529	230
Nov-99	2135	180	**Jan-03**	2842	250
Dec-99	2255	185	**Feb-03**	3185	281
Jan-00	2353	199	**Mar-03**	3010	281
Feb-00	2548	222	**Apr-03**	2545	232
Mar-00	2619	230	**May-03**	2495	218
Apr-00	2320	209	**Jun-03**	2684	216
May-00	2558	210	**Jul-03**	2752	214
Jun-00	2762	229	**Aug-03**	2794	236
Jul-00	2681	266	**Sep-03**	2523	233
Aug-00	2791	279	**Oct-03**	2653	239
Sep-00	2972	310	**Nov-03**	2721	246
Oct-00	2965	295	**Dec-03**	2853	256
Nov-00	3036	265	**Jan-04**	3035	295
Dec-00	2446	214	**Feb-04**	3121	282
Jan-01	2464	208	**Mar-04**	3286	280
Feb-01	2527	185	**Apr-04**	3323	284
Mar-01	2298	195	**May-04**	3607	317
Apr-01	2339	212	**Jun-04**	3453	305
May-01	2406	220	**Jul-04**	3654	324
Jun-01	2343	215	**Aug-04**	4010	368
Jul-01	2282	214	**Sep-04**	4062	384
Aug-01	2308	208	**Oct-04**	4628	422
Sep-01	2237	200	**Nov-04**	4281	406
Oct-01	1873	190	**Dec-04**	3822	371
Nov-01	1640	163	**Jan-05**	4018	369
Dec-01	1554	148	**Feb-05**	4206	393
Jan-02	1589	153	**Mar-05**	4739	466
Feb-02	1693	156	**Apr-05**	4693	488

Source: various publications of The Drewry Monthly and retrieved 8 July 2005 from the World Wide Web: http://tonto.eia.doe.gov/merquery/mer_data.asp?table=T09.01

Voyage Capesize rates (USD/ton)
(West Australia - China)

Appendix 8

Date	Voyage rate (USD/ton)	Date	Voyage rate (USD/ton)
Jan-99	2.6	Mar-02	4.30
Feb-99	2.6	Apr-02	4.40
Mar-99	3.55	May-02	3.85
Apr-99	3.55	Jun-02	3.75
May-99	3.55	Jul-02	3.50
Jun-99	3.55	Aug-02	3.65
Jul-99	3.35	Sep-02	4.40
Aug-99	3.35	Oct-02	5.50
Sep-99	4.25	Nov-02	5.60
Oct-99	5.5	Dec-02	6.20
Nov-99	5.55	Jan-03	6.40
Dec-99	5.4	Feb-03	6.70
Jan-00	5.10	Mar-03	7.55
Feb-00	5.35	Apr-03	8.05
Mar-00	6.75	May-03	8.55
Apr-00	6.80	Jun-03	8.30
May-00	6.55	Jul-03	8.05
Jun-00	6.10	Aug-03	8.55
Jul-00	6.30	Sep-03	9.25
Aug-00	6.45	Oct-03	16.45
Sep-00	6.80	Nov-03	17.55
Oct-00	7.00	Dec-03	18.30
Nov-00	7.05	Jan-04	19.90
Dec-00	6.55	Feb-04	18.30
Jan-01	5.80	Mar-04	15.15
Feb-01	5.45	Apr-04	12.75
Mar-01	5.55	May-04	10.80
Apr-01	5.25	Jun-04	10.80
May-01	5.20	Jul-04	12.90
Jun-01	5.15	Aug-04	15.9
Jul-01	4.30	Sep-04	15.35
Aug-01	3.45	Oct-04	15.95
Sep-01	3.50	Nov-04	19.55
Oct-01	3.35	Dec-04	19.4
Nov-01	3.20	Jan-05	15.35
Dec-01	3.20	Feb-05	15.8
Jan-02	3.20	Mar-05	16.35
Feb-02	3.70		

Source: The Drewry Monthly (Jan 1999- April 2005)