A STATISTICAL INVESTIGATION
OF THE
OCEAN CHARTER MARKET

by

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We accept this thesis as conforming to the
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THE UNIVERSITY OF BRITISH COLUMBIA

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ABSTRACT

Most studies in the area of ocean shipping are descriptive. Certain aspects of tramp shipping have been subjected to empirical analysis, but few authors have been concerned with an objective study of the behaviour of charter rates.

The major purpose of this thesis is to analyse the behaviour of tramp shipping rates over the years 1960 - 1968, and to discover what impact the forces of supply and demand had on voyage and time charter rates during those years.

To accomplish this objective, the thesis is divided into two distinct parts: the first half of the text is confined to identifying the various markets that exist in the shipping industry today. Incorporated with this discussion are pertinent facts and figures that exemplify the changing pattern of vessel ownership within the industry, as well as the impressive growth and diversification of the various facets of ocean shipping.
The second half of the text is concerned with a statistical analysis of tramp charter rates, i.e., voyage and time charters. Monthly data were gathered on several variables of supply and demand in the shipping industry. The relationships between these variables and charter rates were examined in four distinct categories:

1. between the various categories of rates, i.e., voyage, time and tanker rates.
2. the relationship between laid up tonnage and charter rates.
3. the relationship between charter rates and the various stages of activity in the shipyards, i.e., ship ordering, ship launching and ship completions.
4. the relationship between the demand for shipping space, as indicated by world sea trade, and charter rates.

A number of hypotheses concerning the economic behaviour of charter rates with respect to these variables were formulated and tested by means of a series of multiple regression models to determine whether these hypotheses could be accepted or rejected.
Initial tests produced what appeared to be some significant results. However, these proved to have high autocorrelation in the residuals. Following more rigorous testing to remove the autocorrelation, the relationships broke down and the hypotheses had to be rejected.
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CHAPTER I

INTRODUCTION

PURPOSE OF THE STUDY

The main purpose of this study is to explore, analyze, and attempt to isolate some of the underlying causes for the fluctuations in tramp shipping rates during the period 1960 - 1968. To achieve this goal, it is necessary to review the basic structure of the tramp shipping industry and then to test empirically hypotheses about the operation of the charter market. An attempt will be made, using a multiple regression analysis, to determine the impact of supply and demand variables on charter rates. If significant relationships are found, it may be possible to suggest policies or procedures appropriate for management responsible for vessel chartering.

IMPORTANCE OF THE STUDY

The most obvious feature about freight rates in the shipping industry is their violent cyclical nature. This is especially true in the tramp shipping market for reasons which will be discussed later but it is also true to a lesser
degree in all shipping markets. This fact has led to many controversial discussions among authors in the shipping area as to the causes of these fluctuations. Often they are attributed to the international nature of shipping and its consequent lack of government controls and regulations. Discussions concerning national fleets, subsidies, cargo preference and rate discrimination are ubiquitous in any literature written on the subject. However, to the knowledge of the writer, there has never been a unanimity of opinion except in a very general way. Specifics are avoided, and the subject is usually dismissed as being of an academic rather than of a practical nature.

This is not the case however. Apart from the insignificant amount carried by commercial aircraft, international trade is practically all performed by ships. The sheer size of the world fleet is intimidating: over 22,000 ships totaling 275 million deadweight tons and on order there is a massive investment of almost 100 million tons.¹ What is determining the size of the world fleet? The answer is trade

¹ "Factors Influencing the Size of World Fleets", Shipping World and Shipbuilder, November 1969, p. 1544.
and the expectations of trade to fill these ships. Dry cargo movements have been increasing at an annual rate of about 7 to 8 percent during the 1960's; oil movements at a somewhat higher rate of about 9 to 10 percent. To meet these rates of growth, the dry cargo fleet has been expanding at some 5 to 6 percent per year and the tanker fleet at about 8 percent.

The point of all of these statistics is to impress the fact that shipping is a big business. And, as in any other business, the chief objective of the shipowner is to make a reasonable profit and the chief objective of a shipper is to arrange for his products to reach the market at the lowest possible cost. Therefore, nothing could be more practical from the point of view of a shipowner or a shipper than a better understanding of the nature of ocean shipping rates and the factors that influence the level of shipping freights charged. For to operate within some defined objectives, users and sellers of shipping services must be able to plan for present and future activities with some degree

2 Ibid.
3 Ibid.
of certainty. To do this, some indication of the present and future behaviour of freight rates would be beneficial.

Theoretically, freight rates in the shipping markets, like any other prices, are determined by the forces of supply and demand. Unfortunately, too little is known in a statistical sense about the exact relationship between the supply and demand of shipping as a whole, or even of shipping of particular types of commodities on particular routes. But the drastic fluctuations of freight rates suggest that the problem of adapting the supply of tonnage to the demand for shipping space is one of singular difficulty.

A close examination of the shipping industry suggests that this may be attributed to several factors. The first is that, at least until recently, the period between the decision to order a ship and the delivery has been so long that the bloom, as it were, has worn off the boom. A decision not to build, because of a depression, tends to have little effect because in any large-scale system there is always a hidden extra capacity which can be brought into use in an emergency, as the Suez situations of 1956 and again in 1967 clearly demonstrated of shipping.
The second is the great difficulty of estimating the direction, volume and character of international trade flows consisting of large number of separate commodities moving on a particular route. It is possible, allowed a liberal use of assumptions, to predict the range of fluctuations in international trade as a whole. It is also relatively easy, given such a prediction as the main assumption, to calculate a change in the pattern of maritime trade in a particular product, though the reliability of such estimates may be subject to question. Though international trade, as a whole, is carried in ships, this is becoming increasingly irrelevant to the problem of balancing the availability of a particular type of ship for the particular trade for which they are built.4

A third reason for the difficulty of adapting supply to demand is that shipping has increasingly become a prestige instrument in which ships are built not to carry cargoes but to fly flags. Finding them expensive as mere flagpoles, the

4 This is exemplified particularly in the area of tankers which periodically infringe on tramp trades in the carriage of grain.
owners then contrive a variety of artificial arrangements to divert cargoes from fleets that were built on the assumption that these cargoes would form part of the load factors which justified the original decision to build them. In such a situation, oversupply is endemic, and the magnificent mechanism of the market tends to be blamed for a situation for which it does not carry a shred of responsibility.

There is a fourth reason why the shipping industry (and with it the shipbuilding industry) has been unusually vulnerable to economic pressures. It might be assumed that the greater the complexity of the environment within which it had to operate, the greater would be the efforts these industries would make to assess at least those elements in the situation which are predictable or ascertainable. One might expect, for example, a keen, critical, and continuing analysis of the patterns of trade on particular routes, and of the pattern of the shipbuilding industry's order book -- a unique expression of the collective judgment of the world's shipowners -- to be undertaken by every large-scale unit in the industry. From this analysis, shippers and owners might attempt to assess the impact that their findings may have on
the interacting forces of supply and demand in the industry. From the facts gleaned from such an analysis, it may be possible to speculate on future activities in the shipping markets as a whole or even in specific areas or on specific routes.

Unfortunately, there is an element of paradox in analysis in the latter case, because in industries such as shipping, activity fluctuates more or less proportionately to economic activity as a whole. This fact alone practically negates any efforts to make sensible predictions on the basis of the data gathered from any particular area of activity. This is so because of the fact that a high proportion of the industry's earnings are obtained in cross trades where prosperity may bear little or no relation to the level of economic activity in the country of origin of any specific trade. The Canadian-Chinese grain trade may well slump for reasons which no one could anticipate. Moreover, the direct import and export trades between Canada and second countries are subject to many influences outside Canada's economy. A drought or a blight in some of the South American countries can affect the import trades as much as an earthquake in
Chile or a change of government in Ceylon can affect the export trades.

Though it is true that in a world-wide trading system, many of these influences tend to cancel each other out and may, in total, be predictable over a sufficiently long period, it is not possible to predict which sector of shipping is the next to be affected or what scope there will be for effective redeployment of the resources involved in each case. When attempting to predict any future level of activity in any market, a forecaster likes "other things" to remain equal. They seldom do. As a consequence, attempts at prediction or forecasting are often stymied by the recalcitrant sectors of the economy which tend to upset calculations.

It would be tempting to conclude from this argument that the shipping industry should be excluded from "sensible" attempts to forecast any future activity or indeed to peer ahead in an attempt to estimate which direction shipping freights will move or the magnitude of their fluctuations. However, the right conclusion should be the exact opposite of this. Shippers and owners alike are still faced with the
problem of making investment decisions in either capital goods, or a budget of resources for future periods to continue with their own operations. In such a situation, efforts should be extended in an attempt to broaden and improve the quality of the "stream of relevant fact". For any industry, and shipping is no exception, must benefit from the enlargement of understanding and the exchange of information.

With these thoughts in mind, and recognizing the grave dangers of the undertaking, the writer feels that any attempt at analysing freight rates in the shipping market may help in improving the availability of information in this important field.

If one looks at the tramp shipping market pragmatically, there are certain relationships that exist intuitively by the interaction of supply and demand variables. Among these are the following:

(a) The volume of laid up tonnage should vary inversely with the level of freight rates.

(b) The volume of ships completed and ships ordered should bear a close relationship to the level of rates; the former of course should correlate
more closely in a time lag situation than would the latter due to the lead time required to build vessels. In times of rising rates, the increase in vessels ordered should bear a close relationship to the increase in rates.

(c) Fluctuations in the amount of world trade should relate closely to the fluctuations in freight rates.

One could continue with this list *ad infinitum* but the few examples given are sufficient to suggest many more relationships that exist in the shipping market. However, any literature written on this subject seems content to dismiss these relationships by suggesting that they exist and making no effort to supply more precise information.

This study then will be very modest in its intention. It is proposed to test empirically the relationships between different variables of supply and demand in the shipping market based on the hypothesis:

"Fluctuations in shipping rates in the tramp shipping industry can be explained by the use of multiple regression models incorporating details of the supply of and demand for shipping space."
From the results of this analysis, it is hoped that some conclusions can be drawn as to their applicability to decision making in the economic problems in the shipping industry.

LIMITATIONS AND SCOPE OF THE STUDY

A major problem encountered in writing a paper on ocean shipping rates is in deciding which information to include and which to leave out. Many factors require consideration; certain information is essential if the finished product is to be of any significance, but beyond that, one has to strike a delicate balance in deciding what additional details to provide in order to present a comprehensive picture of ocean shipping and still keep the paper within manageable proportions.

It is obvious that tankers, cargo liners and tramps are inextricably interwoven when ocean transport is considered. One cannot be studied without considering the others, and yet each is worthy of individual examination. In an effort to be somewhat specific, the decision was made in planning this paper to restrict the area of study to that of tramp shipping, or more specifically to a study of the
volatility of shipping rates in the open tramp market.\(^5\)

Unfortunately, in this, as well as in any other area of ocean shipping, there is a paucity of statistics available. This fact contributes greatly to the limitations of the study. First, data on shipping rates for the years under study are available only for the tramp market in the dry cargo trades, thus the irrevocable choice to limit the study to the open tramp market. Secondly, the data must be procured from secondary rather than from primary sources. The validity of secondary data is sometimes subject to question; however, the disparity between data in various publications should not be great enough to influence any of the results obtained. Thirdly, data are not available for one of the major contributory factors to fluctuating tramp shipping rates: the length of haul. This variable naturally indicates the ton-mile performance of tramp vessels and is a variable which obviously affects both the supply and demand of shipping. As the length of haul increases, not only does demand increase, but so also does output.

\(^5\) See Chapter II for an explanation of the "open tramp market."
Another source of concern was in finding a proxy to use to measure the fluctuations in freight rates. U.N.C.T.A.D. defines a freight rate as the price paid for the carriage of an item of merchandise such as a ton of iron ore or wheat, a crate of china or a piece of machinery. In addition, they point out that in the tramp market alone there are several basis on which the concept of "freight rate" can be applied: the rate per ton for the tramp on voyage charter (which, however, is affected by the relation between the size of the consignment and the deadweight of the vessel) and the rate per deadweight ton for the time chartered vessel. Besides these differences, there are those arising from differences relating to the party bearing the cost of loading and discharging and of cargo insurance. It is obvious that the time charter rates would never include these costs whereas the tramp voyage charter rate may or may not include them; it may, for example, exclude all such costs or it may include the costs of loading, but not the costs of discharging; it may not cover the costs of loading but may cover the costs of trimming, may cover discharging but exclude loading,

and so on.

As can be seen from the above, the term freight rate is loosely applied to a number of different arrangements in the tramp shipping market. As a consequence, the comparison of actual rates ruling in different markets, assuming that these could be obtained, is difficult. For the purpose of this study, interest is not in freight rates per se, but rather in the variations in freight rates over time. Thus published freight indices were chosen to act as a proxy for freight rates.

Today there is a plethora of index numbers regularly calculated to depict freight rates and their movements. For the purpose of this study, two of the major indices will be used; those calculated by the United Kingdom Chamber of Shipping and those calculated by the Norwegian Shipping News.7

It must be pointed out that index numbers provide a measure of changes in tramp shipping freights; it does not measure directly the level of earnings, still less does it

7 See Appendix A for an explanation of the construction of these indices.
measure profit or loss. In addition, a certain degree of caution is needed in interpreting the evidence on freight movements as presented by freight rate indices. This is not the place to enter into a statistical discussion of the merits of index numbers, but it should be borne in mind that any index number is an average based on a pre-determined weighting pattern. For any particular year the weighting shown by the indices need not correspond at all closely with the cargo movements recorded. This is simply the inherent limitation of the statistical device.

**INTRODUCTION TO THE TEXT**

Following this introductory chapter in which the importance of the problem has been outlined, Chapter II attempts to provide the reader with a short outline of the shipping industry in general with specific reference to the tramp shipping industry. More specifically, the Chapter shows that the industry is not a single market, but rather a combination of related markets with complex relationships between them.
Chapter III provides some insight into the forces of supply and demand which operate in these markets and which have distinct bearing on the level of freight rates which will prevail at any given time in the tramp market.

Chapter IV and V present an account of the empirical testing of the statistical data which has been gathered and tenders an analysis of the results obtained through the testing techniques employed.

Several related studies in the field of shipping rates have been attempted over the years and these are outlined briefly in Chapter VI. The results reported in these studies are examined in the light of the results obtained through the empirical testing attempted and reported in Chapter IV of this thesis.

Chapter VII presents a brief summary of the study with some suggestions for further research in the area.
CHAPTER II

IDENTIFICATION OF SHIPPING MARKETS

INTRODUCTION

A prerequisite to any analysis is a thorough knowledge of the factors relevant to the functioning of the industry under study. In the shipping industry this is essential because of the complex nature of its operations. As a prelude to the analysis of the specific area of tramp shipping rates, several preliminary parameters must be considered. First, the various shipping markets must be identified. Following this, the forces which are at work in these markets must be identified. Having defined these parameters, the procedure becomes one of examining the relationships between these identified market forces which in turn will hopefully lead to conclusions about the behaviour of tramp shipping and offer support to the original hypothesis as stated.

SHIPPING MARKETS

Broadly speaking, ocean shipping breaks down into three separate and fairly distinct types of markets:
1. the oil tanker freight market
2. the dry cargo liner freight market
3. the dry cargo bulk freight market

The delineation of these markets ends in name only however, since it should be emphasized that few, if any, of the trades in one market are immune to potential competition from other markets. Thus an effective link is established between the freight rates existing in one market with those in another.

1. THE OIL TANKER FREIGHT MARKET

A cursory examination of Table I indicates that the largest part of total world seaborne trade since 1960 has been in the carriage of oil. To meet this demand, the size of the world tanker fleet has increased rapidly, and its growth over the last few decades has been little short of phenomenal. In 1913 the gross tonnage of the world fleet of tankers was about 1.3 million tons.¹ By 1960 this had

TABLE I

GROWTH OF WORLD SEABORNE TRADE
1960 - 1967

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DRY CARGO millions of metric tons</th>
<th>OIL millions of metric tons</th>
<th>TOTAL millions of metric tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>540</td>
<td>540</td>
<td>1,080</td>
</tr>
<tr>
<td>1961</td>
<td>570</td>
<td>580</td>
<td>1,150</td>
</tr>
<tr>
<td>1962</td>
<td>600</td>
<td>650</td>
<td>1,250</td>
</tr>
<tr>
<td>1963</td>
<td>640</td>
<td>710</td>
<td>1,350</td>
</tr>
<tr>
<td>1964</td>
<td>720</td>
<td>790</td>
<td>1,510</td>
</tr>
<tr>
<td>1965</td>
<td>770</td>
<td>870</td>
<td>1,640</td>
</tr>
<tr>
<td>1966</td>
<td>800</td>
<td>960</td>
<td>1,760</td>
</tr>
<tr>
<td>1967</td>
<td>810 (1)</td>
<td>1,050 (1)</td>
<td>1,860 (1)</td>
</tr>
</tbody>
</table>

(1) Provisional

increased to over 40 million tons,² and by 1968 stood at 69.1 million tons or about 36 percent of the total world fleet.³

Moreover, the increase in the overall size of the tanker fleet was matched by the increase in the size of the tankers themselves. In 1947, the average tanker was one between 12,000 and 16,000 deadweight tons.⁴ Since 1947, the size of the tankers has developed so rapidly that today vessels with deadweight tons far in excess of that are no longer exceptional. Lord Geddes, President of the United Kingdom Chamber of Shipping, expresses this growth succinctly:

"Tanker companies are among those who have pointed the way with their giant carriers. Last year, a 312,000 - tonner docked at Bantry Bay and ships of 200,000 tons will soon become commonplace...there is an obvious saving when ships of this magnitude carry crude oil on the long voyages around Africa, replacing up to 10 voyages by smaller vessels"⁵

³ Ibid.
⁴ McCaffrey loc.cit.
It is the latter part of this statement that sets the stage for the overlapping of this tanker market into the field of tramp shipping. This occurs because of the nature of the ownership and operation of the world tanker fleet. Basically, the tanker fleet can be divided into three groups:

1. tonnage owned and operated by oil companies which amounts to approximately 35 to 40 percent in terms of dwt capacity of the total tanker fleet.

2. vessels owned by private shipping firms, but hired to oil companies for periods that cover all or most of the ship's useful life. This tonnage is approximately 40 to 45 percent of the world's tanker deadweight capacity.

3. tankers owned by private shipping firms and owner-operated in the spot market as tramps for single voyages or for a few consecutive voyages or time chartered to oil companies for short periods.

Groups 2 and 3 as listed above contain practically all of the large tankers which are now in service since these large ships generally do not operate under free market conditions. The obvious advantage in operating costs is with the large tanker, quick, highly automated and run by a small crew. As a consequence, in times of receding demand in the oil trade, many smaller tankers - as listed under 3 above - can find no oil to carry. However, they can carry grain - not so conveniently perhaps, but at a loss less than they would incur by laying up. Thus, in these bad times, these tankers enter the grain trade - one of the staple trades of the tramps. Theoretically, this action should result in an oversupply of vessels plying the grain trades, with resultant pressure placed on the level of tramp freight rates in both the very short run (in spot or voyage charter rates) and in the slightly longer run (the time charter market).

Infringement of the oil tanker freight market on the dry cargo freight market does not end here however. Recent

7 U.N.C.T.A.D. op. cit. p. 21
technology has evolved a new type of combined ship classed as an "OBO" vessel, the initials standing for ore/bulk/oil. "This type of ship first appeared in 1964, when two 54,000 tonners were built. The principle here is to utilize the entire hold capacity for either solid or liquid cargoes, employing a hermetic method of sealing hatch covers when carrying liquids. These ships overcome the limitations on employment of ordinary tankers or ore/oil ships, since they are able to transport full cargoes of crude oil or any of a wide range of commodities."8

Given the versatility of this type of vessel, it can be seen that in periods of slow demand in the oil trade, these vessels can easily be converted to compete in the movement of bulk commodities, traditionally the domain of tramps and bulk-carrying vessels. This overlap might also create some disturbing influences on freights in the dry cargo bulk market.

2. THE DRY CARGO LINER FREIGHT MARKET

The dry cargo trade is now handled by three types of ships: liners, tramps and bulk carriers. For the moment, consideration will be given only to liners and tramps. The

8 Ibid p. 23
distinction between a liner and a tramp may be a physical one, in the sense that liners are often more elaborately equipped than tramps, but the most important distinction is commercial and depends on the type of commercial arrangements under which the ship is operated.9

One way to define dry cargo liner shipping is to say that it is carried out by vessels which make regular sailings out of definite ports and which play a fixed route. An equally important distinction of liner shipping is the fact that the cargoes carried are generally of a heterogeneous nature which do not lend themselves to shipments by tramp vessels or by industrially-owned fleets. In effect, liners consolidate the traffic of many shippers and charge fixed and fairly stable rates for their service.

Obviously, the cargo liners experience competition within the framework of liner operations. However, in most instances they are able to control this competition. One of the most successful methods they employ is the establishment of freight conferences. A freight conference, in

9 Ibid. p. 2.
simple terms, is an association of shipowners who make an agreement between themselves to regulate the terms and conditions under which they will operate in competition with each other.

This arrangement leads one to the conclusion that the dry cargo liner market operates autonomously and is not subject to competition from other markets or indeed, by the very nature of the cargo that liners carry, they themselves would not undertake to infringe on any other market. This is not so. Under several conditions, cargo liners operate in direct competition with the tramp market.

The general nature of the operation of cargo liners and the high stowage factor of the general cargo that they carry implies that the ship's carrying capacity is seldom utilized. However, once the ship is committed to sailing, there is very little difference in sailing with an empty ship or a full ship. It is this characteristic which has prompted cargo liners to carry a wide range of tramp-type commodities out of necessity rather than a desire to do so. In many cases, bulk materials are taken on to fill up the ship, especially the lower holds because these spaces are not
suitable for the more delicate classes of cargo, or, more likely there is not enough other cargo to constitute a full load.  

Due to the fact that rates on tramp cargoes are more flexible than those applying to pure liner cargoes, in such instances the commodities referred to are carried by the liners at "open rates".

Fisser suggests two other possibilities of the liner trade encroaching upon the domain of tramp shipping:

"First of all, many liner companies maintain a park of reserve vessels, which can be placed into service following the demand without being dependent upon unstable rate structures of the time charter market. These reserve fleets consist mainly of high-class tonnage, which during periods of reduced intensity of the liner trade will try to find employment on the free market, thus competing with tramp operations for cargo at a moment at which the demand for tramp tonnage is already slackening on account of the declining time charter demand....Moreover, liner companies will contract the transport of large scale bulk shipments, distributed over a longer period of time, in order to obtain a long-term security of minimum employment, necessary for the maintenance of a regular service."

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10 Ibid. p. 29.

11 When a rate is "open" it means that no rate is specified in the rate schedule for the cargo item concerned and the rate in question is fixed freely between the liner operator and the respective shipper.

A logical result gleaned from the above is that in such trades tramp shipping has to keep its rates at rock bottom, if, considering the slower type of transport, it wants to remain competitive.  

These few examples suggest that tramp ships are always open to competition from liner companies. Most liner companies, however, maintain that they are not deliberately in competition with tramp shipping, although it is inevitable that their spheres of activity overlap to some extent. Regardless of their intentions, liners do exert a definite pressure on tramp shipping rates in such instances.

On the other hand, and for quite another reason, the operations of liner and tramp shipping interact with each other. Since liner companies operate on fixed schedules and under certain conditions offer incentives to shippers for

13 Ibid.

exclusive freighting rights,\textsuperscript{15} there are periods of peak demand that the liners are unable to cope with. Tramp shipping becomes a necessary complement to liner trades in these cases which oblige this trade to employ tramps on time charter, in order to be able to meet the requirements expected to be fulfilled by this trade in some traffic areas.\textsuperscript{16}

3. THE DRY CARGO BULK FREIGHT MARKET

The character and nature of the dry cargo bulk freight market have changed considerably in the last few decades. To understand the relationships fully as they exist in today's market, a brief resume of the changes that have taken place in this area would be of benefit.

Traditionally, the ships operating in this market were all tramp ships. In essence the tramp ship was prepared to carry any cargo between any ports at any time. A definition of the vessels used and the nature of their operations is succinctly expressed by Fisser:

\textsuperscript{15} In order to control the competition of lines which are not members, the conferences sometimes establish a system of dual rates under which shippers of cargo who reserve their shipments exclusively to the ships of the members of the conference receive lower freight rates than shippers who use shipping lines which are not members of the conference.

\textsuperscript{16} Fisser, \textit{op. cit.} p. 27.
"A tramp ship may be defined as a vessel, mostly of medium size and without any special purpose equipment, not engaged in regular trade but following cargo wherever it is offered at the most favorable conditions, i.e., not adhering to a fixed route, she will touch only profitable ports...."\(^{17}\)

The ultimate in precise attempts at definition was reached in certain British legislation which detailed closely the specifications which could and could not be admitted to the class of tramps. It concluded:

"...a tramp voyage is one in the course of which all the cargo is carried under charter party."\(^{18}\)

It is this phrase rather than the details which is really significant for our purposes. This will become clear when we discuss the different commercial arrangements under which the dry bulk cargo is handled.

The service performed by these vessels consisted of transporting bulky goods of low value, such as ore, coal, grain, etc., under conditions where speed was a much less important consideration than cheapness of transport.

\(^{17}\) Fisser, *op.cit.* p. 5.

\(^{18}\) British Shipping (Assistance) Act, 1935.
When the amounts of global traffic of bulk commodities was insignificant, this type of tramp vessel was entirely adequate. However, overall increases in the annual shipment of these bulk commodities, and increased competition in international markets for the sale of these commodities, prompted some new thinking on the part of shipowners and users of shipping services on the problem of transporting enormous quantities of this relatively low cost merchandise over great distances. A partial solution became one of reducing the costs of sea freights and cargo handling charges.

More specifically:

"Prior to 1939, and indeed for more than another decade, sea freights did not weigh heavily in the calculations of dry cargo charterers.... By and large, users did not criticise the types of vessels put before them by shipowners. They grumbled about high freights in short-lived booms and enjoyed the low rates prevailing in the far longer periods of recession which followed. But neither the charterers nor the shipowners made any effort to devise means by which freights could be permanently cheapened, with no sacrifice of seaworthiness in ships, and still leave their owners a profit."19

As a consequence of this new thinking, researchers in the shipping industry began exploiting the economies of increasing ship size and carrying capacity, and in the early 1950's the age of the bulk carrier arrived.

"Until this time the norm of tramp ships engaged in lifting bulk cargoes was around 9,500 tons deadweight. This was the size of the 'Liberties' and the 'Empires' built during the Second World War. The first vessels to be dubbed as bulk carriers were half again as big as the 'Liberties' and in a very few cases venturesome shipowners placed orders for 20,000 tonners."\(^{20}\)

Since this early beginning, the increase in the size of bulk carriers has been little less than phenomenal. According to "Fairplay", at the middle of 1968, dry bulk carriers of over 150,000 tons had been ordered or delivered.\(^{21}\) Admittedly, it is somewhat loose terminology to use ship capacity as the sole criterion for defining a bulk carrier. The term could be applied with equal justice to any vessel capable of being rapidly loaded or discharged when carrying homogeneous bulk cargoes - which would include many of the modern tramps. But for the purposes of this study, a bulk

\(^{20}\) Ibid.

carrier will be considered as a larger-than-ordinary ship which charterers hire in the expectation of paying lower freights.

Most important however, is in the fact that the advent of the bulk carrier in the dry cargo bulk market has had significant impact on the absolute amount of cargo which was traditionally lifted by the conventional tramp ship. An examination of Table II permits an assessment of the impressive growth of bulk carrier employment in the main bulk trades.

The tremendous upsurge in the size and carrying capacity as exhibited by the bulk carrier has led some authors to suggest that the death knell has been sounded for the conventional tramp ship as it exists today. Bes believes that its days are over. He is supported by the action of the Court Line who, in 1962, disposed of their general purpose tramp fleet to go in for bulkers and tankers, although these are sometimes let on voyage charter in the spot market, which

TABLE II

SHIPMENTS OF SIX MAJOR BULK COMMODITIES

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Tonnage Shipped</th>
<th>Transport Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>million tons</td>
<td>1,000 million ton-miles</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>BULK CARRIERS</td>
</tr>
<tr>
<td>1960</td>
<td>233</td>
<td>65</td>
</tr>
<tr>
<td>1961</td>
<td>244</td>
<td>83</td>
</tr>
<tr>
<td>1962</td>
<td>251</td>
<td>104</td>
</tr>
<tr>
<td>1963</td>
<td>274</td>
<td>131</td>
</tr>
<tr>
<td>1964</td>
<td>315</td>
<td>170</td>
</tr>
<tr>
<td>1965</td>
<td>336</td>
<td>196</td>
</tr>
<tr>
<td>1966</td>
<td>349</td>
<td>218</td>
</tr>
<tr>
<td>1967</td>
<td>361</td>
<td>248</td>
</tr>
</tbody>
</table>

brings them under our definition of a tramp. 22

On the other hand, other authors 23 feel that bulk carriers have already fairly well caught up with the facilities of the world's harbours, and this is undoubtedly the factor that will provide an effective brake to their development. It is certain that the deadweight of bulk carriers could be increased at the same pace as that of tankers, but this would prove far in excess of the overall rate for the expansion of ports and facilities. From this, economic unbalance would quickly be induced by a restriction of the fields of operation.

Thus, since dividends are of paramount importance to shipping companies, idealism must be tempered with practicability. It is a fair assumption that the medium sized tramp vessel will fit the bill for years to come. This assumption is reiterated by Cufley who is adamant in his


defense of the general purpose tramp. 24

COMMERCIAL ARRANGEMENTS IN THE DRY BULK CARGO FREIGHT MARKET

Accompanying this change in the physical make-up of the dry bulk cargo fleet is the change in commercial arrangements under which dry bulk cargo now moves. To aid in the understanding of the analysis which follows in Chapter IV, it is important that the distinction between these contractual arrangements be understood.

Today, the dry cargo bulk freight market can be divided into several sections with the following broad groups being identified:

1. Direct Ownership
2. Negotiated fixtures*
3. Open Market fixtures

U.N.C.T.A.D. presents a comprehensive discussion about the distinction between these commercial arrangements:


* "Fixture" is a standard term used to describe a chartering contract.
"The factor determining whether a fixture is arranged through the open market or is negotiated is largely the length of time which it is to cover. At one extreme, a fixture for a single voyage from A to B is almost invariably arranged in the open market. At the other extreme, a charter for twenty years is always a matter for negotiation between the prospective charterer and the shipowner. Between these two extremes, it can be said that any fixture for less than one year is likely to be arranged through the market, while anything for a period of three years or more is almost certainly arranged by negotiation. Fixtures of between one and three years may be arranged in either way. Most fixtures, however, tend to be either under one year or over three years, with relatively little in between. It is therefore convenient in exposition to treat open market fixtures as covering everything under one year and negotiated fixtures as covering anything over three years."  

Using this discussion as a criterion for segmenting the dry cargo bulk market contractually, one thing is apparent. Chapter I alluded to the paucity of statistics available which in turn limited this investigation of the tramp shipping market to two types of vessel chartering: voyage charters (on a trip or spot market basis) and time charters (consisting of fixtures not exceeding the period of one year). As a consequence, interest in the bulk cargo market is with the group defined above as "open market fixtures". Nevertheless  

it is important to consider the relationships between these 'sub-markets' markets within the totality of the dry bulk cargo freight market.

1. **DIRECT OWNERSHIP**

In the dry cargo market, direct ownership of vessels is most prominent in trades such as meat and fruit where ships are generally regarded as liners rather than tramps. However, in certain cases such as the ore and sugar trade, some companies find that the extent of their trade in these dry bulk commodities warrants direct ownership of vessels.

If all journeys by these vessels are for outward trade, then theoretically a back haul of commodities for the inward journeys would be desirable as opposed to a return voyage in ballast. This arrangement would result in two things. First it would decrease the overall cost of the transport of the commodities thereby enhancing the competitive pricing position of the company's products. On the other hand, it would decrease the amount of cargo

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available for vessels operating in the open market. Since any remuneration above the operating costs of the vessel would be advantageous, the rates charged under such arrangements could well be below the prevailing spot rates for similar contracts by vessels operating in the open market. The assumption is that this would create a downward pressure on open market rates under these conditions.

Unfortunately, no authority can be found to substantiate this assumption, and it may be that speculation in this respect is unfounded. Regardless, even if no back hauls are contracted by these ships, they have indirectly reduced the amount of bulk cargo available for tramp liftings and this may have bearing on the prevailing rates in the open market.

2. NEGOTIATED FIXTURES

Negotiated fixtures in the dry bulk cargo market flourished with the introduction of bulk carriers and highly specialized vessels. The advantage of these long term arrangements to both shipowner and charterer is their security and stability -- the shipowner knows that his ship will be
earning for the period of the charter and the charterer knows that his shipping needs will be met. This aspect is especially crucial in the case of highly specialized vessels since "... the risks of operating in the short term market are such that shipowners will rarely, if ever, build such a vessel unless they have a contract or charter of sufficient length to enable them to amortize the capital cost of the vessel. Such a vessel would then likely to enter the short term market only for the residue of its active life beyond the amortization period." 27

The open market, or short term arrangements do not remain unaffected by these long term charters. The two are intimately related because it is obvious that in many (except the highly specialized) trades, the alternative to both charterer and shipowner to a long term arrangement is a series of short term arrangements. This decision is closely related to the long term casts and expectations of both shipowner and shipper. Therefore, the supply of ships available and competing in the open market may depend to a great extent on the judgment of these people. Either

27 Ibid, p. 41.
decision will directly affect the level of rates that will prevail at any given time in the open market.

3. OPEN MARKET FIXTURES

The mechanics of the open market are far more complicated than those for negotiated long term arrangements involving only one shipowner and one charterer. The open market embraces the aggregate at any given time of tramp shipowners seeking employment of their vessels and shippers requiring the services of tramp ships for a limited period. We have intimated that there is great interaction between this open market and the other identified markets of shipping. This statement can best be exemplified by observing the related operations of the open market. Cufley outlines these operations admirably when he lists the functions of tramp ships: 28

1. To provide shipping space for all commodities whose movements cannot be predicted with accuracy.

2. To transport marginal tonnage requirements in respect of those commodities where the bulk of

28 C.F.H. Cufley. "The Ideal Tramp..." op. cit. p. 10
the traffic is lifted by integrated or hired fleets.

3. To provide cargo liners with a reserve of space to deal with seasonal and other fluctuations.

4. To offer lower rates than conference tariffs for shipload lots.

5. To provide a pool of shipping available for emergencies.

The importance of this market in the shipping industry cannot be overemphasized however. Even though it would appear that the ships in the open market perform what is sometimes designated as the "skirmish work" of international trade,\(^{29}\) the seemingly aimless wanderings of the vessels employed in the open market are actually planned with great care and foresight. A cargo is always desirable; but some cargoes are more desirable than others, their desirability being dependent to a very large degree on one important feature -- profit. For in this segment of shipping, as in

any other segment, the chief objective of the shipowner is to make a reasonable profit. The amount of profit to be made depends in turn on the freight rate which can be charged for the transport of the commodities. It follows that the prevailing freight rate in any trade will depend on the number of ships vying for that trade and the amount of cargo available for transport. In other words, the interaction of the demand for and the supply of shipping space.

**SUMMARY**

In this chapter we have tried to sketch briefly the underlying market structure of the shipping industry. It is apparent from the discussion that the industry is not concerned with a single market but with several, or many, and this must be kept in mind when we attempt to explain the rise and fall in prevailing market prices (rates). Nevertheless, it should also be remembered that there are so many links and connections between these markets, that a clear picture becomes difficult to draw. When, as is frequently the case, routes of competitors coincide only in particular segments and differ in others, one may even argue that no single market exists.
Notwithstanding these conceptual difficulties in isolating the markets in the shipping industry, we have laid the groundwork for an investigation of the forces of supply and demand at work within these markets which we have stated are instrumental in determining the level of shipping rates that exist at any given time. It is these forces and the relationships between them which we will attempt to identify in Chapter III.
CHAPTER III

THE FORCES OF SUPPLY AND DEMAND IN THE SHIPPING MARKETS

INTRODUCTION

Taking as a point of departure the premise that the level of rates in the shipping markets are determined by the interaction of supply and demand, the objective of this Chapter is to identify the forces at work in the market which are likely to exert pressure on the demand for shipping space and the supply of vessels. Specific reference will be made to the tramp or open shipping market, but, as has been argued previously, all of the shipping markets are related, and therefore in many cases, the discussion can be applied equally well to segments of the other markets of the shipping industry.

One more important qualification must be made. Interest in this study is with the fluctuations in shipping rates, and since "... the demand for the supply of vessels to the open market fluctuates in the short run, charter rates in the open market also fluctuate within wide limits. Rates
in the long term market are much more stable and less subject to variations arising from short term movements in demand conditions.\(^1\) Consequently, the area of concern in this chapter will be restricted to the short run. However, it must be remembered that the operations of the long term market will have distinct bearing on rates in the short term e.g. the incidence of long term chartering of vessels.

Part of the difficulty here involves the time dimension — the delineation between the long and short run. For the sake of analysis we can define the long run as a period of time sufficient for new tonnage to be built and delivered. In this respect, the short run will be confined to periods of less than one year "because ships have a long period of gestation -- from 12 to 18 months...."\(^2\). This will also bring the discussion within the parameters of voyage and time charters as previously defined.

\(^1\) U.N.C.T.A.D. op. cit. p. 3.

At this point it may be worthwhile to set out some basic assumptions about demand and supply. The demand for world shipping is represented by the volume of goods to be carried and the distances over which they are to be carried. We can further surmise that the demand for shipping services is "derived" from the world demand for commodities and products and their world supply. The supply of shipping we can state as being represented by the world fleet, or more specifically, by the volume of unfixed tonnage in the world available for fixing.

ECONOMIC PORTRAYAL OF THE SHORT TERM SUPPLY AND DEMAND FOR SHIPPING

For the sake of exposition, Figure I shows the relationship of the short term demand and supply of tramp tonnage. An examination of the figure shows that the total supply of shipping is inelastic down to a level of low rates. It is at this point of inflexion (the point at which the supply of

3 This argument, including Figure I is taken from S.G. Sturmey, On the Pricing of Tramp Ship Freight Service Bergen: Institute of Shipping Research, 1965, pp. 5 - 9.
shipping changes from elastic to inelastic) that the "lay-up rate" is encountered. Below this lay-up rate the supply is more elastic and it is this elasticity which prevents rates from falling catastrophically. Even in the deepest of slumps rates cannot fall below the lay-up rate of the ship with the lowest voyage costs per ton unless they fall to a level at which no trade takes place. Lay up of ships will be touched on below but it will suffice to merely show the shape of the supply curve at this point.

The level of freight rates at any one time is given by the intersection of the short term demand and supply curves in terms of commodity ton/miles. When demand is high (for example $D_1$, $D_1$) as shown in Figure 1, the demand curve crosses the supply curve in its inelastic range.

Although the lay up of ships will be touched on later, the "lay-up rate" can be defined here as the rate at which it pays a shipowner to lay up his ship rather than continue it in service. It may be represented as the costs which would be incurred by operating the vessel (and hence avoided by not operating) minus the costs of laying up. The lay-up rate for each ship is different, depending on the costs of operation of the ship concerned. On old ships the lay-up rate is generally higher than on new ships, since the older ships are usually less economical to operate in terms of fuel costs and repair bills. Hence, in a period of falling rates it is the older ships which are the first to move into lay up.
FIGURE I

SHORT TERM DEMAND AND SUPPLY OF TRAMP TONNAGE
Any change in demand is largely taken up by a change in price, with little change in the amount of tonnage supplied; quite small changes in demand lead to large changes in freight rates. If demand is lower \((D_2, D_2)\) so that the demand curve cuts the supply curve where it is becoming elastic, changes in demand have a smaller effect on the volume of tonnage supplied. As demand falls \((to \, D_3, D_3)\) the demand curve intersects the supply curve in the range in which the effect on price is reduced and the effects of the amount of tonnage offered by owners is increased. If demand continues to shrink, a point would eventually be reached at which rates could fall no farther and all future falls in demand affect only the volume of tonnage kept in operation.

This short resume serves to explain the existence of the short term demand and supply curves as they prevail on the macro level. However, interest here lies in why they appear in the form that they do and what forces determine where the level of price will be in equilibrium at their point of intersection. A good beginning might be to examine the elasticity of demand.
ELASTICITY OF DEMAND

At any level of demand, there is a certain elasticity with regards to price. As the level of rate varies, so the demand to carry some commodities will vary, though in the short run, the extent of the variation is likely to be small. At any one time the overall demand for carriage may be fairly inelastic with respect to price. This results from the low price elasticity of the goods being transported which are usually basic raw materials. However, in the carriage of many bulk commodities this overall price inelasticity is becoming irrelevant to the problem of balancing supply and demand on certain routes. International competition for many manufactured products which require basic raw materials for production has become increasingly severe. These raw materials include such items as coal, iron and manganese ore, phosphate rock and sulphur. Equally fierce is the struggle for markets on the part of those who supply the manufacturers with these essential raw materials. Grade for grade there is little variation in the nature of these materials in whatever part of the world they are produced.
And given an approximate parity of technological progress in the developed lands, the same applies to the products of manufacturers. In these circumstances, perhaps the only way to get an edge on one's competitors is to cut the costs of sea freights. Thus the combination of sea freights and raw material cost is becoming increasingly important in the choice of sources of supply. Therefore, even though the overall elasticity of demand for the carriage of these primary products may be very low, the demand can very easily shift from area to area, which in the short run or long run will create imbalances between the supply of ships and the demand for shipping space on various routes.

**SHIFTS IN DEMAND**

As an aid to understanding why tramp rates fluctuate, let us consider further these "shifts" in demand. In the tramp market they can occur very rapidly, a fact which can be attributed to two factors: the highly competitive nature of the tramp market and the lack of control of tramp rates.

Emery Troxel suggests that the transport of bulk commodities in the tramp shipping industry shows some signs
of pure competition. To substantiate this statement, he postulates the reason for this is the fact that the supply side of the tramp shipping market is characterised by a large number of firms each consisting of a small number of vessels. And because of the nature of the operation of the vessels themselves of engaging in transport services wherever net returns will be most advantageous, the ships always stand ready to follow locational changes in transport demand.

Consequently, the large number of tramp operators are not usually faced with a few large buyers of their services, since the general "non specialization" of these vessels allows their owners or operators to choose among the many shippers of the various types of merchandise requiring this kind of transportation. In other words, because the tramp operator can in most cases transport grain, as well as coal, fertiliser, sugar, or many other such products, he also faces a competitive market on the demand side.

However, the degree of market competition declines as specialization increases, be it on the supply side or the demand side. Concerning the former, ships are not totally homogeneous, if only because they differ according to tonnage, speed or cargo handling equipment. This differentiation on the supply side affects demand because different routes have varying requirements for vessels of particular speed, carrying capacity or cargo handling equipment, at least within certain limits. To this may be added that on the demand side, once an operator has chosen to handle a particular type of cargo -- albeit the most advantageous to him -- frequently the degree of competition is reduced since the number of shippers of the commodity in question may be small. Then the freight rate charged will, within certain limits, depend on the bargaining power of the parties.

A further aid to the competitive nature of the tramp market is the quick and easy communication of information about the current conditions in all markets. This takes place through the medium of shipbrokers, who with their

extensive network of contact all over the world, bring charterers and owners together; prices which have been negotiated are rapidly circulated so that the tone of the market can be monitored. A very large part of the world chartering in the tramp market is done either in New York or on the Baltic Exchange in London, which perform all the functions of an organized market.

The existence of a market and of brokers is not sufficient to ensure that the market will behave in a perfectly competitive way. This is helped by other considerations. Neither exit nor entry into the tramp market is restricted in any way. Concerning the former, it is the "mobility" of the ships themselves which allows them to move easily out of one market to seek cargo in another. The latter is unhindered by any insurmountable economic or financial considerations since the vessel is actually the firm, under the jurisdiction of the captain for most of the time and supervised only loosely by head office. In addition, and because of the international nature of tramp shipping, the market is unhampered by any type of regulation or

artificial price controls\textsuperscript{8} which would tend to distort the competitive environment.

The foregoing suggests several reasons why freight rates in the tramp market are able to fluctuate so rapidly. It remains now to identify and investigate some of the forces of demand and supply that cause these rapid shifts and imbalances to occur.

\textbf{FORCES OF DEMAND}

The demand for ships depends on the state of world trade, since, as has been mentioned, it is derived from the demand for all the various commodities which move by sea. The volume of trade has been increasing at a steady pace over the years as was illustrated in Table I. From the point of view of transport performance, ton miles is probably a better measure than merely tons and in these terms the

\textsuperscript{8} This has been tried several times in the past however. Ultimately, the schemes received opposition from the tramp owners who believed that normal market procedure was the only sure and satisfactory way of adjusting supply and demand. The reader is directed to H. Gripaios. \textit{Tramp Shipping}, Chapter 7 for a discussion of the various schemes that have been attempted for freight rate stabilization.
rise in trade was also shown. The statistics for the transport performance of bulk commodities was depicted in Table II, but these are assembled again in Table III with the addition of the average length of haul. It should be mentioned in this regard that the two components of demand — volume and distance — need not necessarily move together. This was clearly illustrated after the closure of the Suez Canal in 1967, which led to the lengthening of many trade routes and so to an increase in ton/miles demanded without any necessary increase in the volume of goods to be moved.

An increased level of the volume of trade may not be sufficient impetus for a general rise in the level of rates. On the contrary, if the demand for trade arises on the routes which ships have previously travelled in ballast, then these ships will merely absorb the cargo and the effects on the freight rates is likely to be depressive in the reverse direction. This fact is exemplified in Lewis' explanation of the behaviour of inward and outward freight rates. He states:

"...if outward cargoes are smaller, some boats will be going out in ballast, and the outward rate will be at a minimum. If, then, the demand for ships inward increases, the inward rate may rise, but the outward
TABLE III

MOVEMENTS OF SIX MAJOR BULK COMMODITIES

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TONNAGE SHIPPED</th>
<th>TRANSPORT PERFORMANCE</th>
<th>AVERAGE TRANSPORT DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>millions of tons</td>
<td>1,000 million ton miles</td>
<td>Nautical miles</td>
</tr>
<tr>
<td>1960</td>
<td>233</td>
<td>767</td>
<td>3,290</td>
</tr>
<tr>
<td>1961</td>
<td>244</td>
<td>853</td>
<td>3,500</td>
</tr>
<tr>
<td>1962</td>
<td>251</td>
<td>875</td>
<td>3,500</td>
</tr>
<tr>
<td>1963</td>
<td>274</td>
<td>980</td>
<td>3,600</td>
</tr>
<tr>
<td>1964</td>
<td>315</td>
<td>1,178</td>
<td>3,700</td>
</tr>
<tr>
<td>1965</td>
<td>336</td>
<td>1,298</td>
<td>3,900</td>
</tr>
<tr>
<td>1966</td>
<td>349</td>
<td>1,396</td>
<td>4,000</td>
</tr>
<tr>
<td>1967</td>
<td>361</td>
<td>1,501</td>
<td>4,200</td>
</tr>
</tbody>
</table>

Source: Maritime Transport. 1968 p. 28.
rate cannot fall because it is already at a minimum."  

Lewis goes on to explain that rates on outward journeys may indeed rise if shipping is in a boom period and queuing delays caused by increased inward cargoes would delay outward cargoes to the point where waiting was more expensive than seeking cargo elsewhere. His general conclusions were:

"There is a tendency for inward and outward rates to move inversely on any route when the general conditions elsewhere are stable; and there is a tendency for them to move together in the same direction when market conditions are generally changing."

The foregoing serves to complicate the problem of isolating the effects of increased trade movement on the level of freight rates. And, dealing as we are with freight rate averages as computed in the freight rate indices, the problem assumes greater proportions.


Any consideration of the short run demand for tonnage space must take into account the distinct seasonal movements that it displays. The seasonal movement in dry cargo bulk freights is caused mainly for the shipment seasons for grain and to a smaller extent, sugar.\textsuperscript{11} In addition, the seasonal movement is further aggravated by demands for fuel in the northern winters and can be seen with the "comparative strengthening of freights in Autumn as anxious shippers attempt to complete shipments to and from areas likely to be closed by ice...."\textsuperscript{12} However, this does not constitute an insurmountable problem since there are several methods for removing seasonality from data prior to empirical testing. In addition, there are qualitative aspects of demand which are impossible to quantify and which are not amenable to proposition or empirical validation such as we hope to perform. However, many of these aspects are germane to the problem of tramp shipping rate fluctuations, and as such, cognizance should be taken of them.

\textsuperscript{11} Gripaios, \textit{op. cit.} p. 16.

\textsuperscript{12} \textit{Ibid.} p. 17.
It has been said that tramp freight rates in the short term are governed by changes in demand arising from natural disasters, wars, crop failures and so on. The truth of this statement is difficult to dispute. A crop failure or a bumper harvest can reverse the flow of commodities or remove traffic to another corner of the world. In the area of tramp shipping, the impact of these events is personified since:

"No less than 66% of annual tramp movements by weight is made up of agricultural produce whose production is directly covered by climatic factors; a further 18%, consisting of solid fuel and fertilizer, is to some extent dependent on the weather."\(^{14}\)

The wars and natural disasters are also inclined to cause violent upheavals in the pattern of trade. The effect that these upheavals have on the level of freight rates in the tramp industry is incredible. Such an event occurred in 1967 with the closure of the Suez Canal, and the effects of this closure on tramp shipping is succinctly reviewed by "Fairplay" in their annual freight market review, and illustrates precisely how an event such as this can affect


\(^{14}\) Studer. *op. cit.* p. 10.
shipping rates:

"The scene was set for a mightly freight-rate war in the grain trades between these giant dry-cargo trans­ports and the surfeit of tankers made redundant by the seasonal recession in the demand for oil. It seemed inevitable that dry-cargo charter rates would plummet to new low depths of unprofitability and, ultimately, force many ships into lay-up berths.

However, the gods of war smiled kindly upon tramp shipowners - as they have done so often in the past - and the erstwhile scene of depression was transformed within 24 hours to one of joyous optimism. Instead of a battle between the big dry-cargo bulk carriers and tankers, they joined forces to combat the threat levelled at the Western countries' oil supplies. During the two months of June and July, somewhere in the region of 70 bulk carriers, ranging in sizes from 20,000 tons to 80,000 tons deadweight, and aggregating approximately 2,750,000 tons dead­weight, were hired for varying periods on time charter up to a year. Most of these were taken as replacements for ore/oil carriers and tankers employed in the dry cargo trades so as to release them for a switch into the more profitable oil-transport business."

It is apparent that the effects of such an event would render freight fluctuations inconsistent with what otherwise would be the effect of the normal laws of supply and demand. With the withdrawal of the oil-carrying capacity from the dry cargo trade, it would be a while before the supply and demand for shipping in this market could be

reconciled and rates would undoubtedly rise.

Mention of all the minor upheavals would entail a list which is infinitely long. Currency restrictions, reciprocal trade agreements and the vagaries of government policy are all reflected in some manner in the demand for shipping space. However, in these circumstances, as well as in all of the other aforementioned situations, the level of rates will be determined by forces intrinsic to the supply of ships interacting with these fluctuations in demand. It is this side of the coin which must be investigated now.

FORCES OF SUPPLY

The broad definition of the supply of shipping as being represented by the world fleet was refined to be the amount of unfixed tonnage in the world available for fixing. In the short term supply of shipping space this is a restricting factor.

"...it will be found that the amount of tonnage able to enter any particular trade in response to a sudden increase in demand will only be a small proportion of the total world tonnage; some ships will be on long term charters to specific trades; liner companies, even if they have near-empty ships, are tied to specific routes and schedules; many
vessels are specialized to a particular cargo, and others are limited to particular seas and coastal areas. "16

In the short run therefore, it can be surmised that the supply of tonnage is fairly rigid. However, even in the short run, the tonnage available for fixing is not an absolute factor in governing the supply of shipping space. There are variations which can be introduced which could increase this supply of shipping space available. A fuller or more efficient use of cargo space is one way. A further possibility is to increase the speed of the vessels, but this is severely restricted both by technical and financial considerations. "Fuel consumption increases disproportionately once the 'economical speed' is passed, and in any case, the advantage of greater speed would probably be nullified by an increase in time spent in port. With the physical limitations placed on cargo handling by dock accommodation and equipment, rapid turn round may not be possible."17 Even though it would pay to incur overtime for loading and discharging at a time when freights were high, the saving is further offset "by the general port congestion which

16 O'loughlin, op. cit. p. 70.
17 Jones, op. cit. p. 33.
normally accompanies active trade conditions." Any like-lihood of such adjustments to supply would only occur, if at all, when freights were sufficiently high to warrant such action. Therefore, the elasticity that can be introduced into the existing supply (even at high freights) is confined within narrow limits, and in these circumstances, the supply of tonnage is very inelastic.

The amount of tonnage that will be operating at any given time will be dependent on the level of rates. Professor Sturmey suggests that the tramp operator goes into the market with three rate levels in mind: (1) the continuation rate, which year-in year-out will provide a level of profit sufficient to keep the owner happily in business; (2) the transfer rate which will enable him to more or less break even but leave him wondering whether he would not be wiser to use his capital and skill elsewhere.

"Logically, this rate should be no less than the total costs; in practice the shipping company may have investments which will produce a sufficient

18 Gripaios, op. cit. p. 64.
return that the whole outcome of the business is profitable, while management may regard shipowning as a way of life or a national duty of such importance that failure to cover total costs over a period of years will not lead to the transfer of capital from the industry."  

(3) the lay up rate, which is equal to the level of voyage costs minus the costs of lay up, and which is the rock-bottom level that the owner will accept; in general this "is about 5% below the level of voyage costs."  

Let us consider farther the forces of supply as they would operate under conditions of the "continuation rate" and the "lay up rate" since it is within these two situations that rate fluctuations are most likely to occur.

**FORCES OF SUPPLY UNDER THE CONTINUATION RATE**

Disregarding for the moment the extreme inelasticity of supply of shipping at very high freights, it is found that in the operations of a normal market (where conditions are such that very high or low profits are the exception rather than the rule) at all levels of rates above the level


where the most expensive to run vessels move into lay-ups, the total supply of shipping is also inelastic. However, there is more flexibility within this range. This happens when, as has been mentioned in Chapter II, liners will move into tramp trades and oil-carrying vessels can be cleaned out for the carriage of grain.

The results of this flexibility are such that at any given time there is a certain volume of floating tonnage available to meet the demand. The presence of this reserve supply, and the mobility of the vessels themselves of being able to reach most markets in a short time, even if they are in distant waters when a rise in demand occurs, "is the principal cause of the sensitive nature of the freight market inasmuch that in the short run an increase or decrease of the available tonnage, in any one market, brings about minimum or maximum rates." 21

During the normal operation of a fairly profitable market, there are other factors which would undoubtedly upset any balance between supply and demand. One of these

21 Jones, op. cit. p. 32.
is the institutional structure of the industry itself. The presence of large shippers such as oil companies and ore importers, who do not have sufficient tonnage for their own needs, implies that a change in ownership policy of their behalf can cause new orders to be placed even if there should be an aggregate oversupply in the industry. On the other hand, a decision to negotiate more long term arrangements could mean a withdrawal from the stock of tonnage in the short term market and a case of undersupply would result.

The discrete nature of ship ordering should be another factor which would significantly increase the uncertainty of the supply of tonnage in the short run. In the case of unforeseen increases in demand "rates in general may reach a level which will stimulate shipowners to order new tonnage."\textsuperscript{22} Further to this, if a large number of owners in different parts of the world order tonnage independently of each other, as it all comes into service there is likely to be a rather sudden oversupply of tonnage and a consequent fall

\textsuperscript{22} O'Loughlin, \textit{op. cit.} p. 88.
in freight rates. It has been suggested that this is not the case and the more likely result is that if freight rates decline during the construction period, there may be no pressure for delivery and construction may be slowed down or suspended. In this situation, the effect may be widely dispersed over the construction stage. Our empirical work will attempt to test these assumptions to see if either holds true for the period under study.

The foregoing has suggested conditions which arise to alter the supply of tonnage during a time of normal profitable trading for tramp shipping. It has been concluded that there are certain pressures exerted on rates that will increase or decrease them coincident with the amount of tonnage available. However, the impact of these conditions is magnified if they occur in a period of depressed rates. At this time the problem is made more complex by the introduction of laid-up ships.

23 Jones, op. cit. p. 38.
FORCES OF SUPPLY UNDER THE LAY-UP RATE

"Laying up signifies in shipping the removal of tonnage from employment, implying, however, also the intention and hope of its reactivation in a changed market situation. Laid up and reactivated tonnage will directly and effectively influence the supply situation of tramp tonnage." 24

The laying up of vessels can be instigated by two things: a subsidence in demand for shipping space or an oversupply of tonnage available. In either case freights may become so depressed that a large volume of tonnage, which in normal conditions would be maintained, is laid up.

The level of rates at which owners will lay up their vessels will differ considerably, dependent of course on the type and age of the ship and the level of national wage costs. Frequently, older ships, whose operations are unprofitable in high-wage countries, are sold to owners in low-wage countries. The low-wage costs in these countries enable the owners to sustain the high repair costs on old ships. 25 It is apparent that the older ships retained by

24 Fisser. op. cit. p. 191.
high-wage countries will be the first to move into lay up. Between this highest lay-up rates and the theoretical low point at which no tramp shipping would operate, the supply is elastic. The range of elasticity depends on the different levels of rates at which vessels will move in and out of lay up.

Professor Sturmey argues that the supply of shipping is inelastic in the short term even at low rate levels. Because each owner will accept any rate above the lay-up costs rather than lay his ship up, changes in demand are reflected initially not in changes in capacity offered but in changes in rates. In this way, he suggests, the situation emerges that tramp shipping can be depressed but operating to capacity. Jones' view disputes this point. He maintains that under conditions of depressed rates and lay ups, even "a slightly higher rate would be sufficient to bring on the market fairly rapidly a large amount of serviceable tonnage."

An a priori presumption is that the former argument is the most valid. For as Professor Sturmey points out:


27 Jones, op. cit. p. 33.
"Once rates enter this more elastic range of the supply curve, the total volume of tonnage on offer ceases to be important. Demand, and the points at which different owners will lay up their ships, determine the course of freight rates."\(^{28}\)

Under an assumption such as this, the implication is that the level of rates would be a function of both volume of trade and the level of laid-up tonnage rather than a straight inverse relationship between freight rates and laid-up tonnage as envisaged by Jones. Both of these assumptions may be amenable to empirical testing as we shall see later.

Complicated as this question of lay up is, one fact is clear. The decision of whether or not to lay up a ship is not a minor one. The actual cost of putting a vessel in lay up and reactivating her may be as much as £6,000.\(^ {29}\) A natural conclusion therefore is that the decision for lay up would be strongly influenced by the expectations of ship-owners as to the future market conditions based on their evaluation of how long the market depression will last.

A mere reflection on the word 'expectations' suggests that this may be a potent force working on both the supply

\(^{28}\) Sturmey, *On the Pricing* ...., *op. cit.* p. 15.

\(^{29}\) O'Loughlin, *op. cit.* p. 147.
and the demand side of the shipping market. It is a force that should be investigated to gather a clear picture of the relationships that lie at the heart of the problem of freight rate fluctuations.

**RELATIONSHIP BETWEEN EXPECTATIONS AND SUPPLY AND DEMAND IN SHIPPING MARKETS**

We have mentioned above that the expectations of shipowners may permeate the decision of new vessel ordering and the decision to lay up tonnage during a period of depressed rates. In addition, it might be surmised that expectations of sudden increases in the supply of vessels coming on the market would influence the level of freight rates, since freights have generally declined seriously before the supply of new tonnage from the yards becomes available.  

The degree of optimism or pessimism of both shippers and shippers is reflected in the manner in which vessels are chartered.

30 Jones, op. cit. p. 32.
"What happens is that in a period of gently rising freights, certain charterers may begin to grow worried about their ability to secure suitable ships for their cargoes a few months or even a year or more ahead. The first signs of such a trend are an increase for charterings for "consecutive" voyages, probably at a scale of rising freights for each successive load, plus an increase in the number of short-term charters... Once started, such a movement tends to snowball, and more charterers enter the market fearful that the actions of others in protecting forward loading positions will prejudice their own chances of getting space to meet their requirements."31

Shipowners, on the other hand, would be reluctant to charter out their vessels for long periods of time in a rising market if expectations were that rates would go higher.

In a period of falling rates, the reverse situation is true. Shippers wish to charter strictly on a voyage basis in anticipation of rates decreasing to a lower level while shipowners would prefer to let charters for longer periods in the hopes of gaining extra profits before a slump sets in.

The foregoing suggests that expectations have significant impact on the supply of tonnage available in the short term market. However, demand is also affected. In the case of a very weak market where rates have been at a low

level for some period of time, chartering is, almost invariability, on a hand-to-mouth basis. Charterers, in the main, do not take ships in forward positions, as they feel that rates may go lower still, and owners are reluctant to fix ahead at current levels in case matters improve. As a result, stocks of commodities are sometimes allowed to become depleted to a point at which regular shipments become essential and in consequence, the effect upon freight rates of even a slight shortage of tonnage in a particular area may be considerably magnified.

In short, what is asserted here is that the market sentiment or tones, i.e. the degree of optimism or pessimism exhibited by shipowners or shippers, cannot be discounted when one is trying to isolate some of the causes of freight rate variations. The sentiment of the market stems from psychological factors and represents an expression of the transient feelings of the people actually operating in the open market.

32 "The Year in the Freight Markets", The Syren and Shipping, January 2, 1963, p. 203

Chapter III has attempted to identify some of the forces which are at work in the shipping markets. It was suggested that the forces and the relationships between them were very complex. Moreover, it is apparent that the combinations of any, or all of them, will result in some disruption in the equilibrium of the supply of and the demand for shipping. Ultimately, these imbalances will be reflected in the fluctuating level of freight rates.

The discussion in Chapter III has suggested also that several relationships exist in the tramp shipping market which should be amenable to empirical validation. Placed in the form of hypotheses, these relationships include the following:

1. There exists an inverse relationship between charter rates and laid up tonnage.
2. Periods of high freights will stimulate shipowners to order new tonnage.
3. The incidence of new vessels entering the shipping trade will have a depressing effect on charter rates.
4. The level of charter rates will be a function of the volume of seaborne trade.

In the following chapter, these and several related hypotheses (although not necessarily in that order), will be subjected to empirical tests. It is hoped the results of these tests will establish whether these commonly-held assumptions can be accepted or rejected on the basis of the data in hand.

It is realized that any empirical analysis will be started with several ponderous difficulties. The abundance of exogenous variables influencing the operations of the shipping markets is one. Qualitative variables intrinsic to the industry itself complicate any attempts to determine the impact of supply and demand variables (which can be quantified) on rates in the voyage and time charter markets. But, as was mentioned in the introduction to this thesis any attempt made to analyse freight rates in the shipping markets may help in improving the availability of information in this important field. It is with this thought in mind that the analysis in Chapter IV begins.
CHAPTER IV

EMPIRICAL INVESTIGATION OF CHARTER RATE LEVELS

INTRODUCTION

The previous chapters have provided a brief outline of the shipping industry in general and the tramp shipping industry in particular. Several forces of supply and demand in the shipping markets have been identified. The purpose of this chapter is to present an analysis of the statistical tests which were performed on the quantified data of supply and demand variables and shipping rates in the tramp shipping industry which have been assembled.

It must be remembered that any statistical analysis is "ex post" and as such it often leads the unwary into unrealistic assumptions and often to make inappropriate comparisons; "lies, damned lies, and statistics" too often has a ring of truth about it. Therefore, caution must be used when interpreting the results of any statistical tests performed, particularly if these results are extrapolated to predict future events. With reference to the area under study in this paper, predictions such as future rate levels
would be extremely dangerous considering the background of uncertainty against which the shipping industry operates. However, if, through statistical testing, it can be determined what impact supply and demand variables have had on voyage and time charter rates in the tramp shipping industry in the past, it may be possible to determine, under ceteris paribus conditions, what is the "likely" behaviour of voyage and time charter rates in future. It is hoped to be accomplished by testing the assumptions of the original hypothesis.

It would be pertinent at this point to reiterate the original hypothesis as stated in the introduction to this paper:

"Fluctuations in shipping rates in the tramp shipping industry can be explained by the use of multiple regression models incorporating details of the supply of and demand for shipping space."¹

THE USE OF MULTIPLE REGRESSION AS A STATISTICAL DEVICE

The use of multiple regression as a tool for the

¹ See p.10 ff.
estimation of parameters in economic relationships is widespread. The technical details of the method of estimation are purposely omitted from this paper. The procedure in the case of a relationship between two variables is discussed in most statistics texts. In the case of more than two variables, the logical method for deriving the results is the same as the simple case involving only two variables, but the mathematical tools required for understanding it are more sophisticated. This case is discussed in both advanced statistics and econometric texts.

It will be assumed therefore, that the reader is familiar with the statistical technique of least-squares regression. However, it may be beneficial to retrace with some care, the arguments which lead up to the linear regression hypothesis as it is usually stated at the outset of an estimation problem. A brief recall of the elements of least-squares regression and a review of some of its properties which substantially affect the formulation of the economic models to which it is applied, may help clarify the problems which accompany the analysis performed
The purpose of multiple regression is to estimate the parameters of a relationship which has the form:

\[ Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \ldots + \alpha_k X_k + u \]  

(4.1)

This form assumes that the relationship between the variables is linear with \( Y \) being the dependent variable - the one whose fluctuations are explained by the relationship;

\( X = (X_1, X_2, \ldots, X_k) \) is the set of independent variables - ones which it is hypothesized are relevant explanatory influences of variations in the values of \( Y \);

\( \alpha = (\alpha_0, \alpha_1, \ldots, \alpha_k) \) is the set of parameters - in this case constants, whose true values are unknown - which relate \( X \) and \( Y \);

\( u \) is a random error (disturbance term) whose value is unknown. It is usually assumed that it has a mean of zero. The presence of this term in empirical economic relations is justified on the following grounds:

1. The set \( X \) can rarely include all possible
factors which influence Y. Consequently, u contains the influences which are omitted either because:

a) their individual importance in explaining the behaviour of Y is very small compared with that of the variables included in X; or

b) it may be either impractical or impossible to quantify these omitted variables.

2. The sample observations on Y and X may be subject to errors of measurement - almost certainly the case with macroeconomic data at least - so that even if there is an exact relationship (one without an error term) between variables, the relationship between the measured values will require an error term.

3. Statistical analysis invariably must generalize on various facets of human behaviour. A relationship such as (4:1) implies that two identical changes in the values of X will produce identical changes in Y. However, there is always some element of randomness in the human
element of response to the same stimulus, and this is accounted for by the presence of $u$ in (4:1). This is in contrast to the non-randomness expressed in the remainder of the relationship.

The inclusion of this error term is very important to this study as will be seen later. The reason for this is that the assumption of independence (a mean value of zero) in the error term is often inappropriate to economic analysis, particularly so when the observations consist of time series such as used in this study. In this case the observed X's and Y's in their natural order denote successive periods over the years under study. In a situation such as this, it is often found that adjoining disturbance terms (which refer to consecutive periods) are no longer independent but positively related. This statistical phenomenon is referred to as serial correlation or autocorrelation.²

The presence of autocorrelation in the error terms does not negate the use of multiple regression analysis

however. It has been shown by Aitken\(^3\) that the method of least squares still yields the best linear unbiased estimates of the regression coefficients provided the lack of independence in the error series is taken into account. However, if account is not taken of this error term in the analysis of a regression equation, any results would lose their significance. If, in fact, the errors were serially correlated and the straightforward least-squares formulas are applied directly to the observations \(Y \ X\), there are three main consequences.\(^4\)

First, unbiased estimates of \(\beta\) will be obtained, but the sampling variances of these estimates may be unduly large compared with those achievable by a slightly different method of estimation. Second, if the usual least-squares formulas for the sampling variances of the regression coefficients are applied, a serious underestimate of these variances will result. In any case, these formulas are no longer valid, nor are the precise forms of the "t" and "F"


tests of significance used in a linear model. Third, any predictions based on the formulas would be inefficient, that is, predictions would have needlessly large sampling variances.

A test for detecting significant deviations from a serial independence assumption has been designed by Durbin and Watson, and extensive use will be made of this test in the analysis below.

One more brief caveat should be introduced before leaving the discussion of regression analysis as performed on the time series used in this study. The primary purpose of this type of analysis is to discover and measure any irregularities which characterize the movement of the data through time. In no way does time series analysis purport to explain the various variables that cause the observed behaviour, nor is the passage of time itself a cause of the behaviour. It is merely a way of measuring the net effect of a number of intricately related variables that cause the

observed behaviour, in relation to the passage of time. Moreover, a high value of $R^2$ (the coefficient of determination) does not necessarily signify a "causal" relationship. We should speak of determination of one thing by another; however, only when a causal relationship can be logically defended; otherwise, an expression such as "associated with" or "accounted for" is probably much better.

**VARIABLES INCLUDED IN ANALYSIS**

Chapter I mentioned the limitations which were imposed on the choice of variables to be used in the empirical analysis. However, during the course of data collecting, sufficient monthly observations from several publications were available for fifteen variables. These are noted below:

a. Voyage Index of Tramp Shipping Rates (VOYIND)
b. Time Index of Tramp Shipping Rates (TIMIND)
c. Tanker Freight Rate Index (TNKIND)
d. New Order of Cargo Vessels (NEWCAR)

See Appendix C for explanation of and sources of the variables used.
e. New Orders of Tankerships (NEWTNK)
f. New Orders of Bulk Carriers (NEWBLK)
g. New Cargo Vessels Launched (LANCAR)
h. New Tankerships Launched (LANTNK)
i. New Bulk Carriers Launched (LANBLK)
j. Trials and Completions of Cargo Vessels (T&CCAR)
k. Trials and Completions of Tankerships (T&CTNK)
l. Trials and Completions of Bulk Carriers (T&CBLK)
m. World Sea Trade (WORSEA)
n. Laid Up Cargo Vessels (LUCAR)
o. Laid Up Tankerships (LUTNK)

It is apparent that the general hypothesis as outlined is only capable of being proven true if the variables chosen to be the independent variables do indeed influence the behaviour of rates (i.e., the dependent variable as implied in the hypothesis). Every investigator presumes that he has selected the proper variables, but it is conceivable, for example, that it is the level of rates that influences the independent variables and not the reverse.

In an effort to establish a framework within which to conduct the statistical tests on the data, it was
decided to examine the relationships between the variables in four distinct categories:

1. between the various categories of rates i.e., voyage, time and tanker rates.

2. the relationship between laid up tonnage and charter rates.

3. the relationship between charter rates and the various stages of activity in the shipyards i.e., ship ordering, ship launching and ship completions.

4. the relationship between the demand for shipping space as indicated by world sea trade, and charter rates.

In each category, only selected combinations of variables were chosen to exhibit in the text of this thesis. This is by no means the extent of testing that was performed, and the reader is directed to Appendix D for a more complete list of the tests performed in each category or combination of categories as listed above.

Early investigation of the relationship between each pair of variables consisted of a series of simple plotted
graphs of the monthly data for comparison against each other. Following this, a series of scatter diagrams were made by plotting one variable against the other. This is not a particularly sophisticated method of discovering relationships between variables, but it does have advantages insofar as it might reveal if there are any fairly obvious coincident variations in the pairs of variables. The graphs and scatter diagrams are not exhibited here primarily because of space limitations and the wish to avoid confusion.

The very short-run fluctuations in monthly data make visual comparison quite difficult and it was therefore decided to construct a correlation matrix of all fifteen variables to see if any, or all of the paired series had some degree of closeness. Table IV is a correlation matrix incorporating the majority of these variables.
<table>
<thead>
<tr>
<th></th>
<th>VOYIND</th>
<th>TIMIND</th>
<th>TNKIND</th>
<th>LUCAR</th>
<th>LANCAR</th>
<th>T&amp;C CAR</th>
<th>NEWBLK</th>
<th>LUTNK</th>
<th>WORSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOYIND</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMIND</td>
<td>0.8960</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TNKIND</td>
<td>0.3639</td>
<td>0.2581</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUCAR</td>
<td>-0.4918</td>
<td>-0.6635</td>
<td>-0.0061</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANCAR</td>
<td>-0.6116</td>
<td>-0.6624</td>
<td>-0.3662</td>
<td>0.5656</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T&amp;C CAR</td>
<td>-0.5998</td>
<td>-0.6666</td>
<td>-0.3046</td>
<td>0.5379</td>
<td>0.7301</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEWBLK</td>
<td>0.4914</td>
<td>0.5132</td>
<td>0.1121</td>
<td>-0.4794</td>
<td>-0.4078</td>
<td>-0.3407</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUTNK</td>
<td>-0.5888</td>
<td>-0.5579</td>
<td>-0.3520</td>
<td>0.5386</td>
<td>0.7125</td>
<td>0.7703</td>
<td>-0.2855</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>WORSEA</td>
<td>0.4639</td>
<td>0.6178</td>
<td>0.1718</td>
<td>-0.6100</td>
<td>-0.6651</td>
<td>-0.7340</td>
<td>0.2082</td>
<td>-0.8116</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**CORRELATION MATRIX - 1960 - 1968 TRAMP SHIPPING VARIABLES**
1. RELATIONSHIPS BETWEEN RATES

VOYAGE AND TIME CHARTER RATES

A good starting point of an analysis of the impact of supply and demand variables on charter rates would be to investigate the relationship between the two rates of concern in this study - voyage and time rates. Of course it should be realized that the time index and voyage index are prices i.e., "market equilibrium points", and it is assumed that supply and demand relationships affect both rates although to a different degree. Therefore, a comparison of the two indices is, in effect, an examination of the behaviour of the relative timing of these equilibria. It is worth investigating as it could be established if common arguments about the behaviour of the two rates are valid for the period which is under study in this thesis.

There is a close connection between voyage and time rates, especially in the short run. W.R. Lewis explains this interrelation:

"Time charter rates are linked with voyage charter rates both on the supply side and on the demand side. On the supply side, the shipowner has
the alternative of seeking a time or voyage charter. On the demand side, some merchants are indifferent as between time and voyage charters and even if this were not so, speculators would take ships on time charters and relet them on voyage charter if the former rates were out of step. The two rates must therefore move together."  

This speculation does exist however, and is associated with the expectations of shipper and shipowners mentioned in Chapter III. If it were not for the possibility of this speculation, there would be absolutely no difference between the trend of charters for a voyage and those for several voyages i.e., time charters. But since uncertainty and speculation - forecasting market developments and acting accordingly - always does exist, there may be differences in rate trends between the two markets.

It is further postulated by Branch\(^8\) that since time chartering extends into the future farther than a mere voyage, rates in this market tend to reflect longer run expectations and do not give the same weight to current market conditions. When it is expected that the market will

---

7 W.R. Lewis, *op.cit.* p.91

strengthen, time charter rates will rise more rapidly than those for voyages and will tend to be above the current voyage rates. On the other hand, when the market is weakening, owners are anxious to fix for as long a period as possible so as to hedge against further deterioration; charterers hold off in anticipation, and the long term rates tend to fall faster than voyage rates and will tend to be below the current voyage rates.

From the discussion above, a general hypothesis can be formulated:

"Generally speaking, voyage and time charter rates move in the same direction, but because time charter rates depend on longer range market expectations, they tend to fluctuate more widely than voyage rates."

Although simple graphs are not an ideal method of research to support or reject an hypothesis, the relationship of interest between the two rates is not a deterministic one and therefore Figure II will suffice to illustrate the point.

A visual examination of Figure II implies that the behaviour of voyage and time charter rates is indeed as surmised above at least for the period 1960 - 1965. From
UNITED KINGDOM CHAMBER OF SHIPPING
TRAMP SHIPPING INDICES
1960 - 1968
(1960 = 100)
this point on there seems to be a slight change in the pattern and time charter rates appear to be consistently higher than voyage charter rates. This is an interesting phenomenon, but one for which this investigator has no ready explanation.

This visual observation of a seeming discrepancy from an accepted argument over previous years, prompted investigation about other commonly held opinions concerning time and charter rates. W.R. Lewis states, "... the time charter rate should depend not so much on the current voyage rate as upon the expected trend of voyage rates in future months."\(^9\) Alan Branch supports this assumption when he says, "... the current time charter rate tends to reflect the expected trend of voyage rates in the future."\(^10\) However, there is also an opposing school of thought that suggests what happens in the voyage market "today" influences what will happen in the time market "tomorrow".

The discussion here suggests that there are different hypotheses which could be formulated, each probably giving different results. However, if at first it is assumed that

\(^9\) W.R. Lewis. _loc. cit._
\(^10\) Alan E. Branch. _op.cit._ pp. 80 - 81
the former argument is true, then an hypothesis could be
constructed as a basis for testing this relationship to see
if common assumptions are borne out by fact for the period
under study in this thesis.

1. "During the years 1960 - 1968, the closest
relationship between voyage and time charter
rates will occur when the level of the time
charter index precedes that of the voyage
charter index, thus implying that the voyage
index is a function of the time index for some
lagged period."

Alternatively, if it is assumed that the second argument
is more valid then a competing hypothesis is just the reverse:

2. "During the years 1960 to 1968, the closest
relationship between voyage and time charter
rates will occur when the level of the voyage
charter index precedes that of the time
charter index, thus implying that the time
index is a function of the voyage index for
some lagged period."

The results of the regressions run on the variables of the
two functional relationships as outlined in the hypotheses
are presented in Table V\textsuperscript{11} and Table VI. On the basis of

\textsuperscript{11} A brief example using the subscripts in Table V
and subsequent tables in this chapter may aid in interpret­
ing the results:

1. TIMIND\textsubscript{t} = f (VOYIND)\textsubscript{t} merely means that this
month's (t) time index is a function of this month's (t)
voyage index.

2. TIMIND\textsubscript{t} = f (VOYIND)\textsubscript{t-1} means that this month's
(t) time index is a function of last month's (t-1) voyage
index. \textsuperscript{See bottom of page 96 for Note}
Table V, hypothesis No.1 is rejected. On the other hand, hypothesis No.2 cannot be rejected because the data would seem to indicate the movement of the indices are as postulated. Although the movement is not particularly strong, which would raise doubts as to its validity, it would appear to indicate that the voyage index is a good indicator of the behaviour of the time index in future periods rather than the reverse as argued by Lewis and Branch.

To these tentative conclusions must be added a word of caution. The results in both tables indicate a high autocorrelation in the residuals as evidenced by the low Durbin-Watson Statistic,\(^{12}\) and thus definite conclusions must be held in abeyance until such time as this problem of serial correlation can be investigated in a later chapter.

**VOYAGE, TIME AND TANKER RATES**

The discussion in Chapter II implied that the tramp shipping market is always vulnerable to competition from

\(\text{Note: (t-1) to (t-6) indicate lags of from one to six months.}\)
\(\text{Sx.y = Standard Error of Estimate}\)
\(\text{D.W.S. = Durbin Watson Statistic}\)

\(^{12}\) See Appendix B for significant levels for the Durbin Watson Test.
### TABLE V

**RESULTS: TIME INDEX \( t \)**

REGRESSED ON VOYAGE INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>COEFFICIENT</th>
<th>( t )-VALUE</th>
<th>( R^2 )</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOYIND(_t)</td>
<td>-23.12</td>
<td>1.26</td>
<td>18.60*</td>
<td>0.80*</td>
<td>346.12</td>
<td>8.24</td>
<td>0.86</td>
</tr>
<tr>
<td>VOYIND(_t-1)</td>
<td>-24.06</td>
<td>1.27</td>
<td>19.46*</td>
<td>0.81*</td>
<td>378.92</td>
<td>7.94</td>
<td>1.23</td>
</tr>
<tr>
<td>VOYIND(_t-2)</td>
<td>-18.07</td>
<td>1.21</td>
<td>15.87*</td>
<td>0.75*</td>
<td>252.04</td>
<td>9.31</td>
<td>1.19</td>
</tr>
<tr>
<td>VOYIND(_t-3)</td>
<td>-12.46</td>
<td>1.16</td>
<td>13.42*</td>
<td>0.68*</td>
<td>180.19</td>
<td>10.51</td>
<td>0.97</td>
</tr>
<tr>
<td>VOYIND(_t-4)</td>
<td>- 7.95</td>
<td>1.12</td>
<td>12.01*</td>
<td>0.64*</td>
<td>144.41</td>
<td>11.31</td>
<td>0.67</td>
</tr>
<tr>
<td>VOYIND(_t-5)</td>
<td>- 1.17</td>
<td>1.06</td>
<td>10.35*</td>
<td>0.57*</td>
<td>107.19</td>
<td>12.42</td>
<td>0.54</td>
</tr>
<tr>
<td>VOYIND(_t-6)</td>
<td>8.23</td>
<td>0.97</td>
<td>8.63*</td>
<td>0.48*</td>
<td>74.53</td>
<td>13.68</td>
<td>0.42</td>
</tr>
</tbody>
</table>

---

* Significant at .01 level
TABLE VI

RESULTS: VOYAGE INDEX \( t \)
REGRESSED ON TIME INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>( t )-VALUE</th>
<th>( R^2 )</th>
<th>F. RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( TIMIND_t )</td>
<td>35.99</td>
<td>0.63</td>
<td>18.60*</td>
<td>0.80*</td>
<td>346.1</td>
<td>5.85</td>
<td>0.88</td>
</tr>
<tr>
<td>( TIMIND_{t-1} )</td>
<td>42.56</td>
<td>0.57</td>
<td>12.77*</td>
<td>0.66*</td>
<td>160.0</td>
<td>7.81</td>
<td>0.77</td>
</tr>
<tr>
<td>( TIMIND_{t-2} )</td>
<td>50.94</td>
<td>0.50</td>
<td>9.20*</td>
<td>0.50*</td>
<td>82.69</td>
<td>9.48</td>
<td>0.51</td>
</tr>
<tr>
<td>( TIMIND_{t-3} )</td>
<td>59.88</td>
<td>0.42</td>
<td>6.86*</td>
<td>0.36*</td>
<td>45.04</td>
<td>10.85</td>
<td>0.37</td>
</tr>
<tr>
<td>( TIMIND_{t-4} )</td>
<td>68.15</td>
<td>0.35</td>
<td>5.27*</td>
<td>0.24*</td>
<td>26.15</td>
<td>11.82</td>
<td>0.32</td>
</tr>
<tr>
<td>( TIMIND_{t-5} )</td>
<td>74.19</td>
<td>0.30</td>
<td>4.34*</td>
<td>0.18*</td>
<td>17.48</td>
<td>12.34</td>
<td>0.26</td>
</tr>
<tr>
<td>( TIMIND_{t-6} )</td>
<td>78.19</td>
<td>0.26</td>
<td>3.72*</td>
<td>0.14*</td>
<td>13.21</td>
<td>12.56</td>
<td>0.20</td>
</tr>
</tbody>
</table>

*Significant at .01 level
tankers which, at times of receding demand in the carriage of oil, are able to convert to grain-carrying facilities. If this is so, then it seems conceivable that when tanker rates fall, the incidence of these ships entering the tramp market will have an influence on tramp rates. In other words, when tanker rates fall, tramp rates should be forced down because of an oversupply of vessels vying for the bulk trade. From this assumption, an hypothesis could be formulated concerning the impact which changes in tanker rates will have on voyage and time charter rates.

"A fall in tanker rates will be followed shortly thereafter by a fall in voyage and time charter rates with the reverse situation when tanker rates rise."

The relationships to be investigated consist of:

\[
\text{Voyage Index} = f (\text{Tanker Index})
\]
\[
\text{Time Index} = f (\text{Tanker Index})
\]

The results of the series of regressions run on these functional relationships are depicted in Tables VII and VIII. The association is not strong; however, the majority of them are considered to be statistically significant at the 95% confidence level. Two things can be inferred from the table.
TABLE VII

RESULTS: VOYAGE INDEX \( t \)
REGRESSED ON TANKER INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>F. RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNKIND(_t)</td>
<td>91.12</td>
<td>0.27</td>
<td>3.60*</td>
<td>0.13</td>
<td>12.97*</td>
<td>12.28</td>
<td>0.21</td>
</tr>
<tr>
<td>TNKIND(_{t-1})</td>
<td>93.04</td>
<td>0.24</td>
<td>3.10*</td>
<td>0.10</td>
<td>9.66*</td>
<td>12.56</td>
<td>0.28</td>
</tr>
<tr>
<td>TNKIND(_{t-2})</td>
<td>93.68</td>
<td>0.23</td>
<td>2.94*</td>
<td>0.09</td>
<td>8.65*</td>
<td>12.69</td>
<td>0.24</td>
</tr>
<tr>
<td>TNKIND(_{t-3})</td>
<td>94.95</td>
<td>0.21</td>
<td>2.65*</td>
<td>0.07</td>
<td>7.06*</td>
<td>12.86</td>
<td>0.22</td>
</tr>
<tr>
<td>TNKIND(_{t-4})</td>
<td>97.84</td>
<td>0.16</td>
<td>2.03#</td>
<td>0.04</td>
<td>4.13#</td>
<td>13.15</td>
<td>0.22</td>
</tr>
<tr>
<td>TNKIND(_{t-5})</td>
<td>99.75</td>
<td>0.13</td>
<td>1.64</td>
<td>0.03</td>
<td>2.71</td>
<td>13.32</td>
<td>0.21</td>
</tr>
<tr>
<td>TNKIND(_{t-6})</td>
<td>100.38</td>
<td>0.13</td>
<td>1.55</td>
<td>0.02</td>
<td>2.40</td>
<td>13.36</td>
<td>0.22</td>
</tr>
</tbody>
</table>

* Significant at .01 level

# significant at .05 level
### TABLE VIII

**RESULTS: TIME INDEX**$_t$

**REGRESSED ON TANKER INDEX**

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>$R^2$</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TNKIND$_t$</td>
<td>96.30</td>
<td>0.27</td>
<td>2.46*</td>
<td>0.06</td>
<td>6.06#</td>
<td>17.94</td>
<td>0.20</td>
</tr>
<tr>
<td>TNKIND$_{t-1}$</td>
<td>94.95</td>
<td>0.30</td>
<td>2.67*</td>
<td>0.07</td>
<td>7.15*</td>
<td>17.89</td>
<td>0.19</td>
</tr>
<tr>
<td>TNKIND$_{t-2}$</td>
<td>96.10</td>
<td>0.28</td>
<td>2.49*</td>
<td>0.06</td>
<td>6.23#</td>
<td>18.04</td>
<td>0.21</td>
</tr>
<tr>
<td>TNKIND$_{t-3}$</td>
<td>96.14</td>
<td>0.28</td>
<td>2.49*</td>
<td>0.07</td>
<td>6.20#</td>
<td>18.13</td>
<td>0.17</td>
</tr>
<tr>
<td>TNKIND$_{t-4}$</td>
<td>100.29</td>
<td>0.21</td>
<td>1.86*</td>
<td>0.04</td>
<td>3.48</td>
<td>18.51</td>
<td>0.20</td>
</tr>
<tr>
<td>TNKIND$_{t-5}$</td>
<td>102.41</td>
<td>0.18</td>
<td>1.56</td>
<td>0.02</td>
<td>2.45</td>
<td>18.71</td>
<td>0.18</td>
</tr>
<tr>
<td>TNKIND$_{t-6}$</td>
<td>102.77</td>
<td>0.18</td>
<td>1.52</td>
<td>0.02</td>
<td>2.33</td>
<td>18.80</td>
<td>0.19</td>
</tr>
</tbody>
</table>

* Significant at .01 level

# Significant at .05 level
First, a one month lag of the tanker index on the time index shows a slightly stronger relationship (although probably not significantly different from a 0, 2, or 3 month lag) and might offer some support to the hypothesis with respect to time charter rates. Secondly, the stronger relationship shown by the tanker and voyage index on a no-lag basis, although appearing to reject the hypothesis with respect to voyage rates, may only be indicative that rate adjustments to competitive pressures in the voyage market are instantaneous, or by the fact that voyage rates may become depressed by the expectation of a transfer of tanker vessels into the voyage market. The monthly index, based as it is on averages, would not reflect this association if it is a short time-lag situation.

Very little could be said of these results even though they are significant and logically valid. However, it is important to note that they do show some evidence of short (0 to 3 month) lags. It could be postulated that a relationship does exist as hypothesized, but very little of the variation of voyage or time rates can be explained by the variation in tanker rates. In addition, the evidence
of autocorrelation prevents us from drawing any pointed conclusions.

2. RELATIONSHIP BETWEEN LAID UP CARGO TONNAGE AND CHARTER RATES

Chapter III established the fact that the movement of ships into lay up follows a period of low rates where some ships find that revenues do not cover the variable cost of operation. Logically, it would be expected that a high level of rates would be associated with a low level of laid up tonnage and vice versa. It can therefore be hypothesised:

1. "The level of laid up cargo tonnage will vary inversely with the level of time and voyage rates."

It is also known from previous discussion that shipowners will accept any rate above the lay-up cost rather than lay their ships up. Consequently, it would be expected that the incidence of laid up tonnage would lag somewhat behind the level of charter rates. This assumption in the form of a second hypothesis would be:

2. "The level of laid up cargo tonnage will lag the level of rates by some time period."

If consideration is given to the fact that owners are re-
luctant to lay up vessels because of the costs involved (particularly if conditions in the market are expected to improve), it might also be assumed that on a voyage basis, owners would continue to operate ships until the time that lay-ups became absolutely necessary because of economic considerations. On the other hand, the length of commitment involved in a time charter should dictate an earlier lay up of these vessels. A third hypothesis can therefore be formulated:

3. "The lagged relationship between laid up cargo tonnage and the time index will be less than the equivalent relationship with regards to the voyage index."

The results of the regressions run on the functional relationships:

\[
\text{Laid Up Cargo Tonnage} = f (\text{Voyage Index})
\]

\[
\text{Laid Up Cargo Tonnage} = f (\text{Time Index})
\]

are listed in Tables IX and X. Several things can be inferred from these results. First, the negative signs of all of the regression coefficients support the assumption of an inverse relationship and thus hypothesis 1 is accepted for both the time and the voyage index. Secondly, also for both
### TABLE IX

RESULTS: LAID UP CARGO\(_t\)

REGRESSED ON VOYAGE INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R*</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOYIND(_t)</td>
<td>4676.39</td>
<td>-33.26</td>
<td>-5.20*</td>
<td>0.24*</td>
<td>27.11</td>
<td>776.55</td>
<td>0.23</td>
</tr>
<tr>
<td>VOYIND(_{t-1})</td>
<td>5058.09</td>
<td>-37.01</td>
<td>-6.26*</td>
<td>0.31*</td>
<td>39.25</td>
<td>718.03</td>
<td>0.29</td>
</tr>
<tr>
<td>VOYIND(_{t-2})</td>
<td>5443.51</td>
<td>-40.74</td>
<td>-7.49*</td>
<td>0.40*</td>
<td>56.16</td>
<td>660.22</td>
<td>0.35</td>
</tr>
<tr>
<td>VOYIND(_{t-3})</td>
<td>5780.41</td>
<td>-43.97</td>
<td>-8.77*</td>
<td>0.48*</td>
<td>77.01</td>
<td>607.44</td>
<td>0.40</td>
</tr>
<tr>
<td>VOYIND(_{t-4})</td>
<td>5896.24</td>
<td>-45.20</td>
<td>-9.48*</td>
<td>0.52*</td>
<td>90.053</td>
<td>577.24</td>
<td>0.47</td>
</tr>
<tr>
<td>VOYIND(_{t-5})</td>
<td>5949.31</td>
<td>-45.80</td>
<td>-9.94*</td>
<td>0.55*</td>
<td>98.82</td>
<td>558.02</td>
<td>0.46</td>
</tr>
<tr>
<td>VOYIND(_{t-6})</td>
<td>5923.66</td>
<td>-45.86</td>
<td>-11.70*</td>
<td>0.63*</td>
<td>137.03</td>
<td>474.33</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Significant at .01 level
### Table X

**Results:** Laid Up Cargo sub\(_t\)  
**Regressed On:** Time Index

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Constant</th>
<th>Regression Coefficient</th>
<th>t-Value</th>
<th>( R^2 )</th>
<th>F Ratio</th>
<th>Sx.( \hat{y} )</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMIND(_t)</td>
<td>4689.69</td>
<td>-31.86</td>
<td>-8.17*</td>
<td>0.44*</td>
<td>66.85</td>
<td>667.26</td>
<td>0.37</td>
</tr>
<tr>
<td>TIMIND(_{t-1})</td>
<td>4856.76</td>
<td>-33.56</td>
<td>-9.52*</td>
<td>0.51*</td>
<td>90.72</td>
<td>603.06</td>
<td>0.40</td>
</tr>
<tr>
<td>TIMIND(_{t-2})</td>
<td>4940.02</td>
<td>-34.48</td>
<td>-10.57*</td>
<td>0.57*</td>
<td>111.84</td>
<td>557.97</td>
<td>0.49</td>
</tr>
<tr>
<td>TIMIND(_{t-3})</td>
<td>4945.58</td>
<td>-34.69</td>
<td>-11.09*</td>
<td>0.60*</td>
<td>123.19</td>
<td>534.72</td>
<td>0.59</td>
</tr>
<tr>
<td>TIMIND(_{t-4})</td>
<td>4927.10</td>
<td>-34.69</td>
<td>-11.42*</td>
<td>0.61*</td>
<td>130.60</td>
<td>518.98</td>
<td>0.55</td>
</tr>
<tr>
<td>TIMIND(_{t-5})</td>
<td>4783.32</td>
<td>-33.55</td>
<td>-10.74*</td>
<td>0.59*</td>
<td>115.44</td>
<td>533.76</td>
<td>0.52</td>
</tr>
<tr>
<td>TIMIND(_{t-6})</td>
<td>4561.39</td>
<td>-31.90</td>
<td>-11.13*</td>
<td>0.61*</td>
<td>124.01</td>
<td>489.31</td>
<td>0.33</td>
</tr>
</tbody>
</table>

*Significant at .01 level
the time and the voyage index, hypothesis 2 is accepted although it will be noticed that the laid up/voyage index relation appears to explain better as the lag is increased while the laid up/time index relation appears more steady. Hypothesis 3 received no support from the results and thus it must be rejected.

As a further illustration, the data for laid up cargo tonnage and the voyage and time indices were plotted on scatter diagrams. Figures III and IV reveal a relationship that appear non-linear. An obvious line of best fit seemed to be concave rather than straight. Consequently, it was decided to use a logarithmic transformation of the variable observations in an effort to improve the fit.

FITTING A LOGARITHMIC CURVE

In the same way that it is possible to represent relations mathematically by a straight line, it is possible to represent them by curves of various types. There are three simple types of logarithmic curves, and if we use \( \bar{Y} \) to represent the logarithms of the Y values, and \( \bar{X} \) to represent the logarithms of the X values, the original
FIGURE III
SCATTER DIAGRAM OF LAID UP CARGO TONNAGE
AND TIME INDEX
1960 - 1967
FIGURE IV
SCATTER DIAGRAM OF LAID UP CARGO TONNAGE
AND VOYAGE INDEX
1960 - 1967
equations and their transformations will be as follows:

(a) \[ \log Y = a + bX, \quad \text{to} \quad \bar{Y} = a + bX \]

(b) \[ \log Y = a + b \log X, \quad \text{to} \quad \bar{Y} = a + b\bar{X} \]

(c) \[ Y = a + b \log X, \quad \text{to} \quad Y = a + b\bar{X} \]

In each case it is evident that the new equation is identical in form with the simple straight-line equation:

\[ Y = a + bX \]

and the same method of regression may therefore be used for finding a line of best fit from the data.

Of the three equations (a, b, and c) listed above, (b) seemed to provide the most satisfactory fit and a series of regressions identical to those performed above were run on the transformed data. The results are exhibited in Tables XI and XII. It is apparent from the tables that the assumption of a non-linear relationship was worthy of merit and the fit of the data was improved somewhat. However, there is no added support or rejection given to any of the three hypotheses from this transformed data.

In spite of the fact that the results in Tables VII to XII are all significant at the 99% level of confidence, no definite conclusions can be drawn because of the presence
TABLE XI

RESULTS: LOG LAID UP CARGO<sub>t</sub>
REGRESSED ON LOG VOYAGE INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R&lt;sup&gt;2&lt;/sup&gt;</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG VOYIND&lt;sub&gt;t&lt;/sub&gt;</td>
<td>23.16</td>
<td>-3.52</td>
<td>-6.19*</td>
<td>0.31*</td>
<td>38.35</td>
<td>0.64</td>
<td>0.14</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>25.10</td>
<td>-3.94</td>
<td>-7.53*</td>
<td>0.40*</td>
<td>56.83</td>
<td>0.59</td>
<td>0.17</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>26.89</td>
<td>-4.32</td>
<td>-9.13*</td>
<td>0.50*</td>
<td>83.52</td>
<td>0.53</td>
<td>0.21</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-3&lt;/sub&gt;</td>
<td>28.19</td>
<td>04.60</td>
<td>-10.70*</td>
<td>0.58*</td>
<td>114.60</td>
<td>0.48</td>
<td>0.30</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-4&lt;/sub&gt;</td>
<td>28.94</td>
<td>-4.77</td>
<td>-12.02*</td>
<td>0.64*</td>
<td>144.63</td>
<td>0.45</td>
<td>0.36</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-5&lt;/sub&gt;</td>
<td>29.38</td>
<td>-4.86</td>
<td>-13.14*</td>
<td>0.68*</td>
<td>172.67</td>
<td>0.42</td>
<td>0.47</td>
</tr>
<tr>
<td>LOG VOYIND&lt;sub&gt;t-6&lt;/sub&gt;</td>
<td>29.68</td>
<td>04.93</td>
<td>-15.19*</td>
<td>0.74*</td>
<td>230.81</td>
<td>0.36</td>
<td>0.50</td>
</tr>
</tbody>
</table>

*Significant at .01 level
TABLE XII

RESULTS: LOG LAID UP CARGO$_t$

REGRESSED ON LOG TIME INDEX

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R$^2$</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG TIMIND$_t$</td>
<td>23.21</td>
<td>-3.50</td>
<td>-10.55*</td>
<td>0.56*</td>
<td>111.34</td>
<td>0.51</td>
<td>0.29</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-1}$</td>
<td>24.14</td>
<td>-3.70</td>
<td>-12.65*</td>
<td>0.65*</td>
<td>160.18</td>
<td>0.45</td>
<td>0.33</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-2}$</td>
<td>24.72</td>
<td>-3.83</td>
<td>-14.77*</td>
<td>0.72*</td>
<td>218.26</td>
<td>0.40</td>
<td>0.43</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-3}$</td>
<td>24.88</td>
<td>-3.87</td>
<td>-16.05*</td>
<td>0.75*</td>
<td>257.71</td>
<td>0.37</td>
<td>0.61</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-4}$</td>
<td>24.90</td>
<td>-3.87</td>
<td>-16.97*</td>
<td>0.78*</td>
<td>288.01</td>
<td>0.35</td>
<td>0.60</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-5}$</td>
<td>24.55</td>
<td>-3.80</td>
<td>-16.36*</td>
<td>0.77*</td>
<td>267.92</td>
<td>0.35</td>
<td>0.69</td>
</tr>
<tr>
<td>LOG TIMIND$_{t-6}$</td>
<td>24.11</td>
<td>-3.17</td>
<td>-16.60*</td>
<td>0.77*</td>
<td>275.67</td>
<td>0.34</td>
<td>0.53</td>
</tr>
</tbody>
</table>

*Significant at .01 level
of the low Durbin Watson Statistic indicating auto-correlation. Before attempting to eliminate this problem, the relationship between shipbuilding and charter rates is examined.

3. THE RELATIONSHIP BETWEEN SHIPBUILDING ACTIVITY AND CHARTER RATES

An important area to investigate is monthly activity in the shipbuilding industry to discover if this activity has any impact on charter rates, or, alternatively, if it is more likely that the rates existing in the market influence the building of vessels. It is apparent that the amount of tonnage built in any one month is very small compared to the total existing tonnage of the world fleet but it does constitute additions to the supply of shipping space available. If shipowner's expectations are reflected in the behaviour of rates as has been suggested, we might expect different reactions during the shipbuilding cycle. This cycle can be divided into three distinct phases: (1) vessel ordering, (2) vessel launching, and (3) completion of the vessel. These phases are investigated in this order below.
It has been suggested by Jones\textsuperscript{13} and O'Loughlin\textsuperscript{14} that tramp freight rates are subject to wide fluctuations which are accentuated by the eagerness with which shipowners place orders for new tonnage during every period of high freights. It can therefore be hypothesised that:

1. "There will be a positive relationship between the level of new orders and the level of charter rates."

In addition, it can be assumed that shipowners would only be encouraged to order new vessels if they expect the high level of freight rates to continue. Therefore, it is to be expected that there will be a slight time lag between the level of freights and the level of new orders; consequently, a second hypothesis would be:

2. "The level of charter rates will precede the ordering of new vessels by some time period."

However, recognising the fact that tramp rates are

\textsuperscript{13} Jones, \textit{op. cit.} p. 34

\textsuperscript{14} O'Loughlin, \textit{op.cit.} p.88
characterized by cyclical movements of "boom" and "slumps" as revealed in Figure II, it might be expected that because of the lead time between the ordering and delivery of a vessel, the placing of orders to take advantage of "boom" periods in tramp shipping would be too late. By the time the major portion of these vessels were delivered, the market may have levelled off and they would not secure the advantages of the high freights existing at the time of ordering. Thorburn\textsuperscript{15} has suggested that building costs at shipyards vary very much with the trade situation as do, to a greater extent, the shipyard price of new vessels. He postulates that reductions by 25 to 50 per cent from the boom years to slump years may occur. Therefore, he concludes that this factor probably contributes towards inducing some shipowners to order new vessels in times of bad trade. If it can be assumed that this could be a major consideration by prospective owners, then we are faced with a completely opposite hypothesis to No. 1, which seems to be valid from a conceptual standpoint. This hypothesis would

be cast as the following:

3. "There will be a negative relationship between the level of new orders for vessels and charter rates."

Table XIII and Table XIV present the results of regression tests run on the functional relationships:

- New Orders (Bulk Carriers) = f (Voyage Index)
- New Orders (Bulk Carriers) = f (Time Index)

On the basis of the statistical results, support is given to hypothesis No.1 since the data appears to substantiate a positive relationship between the two variables. For the same reason, hypothesis No.3 must be rejected. With reference to hypothesis No.2, the data would suggest that there is a slight lag between the level of charter rates and new vessel ordering and thus the hypothesis cannot be rejected. Although the magnitude of this variation between a lag and no-lag situation is small, according to the data it cannot be ignored. This is evident when Table XIV is considered where the pattern of lag is quite noticeable by the obvious decline in the fit of the data following a one month lag of the independent variable. In addition to the fact that the results for both the time and voyage index
<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R²</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOYIND&lt;sub&gt;t&lt;/sub&gt;</td>
<td>-617.93</td>
<td>8.69</td>
<td>5.20*</td>
<td>0.24*</td>
<td>27.05</td>
<td>203.29</td>
<td>1.94</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-777.32</td>
<td>10.17</td>
<td>6.44*</td>
<td>0.33*</td>
<td>41.48</td>
<td>192.07</td>
<td>1.90</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>-651.58</td>
<td>9.02</td>
<td>5.41*</td>
<td>0.26*</td>
<td>29.32</td>
<td>202.4</td>
<td>2.06</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-3&lt;/sub&gt;</td>
<td>-691.85</td>
<td>9.39</td>
<td>5.67*</td>
<td>0.28*</td>
<td>32.24</td>
<td>200.63</td>
<td>1.92</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-4&lt;/sub&gt;</td>
<td>-648.54</td>
<td>9.02</td>
<td>5.35*</td>
<td>0.26*</td>
<td>28.71</td>
<td>204.00</td>
<td>1.89</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-5&lt;/sub&gt;</td>
<td>-546.63</td>
<td>8.07</td>
<td>4.60*</td>
<td>0.20*</td>
<td>21.17</td>
<td>212.39</td>
<td>1.82</td>
</tr>
<tr>
<td>VOYIND&lt;sub&gt;t-6&lt;/sub&gt;</td>
<td>-497.63</td>
<td>7.63</td>
<td>4.27*</td>
<td>0.18*</td>
<td>18.30</td>
<td>215.99</td>
<td>1.70</td>
</tr>
</tbody>
</table>

*Significant at .01 level
### TABLE XIV

**RESULTS: NEW ORDERS BULK CARRIERS, \( t \) REGRESSED ON TIME INDEX**

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMIND ( t )</td>
<td>-408.41</td>
<td>6.44</td>
<td>5.51*</td>
<td>0.24*</td>
<td>26.65</td>
<td>203.7</td>
<td>1.91</td>
</tr>
<tr>
<td>TIMIND ( t-1 )</td>
<td>-450.99</td>
<td>6.83</td>
<td>5.93*</td>
<td>0.29*</td>
<td>35.22</td>
<td>197.05</td>
<td>1.91</td>
</tr>
<tr>
<td>TIMIND ( t-2 )</td>
<td>-380.32</td>
<td>6.22</td>
<td>5.21*</td>
<td>0.24*</td>
<td>27.19</td>
<td>204.40</td>
<td>1.91</td>
</tr>
<tr>
<td>TIMIND ( t-3 )</td>
<td>-346.73</td>
<td>5.94</td>
<td>4.87*</td>
<td>0.22*</td>
<td>23.74</td>
<td>208.54</td>
<td>1.79</td>
</tr>
<tr>
<td>TIMIND ( t-4 )</td>
<td>-268.53</td>
<td>5.27</td>
<td>4.18*</td>
<td>0.17*</td>
<td>17.51</td>
<td>215.27</td>
<td>1.73</td>
</tr>
<tr>
<td>TIMIND ( t-5 )</td>
<td>-231.11</td>
<td>4.93</td>
<td>3.84*</td>
<td>0.15*</td>
<td>14.78</td>
<td>219.43</td>
<td>1.61</td>
</tr>
<tr>
<td>TIMIND ( t-6 )</td>
<td>-108.27</td>
<td>3.86</td>
<td>2.89*</td>
<td>0.09*</td>
<td>8.40</td>
<td>227.90</td>
<td>1.57</td>
</tr>
</tbody>
</table>

*Significant at .01 level
regressed on new orders are all statistically significant at the 99 per cent confidence level, it will be noticed that there is an absence of autocorrelation as evidenced by the Durbin Watson Statistic which is well within the significant limits as outlined in Appendix II.

From this discussion, it can be said with confidence that the level of charter rates has a definite influence on the ordering of new bulk carriers. However, judgement is reserved in stating the amount of variation in new orders that can be explained by the variations in rates particularly in a lag situation because the validity of the statistical results is marginal.

**CHARTER RATES AND VESSELS LAUNCHED**

The launching of vessels precedes the actual delivery of vessels to shipowners by a period of several weeks or even months depending on the type and size of vessel. In other words, this stage of shipbuilding is somewhat closer to the time when these vessels will add to the existing supply than

16 The source from which the data on launchings was extracted revealed a period of from six weeks to five months between launching and completing of vessels.
is the case with vessel ordering. Therefore, it is conceivable that the launching of vessels could have an effect on freight rates, if rates are in any way influenced by these impending additions to supply. An hypothesis following this line of reasoning could be stated:

1. "The level of charter rates will be inversely related to the launching of new vessels, with a strengthening of this relationship shown when the launching of vessels precedes the rates."

However, it is also well known that shipyards have the capacity to vary the scheduling of their launchings by either slowing construction or suspending it entirely if there is no pressure for delivery. This pressure would certainly be absent if a shipowner felt he would be taking delivery of a vessel during a slump period in rates. This dichotomy introduces the opposing hypothesis of an opposite functional relationship i.e., launching as a function of rates rather than the reverse. The hypothesis would be:

2. "The launching of cargo vessels will be positively related to the level of charter rates."

Tables XV and XVI present the results of the regressions run on the relationships accompanying hypothesis 1.
TABLE XV

RESULTS: VOYAGE INDEX\(^{t}\) REGRESSED ON LAUNCHED CARGO VESSELS

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>(R^2)</th>
<th>F RATIO</th>
<th>Sx.y D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANCAR(^t)</td>
<td>122.33</td>
<td>-0.08</td>
<td>-7.12*</td>
<td>0.37*</td>
<td>50.78</td>
<td>10.43</td>
</tr>
<tr>
<td>LANCAR(_{-1})</td>
<td>122.46</td>
<td>-0.08</td>
<td>-7.11</td>
<td>0.37*</td>
<td>50.55</td>
<td>10.47</td>
</tr>
<tr>
<td>LANCAR(_{-2})</td>
<td>122.71</td>
<td>-0.08</td>
<td>-7.07*</td>
<td>0.37*</td>
<td>49.98</td>
<td>10.53</td>
</tr>
<tr>
<td>LANCAR(_{-3})</td>
<td>121.74</td>
<td>-0.07</td>
<td>-6.27*</td>
<td>0.32*</td>
<td>39.32</td>
<td>11.01</td>
</tr>
<tr>
<td>LANCAR(_{-4})</td>
<td>122.11</td>
<td>-0.07</td>
<td>-6.38*</td>
<td>0.33*</td>
<td>40.76</td>
<td>10.99</td>
</tr>
<tr>
<td>LANCAR(_{-5})</td>
<td>121.13</td>
<td>-0.07</td>
<td>-5.67*</td>
<td>0.28*</td>
<td>32.17</td>
<td>11.44</td>
</tr>
<tr>
<td>LANCAR(_{-6})</td>
<td>120.54</td>
<td>-0.06</td>
<td>-5.23*</td>
<td>0.25*</td>
<td>27.36</td>
<td>11.69</td>
</tr>
</tbody>
</table>

*Significant at .01 level
## TABLE XVI

**RESULTS: TIME INDEX**

**REGRESSED ON LAUNCHED CARGO VESSELS**

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>$R^2$</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LANCAR$_t$</td>
<td>135.05</td>
<td>-0.122</td>
<td>-8.15*</td>
<td>0.43*</td>
<td>66.44</td>
<td>13.91</td>
<td>0.68</td>
</tr>
<tr>
<td>LANCAR$_{t-1}$</td>
<td>134.63</td>
<td>-0.119</td>
<td>-7.70*</td>
<td>0.41*</td>
<td>59.31</td>
<td>14.27</td>
<td>0.74</td>
</tr>
<tr>
<td>LANCAR$_{t-2}$</td>
<td>135.80</td>
<td>-0.123</td>
<td>-8.13*</td>
<td>0.44*</td>
<td>66.23</td>
<td>13.94</td>
<td>0.64</td>
</tr>
<tr>
<td>LANCAR$_{t-3}$</td>
<td>135.63</td>
<td>-0.122</td>
<td>-7.91*</td>
<td>0.43*</td>
<td>62.67</td>
<td>14.15</td>
<td>0.68</td>
</tr>
<tr>
<td>LANCAR$_{t-4}$</td>
<td>135.39</td>
<td>-0.120</td>
<td>-7.56*</td>
<td>0.41*</td>
<td>57.21</td>
<td>14.47</td>
<td>0.66</td>
</tr>
<tr>
<td>LANCAR$_{t-5}$</td>
<td>135.04</td>
<td>-0.117</td>
<td>-7.27*</td>
<td>0.39*</td>
<td>52.85</td>
<td>14.74</td>
<td>0.65</td>
</tr>
<tr>
<td>LANCAR$_{t-6}$</td>
<td>135.21</td>
<td>-0.117</td>
<td>-7.25*</td>
<td>0.39*</td>
<td>52.65</td>
<td>14.78</td>
<td>0.56</td>
</tr>
</tbody>
</table>

*Significant at .01 level
It can be inferred from the results that the hypothesis is supported with regards to an inverse relationship between the two variables. The data, however, offer no support to the assumption of a time-lag situation unless one were to construe the very slight movement in this respect exhibited by a two-month lag of the launchings on the time index as being statistically valid, which is doubtful. Hypothesis 2 is rejected immediately without further testing because of the inverse relationship shown in the previous tests which would be identical if tests were performed with the dependent and independent variables reversed. Conclusions drawn on the basis of these results would again be indecisive because of the presence of autocorrelation.

**CHARTER RATES AND SHIP COMPLETIONS**

Ship completions constitute actual additions to the supply of shipping. At this stage the vessels are now available for actual service in the transporting of commodities. An argument frequently advanced is that a fall in freights is due to an increase in total tonnage, or overproduction.  

17 In spite of the fact that, as has been  

17 Jones, *op. cit.* p.37
mentioned, the absolute monthly increases are very small compared to the total size of the existing fleet at the time. This does not necessarily mean this is not a valid argument, but it is assumed that the impact would be quite small. It would also be expected, assuming an inverse relationship exists, that there would be a lag of some time period between the level of ship completions and that of rates. From this argument it can be hypothesised:

"The level of charter rates will be inversely related to the completion of cargo tonnage with a strengthening of this relationship revealed as the completion of vessels precedes the level of rates."

The regression results of the voyage and time index as a function of the completion of cargo vessels are exhibited in Tables XVII and XVIII. The results offer support to the hypothesis regarding the negative relationship between the two indices and completions, but to accept it on the basis of a lag relationship as stated is questionable. It

18 For 1967, according to our data, the highest monthly total for the completion of all dry cargo vessels was approximately one-quarter of one per cent of the total merchant fleet (over 1000 G.R.T.) on June 30 of that year. (Shipping Statistics. Bremen: Institute of Shipping Economics 1968, p. II-4).
**TABLE XVII**

**RESULTS: TIME INDEX $t$**

REGRESSED ON COMPLETED CARGO VESSELS

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>$t$-VALUE</th>
<th>$R^2$</th>
<th>$F$ RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$ &amp; CCAR$_t$</td>
<td>133.06</td>
<td>-0.1258</td>
<td>-8.24*</td>
<td>0.44*</td>
<td>67.99</td>
<td>13.84</td>
<td>0.66</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-1}$</td>
<td>133.55</td>
<td>-0.1275</td>
<td>-8.38*</td>
<td>0.45*</td>
<td>70.36</td>
<td>13.75</td>
<td>0.69</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-2}$</td>
<td>133.37</td>
<td>-0.1252</td>
<td>-8.09*</td>
<td>0.44*</td>
<td>65.56</td>
<td>13.98</td>
<td>0.63</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-3}$</td>
<td>132.64</td>
<td>-0.1194</td>
<td>-7.36*</td>
<td>0.39*</td>
<td>54.23</td>
<td>14.59</td>
<td>0.60</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-4}$</td>
<td>131.67</td>
<td>-0.1131</td>
<td>-6.71*</td>
<td>0.35*</td>
<td>45.12</td>
<td>15.85</td>
<td>0.63</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-5}$</td>
<td>132.44</td>
<td>-0.1169</td>
<td>-7.03*</td>
<td>0.38*</td>
<td>49.43</td>
<td>14.93</td>
<td>0.57</td>
</tr>
<tr>
<td>$T$ &amp; CCAR$_{t-6}$</td>
<td>133.14</td>
<td>-0.1199</td>
<td>-7.29*</td>
<td>0.40*</td>
<td>53.27</td>
<td>14.74</td>
<td>0.59</td>
</tr>
</tbody>
</table>

*Significant at .01 level*
<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R²</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T &amp; CCARₜ</td>
<td>120.69</td>
<td>-0.080</td>
<td>-6.91*</td>
<td>0.35*</td>
<td>47.65</td>
<td>10.55</td>
<td>0.60</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₁</td>
<td>120.93</td>
<td>-0.081</td>
<td>-6.98*</td>
<td>0.36*</td>
<td>48.73</td>
<td>10.55</td>
<td>0.57</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₂</td>
<td>120.68</td>
<td>-0.079</td>
<td>-6.67*</td>
<td>0.34*</td>
<td>44.50</td>
<td>10.76</td>
<td>0.54</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₃</td>
<td>120.20</td>
<td>-0.075</td>
<td>-6.11*</td>
<td>0.31*</td>
<td>37.45</td>
<td>11.10</td>
<td>0.47</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₄</td>
<td>119.16</td>
<td>-0.069</td>
<td>-5.35*</td>
<td>0.26*</td>
<td>28.70</td>
<td>11.58</td>
<td>0.48</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₅</td>
<td>119.00</td>
<td>-0.067</td>
<td>-5.15*</td>
<td>0.24*</td>
<td>26.54</td>
<td>11.74</td>
<td>0.46</td>
</tr>
<tr>
<td>T &amp; CCARₜ₋₆</td>
<td>119.55</td>
<td>-0.069</td>
<td>-5.38*</td>
<td>0.26*</td>
<td>28.96</td>
<td>11.60</td>
<td>0.44</td>
</tr>
</tbody>
</table>

*Significant at .01 level
cannot be rejected because the data does indicate the relationship appears to move in the direction as hypothesized, particularly in the results encompassing the voyage index. The statistical validity is in doubt however since the problem of autocorrelation is in evidence.

4. **RELATIONSHIP BETWEEN WORLD SEA TRADE AND CHARTER RATES**

Chapter II referred to the demand for shipping as being represented by the volume of goods to be carried and the distances over which they are carried. As such, expectations would be that the volume of seaborne trade would be closely related to charter rates. Granted, there is a bit of distortion introduced into this relationship, because, as has been previously mentioned, over half of the world seaborne trade is accounted for by the carriage of oil. Consequently, during an investigation of charter rates as a function of world sea trade, cognizance must be taken of the fact that data used in this thesis include this component. However, it is assumed here that international trade in oil is not generally characterized by the seasonal fluctuations which are found in dry cargo trade, and changes
in demand for tanker capacity is generated not by increases in the volume of oil to be transported, but rather by demands for longer hauls and, in turn, to the supply of tanker ships. Thus the relationship should be relatively the same with the volume of oil trade in or out of the data. An hypothesis can therefore be cast:

1. "The level of charter rates will bear a positive relationship to the volume of world seaborne trade."

Also, given what is known about the supply curve for tramp shipping in the short run, i.e., it is relatively inelastic, and if competition is as ubiquitous in the tramp market as has been maintained, then another assumption would be that any change in the demand for shipping space due to an increased volume of trade would be reflected almost instantaneously in charter rates.

Following this line of reasoning, another hypothesis can be indited:

2. "The closest relationships between charter rates and the volume of seaborne trade will be found when using concurrent observations of the data."

The results of Tables XIX and XX bear out the assumption of a positive relationship existing between
### TABLE XIX

**RESULTS: VOYAGE INDEX**

REGRESSED ON WORLD SEA TRADE

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>$R^2$</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORSEA$_t$</td>
<td>77.06</td>
<td>0.2556</td>
<td>4.82*</td>
<td>0.21*</td>
<td>23.30</td>
<td>11.68</td>
<td>0.23</td>
</tr>
<tr>
<td>WORSEA$_{t-1}$</td>
<td>78.31</td>
<td>0.2461</td>
<td>4.53*</td>
<td>0.19*</td>
<td>20.58</td>
<td>11.88</td>
<td>0.28</td>
</tr>
<tr>
<td>WORSEA$_{t-2}$</td>
<td>79.41</td>
<td>0.2376</td>
<td>4.30*</td>
<td>0.18*</td>
<td>18.51</td>
<td>12.05</td>
<td>0.28</td>
</tr>
<tr>
<td>WORSEA$_{t-3}$</td>
<td>79.54</td>
<td>0.2376</td>
<td>4.25*</td>
<td>0.18*</td>
<td>18.12</td>
<td>12.13</td>
<td>0.26</td>
</tr>
<tr>
<td>WORSEA$_{t-4}$</td>
<td>78.81</td>
<td>0.2446</td>
<td>4.31*</td>
<td>0.18*</td>
<td>18.58</td>
<td>12.16</td>
<td>0.29</td>
</tr>
<tr>
<td>WORSEA$_{t-5}$</td>
<td>75.69</td>
<td>0.2729</td>
<td>4.75*</td>
<td>0.22*</td>
<td>22.58</td>
<td>11.96</td>
<td>0.23</td>
</tr>
<tr>
<td>WORSEA$_{t-6}$</td>
<td>75.68</td>
<td>0.2757</td>
<td>4.63*</td>
<td>0.21*</td>
<td>21.43</td>
<td>12.03</td>
<td>0.26</td>
</tr>
</tbody>
</table>

*Significant at .01 level
### TABLE XX

RESULTS: TIME INDEX$_t$ REGRESSED ON WORLD SEA TRADE

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>$R^2$</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORSEA$_t$</td>
<td>55.17</td>
<td>0.4796</td>
<td>7.24*</td>
<td>0.38*</td>
<td>52.47</td>
<td>14.60</td>
<td>0.33</td>
</tr>
<tr>
<td>WORSEA$_{t-1}$</td>
<td>57.22</td>
<td>0.4648</td>
<td>6.80*</td>
<td>0.35*</td>
<td>46.33</td>
<td>14.96</td>
<td>0.32</td>
</tr>
<tr>
<td>WORSEA$_{t-2}$</td>
<td>60.46</td>
<td>0.4399</td>
<td>6.21*</td>
<td>0.31*</td>
<td>38.67</td>
<td>15.44</td>
<td>0.37</td>
</tr>
<tr>
<td>WORSEA$_{t-3}$</td>
<td>59.14</td>
<td>0.4525</td>
<td>6.40*</td>
<td>0.33*</td>
<td>41.01</td>
<td>15.35</td>
<td>0.29</td>
</tr>
<tr>
<td>WORSEA$_{t-4}$</td>
<td>58.38</td>
<td>0.4611</td>
<td>6.41*</td>
<td>0.33*</td>
<td>41.17</td>
<td>15.39</td>
<td>0.35</td>
</tr>
<tr>
<td>WORSEA$_{t-5}$</td>
<td>55.06</td>
<td>0.4922</td>
<td>6.77*</td>
<td>0.36*</td>
<td>45.87</td>
<td>15.14</td>
<td>0.31</td>
</tr>
<tr>
<td>WORSEA$_{t-6}$</td>
<td>53.45</td>
<td>0.5096</td>
<td>6.79*</td>
<td>0.36*</td>
<td>46.10</td>
<td>15.16</td>
<td>0.32</td>
</tr>
</tbody>
</table>

*Significant at .01 level
the two variables and hypothesis 1 is accepted in this respect (with reservations, however, because of the evidence of autocorrelation). Hypothesis 2, is not rejected completely only because the data appears to show very little variation over the period but it would have to be said that the results are inconclusive. In addition, autocorrelation is again ever present in the residuals.

It was also recognized that the demand for the carriage of seaborne trade is reputed to display distinct seasonal movements. To see if the "fit" of the data could be improved somewhat, the world sea trade data were seasonally adjusted and the same series of regressions were run as a further test of the original hypothesis. For the sake of exposition, Table XXI presents the results of the voyage index regressed on seasonally adjusted world sea trade. As can be seen, the results offer no further support or rejection of the hypotheses than has already been established.

**SUMMARY**

This chapter has examined, by means of graphs,
<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE**</th>
<th>CONSTANT</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>R²</th>
<th>F RATIO</th>
<th>Sx.y</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORSEA_t</td>
<td>77.36</td>
<td>0.2529</td>
<td>4.79*</td>
<td>0.21*</td>
<td>23.02</td>
<td>11.69</td>
<td>0.24</td>
</tr>
<tr>
<td>WORSEA_{t-1}</td>
<td>78.90</td>
<td>0.2408</td>
<td>4.45*</td>
<td>0.19*</td>
<td>19.86</td>
<td>11.92</td>
<td>0.29</td>
</tr>
<tr>
<td>WORSEA_{t-2}</td>
<td>79.31</td>
<td>0.2384</td>
<td>4.33*</td>
<td>0.18*</td>
<td>18.83</td>
<td>12.04</td>
<td>0.28</td>
</tr>
<tr>
<td>WORSEA_{t-3}</td>
<td>79.49</td>
<td>0.2379</td>
<td>4.28*</td>
<td>0.18*</td>
<td>18.36</td>
<td>12.11</td>
<td>0.26</td>
</tr>
<tr>
<td>WORSEA_{t-4}</td>
<td>79.26</td>
<td>0.2409</td>
<td>4.26*</td>
<td>0.18*</td>
<td>18.22</td>
<td>12.18</td>
<td>0.29</td>
</tr>
<tr>
<td>WORSEA_{t-5}</td>
<td>76.62</td>
<td>0.2647</td>
<td>4.63*</td>
<td>0.21*</td>
<td>21.49</td>
<td>12.03</td>
<td>0.25</td>
</tr>
<tr>
<td>WORSEA_{t-6}</td>
<td>75.35</td>
<td>0.2784</td>
<td>4.68*</td>
<td>0.21*</td>
<td>21.91</td>
<td>12.00</td>
<td>0.27</td>
</tr>
</tbody>
</table>

*Significant at .01 level

** Seasonally adjusted
figures and statistical tests, several relationships which were hypothesised to exist between charter rates and various variables of supply and demand in the tramp shipping industry. The data appeared to support or reject several of the hypotheses put forth; however, it was impossible to draw any definite conclusions concerning any relationships because in a large majority of the tests performed, it was obvious that the problem of autocorrelation in the residuals was present. From the discussion presented at the beginning of this chapter, it was apparent the results could not be accepted at face value and that some further manipulation of the data were necessary if there were to be any meaningful results obtained. It is this problem of autocorrelation and the attempt to eliminate it from the data which is the area of concern in the following chapter.
CHAPTER V

EXAMINATION OF THE CHANGE IN CHARTER RATES WITH THE CHANGE IN SELECTED VARIABLES

INTRODUCTION

The problem of autocorrelation in time series analysis proved to be very prevalent in the statistical testing performed and reported in Chapter IV. However, it has been mentioned that the method of least squares still produces the best linear unbiased estimates of the regression coefficients provided account is taken of the lack of independence in the error series (i.e., residuals). There are several methods of dealing with this phenomenon of autocorrelation, one of which is to examine the month-to-month changes in the data rather than the absolute monthly values.¹ This method - albeit a crude one - is

¹The common sense meaning of a regression between first differences is as follows: If (say) high original values of price are associated with low original values of consumption and vice versa, it follows logically that a change from a high price to a low price will be associated with a change from a low consumption to a high consumption figure. In strictly random samples, linear regression coefficients estimated from first differences will closely approximate those obtained from the original values. (See:
commonly referred to as "first differences".

**USE AND METHOD OF FIRST DIFFERENCES OF DATA**

The justification for using a first difference transformation of data is expressed by Fisser:

"The primary device for the estimation of short run reactions is the use of first differences of the data. Aside from the fact that such use often (but by no means always) has the convenience of reducing or eliminating autocorrelation in the residuals, or reducing multicollinearity, it seems analytically the correct form for the estimation of short-run functions." \(^2\)

In this thesis, the primary concern is with short-run reactions, and thus the method seemed the proper one to use.

Transforming the observation on the variables to first differences is accomplished by the following:

\[ Y_i \rightarrow Y_i^t = Y_i - Y_{i-1} \]

\[ X_{ji} \rightarrow X_{ji}^t = X_{ji} - X_{ji}^{(i-1)}, \text{ for } j = 1, 2, \ldots, K. \]


Without delving into the intricacies of mathematical derivation, it will suffice to say here that under this method, the autocorrelation of the disturbance term of the first difference equation tends to zero and it is thus held that the transformation to first differences may therefore serve to deal with the worst cases of autocorrelated disturbances.³

REGRESSION RESULTS USING FIRST DIFFERENCES

The foregoing method was applied to all data and the transformed variables were then subjected to a regression analysis, using the same format of tests as used in the series of regressions run previously, to discover if:

1. the method used would be successful in removing the autocorrelation in the residuals, and

2. the results of the tests would support or reject the hypothesis as set out in Chapter IV.

To avoid confusion and repetition of figures, Tables XXII - XXV present partial comparative results between one

TABLE XXII

\( \Delta \text{TIME INDEX}_t \) \hspace{1cm} \Delta \text{TIME INDEX}_t \hspace{1cm} \text{TIME INDEX}_t

REGRESSED ON \( \Delta \text{VOYAGE INDEX} \) \hspace{1cm} \text{REGRESSED ON VOYAGE INDEX} \hspace{1cm} (RE: TABLE V)

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>D.W.S.</th>
<th>INDEPENDENT VARIABLE</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta \text{VOYIND}_t )</td>
<td>0.5825</td>
<td>4.60</td>
<td>0.20</td>
<td>2.66</td>
<td>( \text{VOYIND}_t )</td>
<td>1.26</td>
<td>18.60</td>
<td>0.80</td>
<td>0.86</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-1} )</td>
<td>0.3616</td>
<td>2.63</td>
<td>0.07</td>
<td>2.45</td>
<td>( \text{VOYIND}_{t-1} )</td>
<td>1.27</td>
<td>19.46</td>
<td>0.81</td>
<td>1.23</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-2} )</td>
<td>0.0081</td>
<td>0.05</td>
<td>0.00</td>
<td>2.17</td>
<td>( \text{VOYIND}_{t-2} )</td>
<td>1.21</td>
<td>15.87</td>
<td>0.75</td>
<td>1.19</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-3} )</td>
<td>-0.1099</td>
<td>-0.74</td>
<td>0.006</td>
<td>2.15</td>
<td>( \text{VOYIND}_{t-3} )</td>
<td>1.16</td>
<td>13.42</td>
<td>0.68</td>
<td>0.97</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-4} )</td>
<td>0.1391</td>
<td>0.93</td>
<td>0.01</td>
<td>2.17</td>
<td>( \text{VOYIND}_{t-4} )</td>
<td>1.12</td>
<td>12.01</td>
<td>0.64</td>
<td>0.67</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-5} )</td>
<td>0.1271</td>
<td>0.84</td>
<td>0.009</td>
<td>2.21</td>
<td>( \text{VOYIND}_{t-5} )</td>
<td>1.06</td>
<td>10.35</td>
<td>0.57</td>
<td>0.54</td>
</tr>
<tr>
<td>( \Delta \text{VOYIND}_{t-6} )</td>
<td>0.1303</td>
<td>0.86</td>
<td>0.009</td>
<td>2.18</td>
<td>( \text{VOYIND}_{t-6} )</td>
<td>0.97</td>
<td>8.63</td>
<td>0.48</td>
<td>0.42</td>
</tr>
<tr>
<td>INDEPENDENT VARIABLE</td>
<td>REGRESSION COEFFICIENT</td>
<td>t-VALUE</td>
<td>R²</td>
<td>D.W.S.</td>
<td>INDEPENDENT VARIABLE</td>
<td>REGRESSION COEFFICIENT</td>
<td>t-VALUE</td>
<td>R²</td>
<td>D.W.S.</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------</td>
<td>---------</td>
<td>----</td>
<td>--------</td>
<td>------------------------</td>
<td>------------------------</td>
<td>---------</td>
<td>----</td>
<td>--------</td>
</tr>
<tr>
<td>Δ TIMINDₜ</td>
<td>1.34</td>
<td>0.27</td>
<td>0.0009</td>
<td>2.38</td>
<td>TIMINDₜ</td>
<td>-31.86</td>
<td>-8.17</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₁</td>
<td>-6.03</td>
<td>-1.25</td>
<td>0.0187</td>
<td>2.45</td>
<td>TIMINDₜ₋₁</td>
<td>-33.56</td>
<td>-9.52</td>
<td>0.51</td>
<td>0.40</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₂</td>
<td>-4.93</td>
<td>-1.02</td>
<td>0.0126</td>
<td>2.48</td>
<td>TIMINDₜ₋₂</td>
<td>-34.48</td>
<td>-10.57</td>
<td>0.57</td>
<td>0.49</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₃</td>
<td>-1.66</td>
<td>-0.34</td>
<td>0.0014</td>
<td>2.46</td>
<td>TIMINDₜ₋₃</td>
<td>-34.69</td>
<td>-11.09</td>
<td>0.60</td>
<td>0.59</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₄</td>
<td>-7.49</td>
<td>-1.54</td>
<td>0.0291</td>
<td>2.16</td>
<td>TIMINDₜ₋₄</td>
<td>-34.69</td>
<td>-11.42</td>
<td>0.61</td>
<td>0.55</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₅</td>
<td>0.32</td>
<td>0.07</td>
<td>0.0001</td>
<td>1.05</td>
<td>TIMINDₜ₋₅</td>
<td>-33.55</td>
<td>-10.74</td>
<td>0.59</td>
<td>0.52</td>
</tr>
<tr>
<td>Δ TIMINDₜ₋₆</td>
<td>-3.19</td>
<td>-1.13</td>
<td>0.0162</td>
<td>1.16</td>
<td>TIMINDₜ₋₆</td>
<td>-31.90</td>
<td>-11.13</td>
<td>0.61</td>
<td>0.33</td>
</tr>
</tbody>
</table>
### TABLE XXIV

#### RESULTS: △ VOYAGE INDEX\(_t\) REGRESSED ON COMPLETED CARGO VESSELS

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>△ T&amp;CCAR(_t)</td>
<td>-0.0007</td>
<td>0.0743</td>
<td>0.0001</td>
<td>1.99</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-1)</td>
<td>-0.0089</td>
<td>0.0042</td>
<td>0.0028</td>
<td>2.09</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-2)</td>
<td>-0.0040</td>
<td>0.4604</td>
<td>0.0026</td>
<td>2.09</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-3)</td>
<td>-0.0045</td>
<td>0.4973</td>
<td>0.0030</td>
<td>2.07</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-4)</td>
<td>0.0101</td>
<td>1.1163</td>
<td>0.0153</td>
<td>2.11</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-5)</td>
<td>0.0105</td>
<td>1.1729</td>
<td>0.0171</td>
<td>2.16</td>
</tr>
<tr>
<td>△ T&amp;CCAR(_t-6)</td>
<td>0.0008</td>
<td>0.0829</td>
<td>0.0001</td>
<td>2.11</td>
</tr>
</tbody>
</table>

#### RESULTS: VOYAGE INDEX\(_t\) REGRESSED ON COMPLETED CARGO VESSELS (RE: TABLE XVIII)

<table>
<thead>
<tr>
<th>INDEPENDENT VARIABLE</th>
<th>REGRESSION COEFFICIENT</th>
<th>t-VALUE</th>
<th>( R^2 )</th>
<th>D.W.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&amp;CCAR(_t)</td>
<td>-0.080</td>
<td>-6.91</td>
<td>0.35</td>
<td>0.60</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-1)</td>
<td>-0.081</td>
<td>-6.98</td>
<td>0.36</td>
<td>0.57</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-2)</td>
<td>-0.079</td>
<td>-6.67</td>
<td>0.34</td>
<td>0.54</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-3)</td>
<td>-0.075</td>
<td>-6.11</td>
<td>0.31</td>
<td>0.47</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-4)</td>
<td>-0.069</td>
<td>-5.35</td>
<td>0.26</td>
<td>0.48</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-5)</td>
<td>-0.067</td>
<td>-5.15</td>
<td>0.24</td>
<td>0.46</td>
</tr>
<tr>
<td>T&amp;CCAR(_t-6)</td>
<td>-0.069</td>
<td>-5.38</td>
<td>0.26</td>
<td>0.44</td>
</tr>
<tr>
<td>INDEPENDENT VARIABLE</td>
<td>REGRESSION COEFFICIENT</td>
<td>t-VALUE</td>
<td>$R^2$</td>
<td>D.W.S.</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------</td>
<td>---------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_t$</td>
<td>0.0622</td>
<td>0.7484</td>
<td>0.0066</td>
<td>2.18</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-1}$</td>
<td>-0.0164</td>
<td>-0.1963</td>
<td>0.0005</td>
<td>2.16</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-2}$</td>
<td>-0.0065</td>
<td>-0.0767</td>
<td>0.0001</td>
<td>2.17</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-3}$</td>
<td>-0.0095</td>
<td>-0.1121</td>
<td>0.0002</td>
<td>2.17</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-4}$</td>
<td>0.0208</td>
<td>0.2429</td>
<td>0.0007</td>
<td>2.17</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-5}$</td>
<td>-0.0452</td>
<td>-0.5261</td>
<td>0.0035</td>
<td>2.12</td>
</tr>
<tr>
<td>$\Delta \text{WORSEA}_{t-6}$</td>
<td>0.0602</td>
<td>0.7138</td>
<td>0.0065</td>
<td>2.24</td>
</tr>
</tbody>
</table>
selected set of regressions out of each category outlined and examined in the previous chapter. Several points can be commented upon from these results, which are typical of those obtained from all the regressions.

First, referring to the primary reason for using first differences, in all cases the positive autocorrelation in the residuals has been eliminated. However, notice should be given to Table XXII concerning two relationships: (1) Time Index$_t$ = f (Voyage Index)$_t$ and (2) Time Index$_t$ = f (Voyage Index)$_{t-1}$. The results reveal that the former is negatively autocorrelated while the latter is in the area of uncertainty as outlined by the significant limits of the Durbin and Watson Test. This of course indicates that no conclusions could be based on these results, which are the only ones that approach being statistically significant in the four tables.

Secondly, it is difficult to explain the reason for the changing of signs in the regression coefficients. However, this may be due in total to the apparent poor fit of the data using first-difference transformations.
Finally, on the basis of the lack of statistical significance in practically all of the results, it would be impossible to draw any conclusions from the results to support or reject any of the hypotheses put forth in the previous chapter. It would also appear to negate any conclusions concerning various relationships that had been drawn on the basis of results obtained from absolute levels of the data.

The poor results of the foregoing tests with first differences of the data, prompted a further investigation. At this point the transformed data (first differences) were plotted to see if anything other than a linear relationship was revealed. Figures V and VI show that this was not the case.

**FURTHER TESTING OF DATA**

Several manipulations of the data were considered in some detail:

1. Monthly data is often subject to seasonal variation, and this was removed in cases where it was thought, on general grounds, that it might exist. The program used was incorporated into the computer regression package. In effect, the program fits a moving average
FIGURE V
SCATTER DIAGRAM OF LAID UP CARGO TONNAGE
AND VOYAGE INDEX
(FIRST DIFFERENCES)
1960 - 1967
LAID UP TONNAGE (000's TONS)

FIGURE VI
SCATTER DIAGRAM OF LAID UP CARGO TONNAGE
AND TIME INDEX
(FIRST DIFFERENCES)
1960 - 1967
to the series, works out the ratio of the actual to the average and constructs a factor for each month which is divided into the actual to give the deseasonalised figure.

2. Logarithmic transformations were used on some of the series for the usual reasons (e.g., that price changes are relative, or that the combined efforts of different variables are multiplicative.

3. Regressions were completed on quarterly averages of the data to eliminate some of the extremely short-run fluctuations.

4. Some of the data were tested with absolute levels of some variables with first differences on the others. It was thought that some of the variables may have very little change from period to period, and that it may show a better relationship if some of the absolute levels were regressed with changes.

5. The number of observations was shortened to eliminate the extreme fluctuations encountered in rates during the Suez crisis of 1967. The data was thus reduced to 87 observations from the original 108.

6. The linear trend was also removed from some of the
data if it seemed that the series would contain it. However, working with first differences on the data does primarily the same job of removing this trend; consequently this method was used to a greater extent.

In each of the aforementioned cases, exhaustive testing was completed using many different combinations of variables, incorporating both leads and lags of the dependent and independent variables. On the whole, approximately 3000 such models were tested. Appendix D contains a list of some of the models that were tested and the results obtained. Several of those tested produced reasonably significant results upon using absolute levels of the data. Unfortunately the same recurring problem of high autocorrelation in the residuals was encountered in every model tested. Moreover, when regressions were run on the same models using first differences of the data, the effects of autocorrelation in the residuals were eliminated (with the exception of those which became negatively autocorrelated) but at the expense of any statistical significance at any acceptable level of confidence.
Before presenting a chapter on a summary and conclusions which have been drawn from the empirical investigation performed here, a brief chapter is presented to reflect on some of the studies which have attempted to do similar work in the area of shipping and to discover what conclusions have been drawn from these works. This follows immediately in Chapter VI.
CHAPTER VI

COMPARISON OF RESULTS WITH OTHER EMPIRICAL STUDIES ON THE SHIPPING INDUSTRY

INTRODUCTION

In the light of the results of empirical testing reported in Chapter IV, it seemed pertinent to reflect on the results of some of the other work that had been performed in the area. It is not the intention here to dwell on the defects of any study in particular as most of them would be acknowledged by the authors themselves. Indeed, the studies quoted may be entirely without defects at all. But it would be desirable to compare some of the results obtained by other authors to those obtained here, and possibly suggest some reasons for any disparity between them.

CORRELATION ANALYSIS AS PERFORMED BY LESLIE JONES

In his book *Shipbuilding in Britain*, Leslie Jones devotes a section\(^1\) to a brief correlation analysis between

\(^1\) Jones, *op. cit.* pp. 37 - 40.
freight rate indices and indices of shipbuilding activity (i.e. index of tonnage commenced, index of tonnage under construction and index of tonnage launched). In one particular table (reproduced in Table XXVI), the author compares (by correlation coefficients) the index of freight rates and tonnage launched over the period 1920 - 1939 and concludes from the results that because of sharp changes in freight rates:

"... there is an almost immediate effect on tonnage launched...simply because there is no pressure for delivery. A fall in freights has an immediate effect on launchings as well as a deferred effect due to the falling off in tonnage commenced."\(^2\)

The author also concludes that the results of the table indicate that tonnage launched has no effect on freight rates because of the lack of any high correlation for some lag that shows tonnage launched preceding freights.

Although Jones' data is an index of ship launchings rather than absolute levels as used in this thesis, and, in addition, is based on quarterly data rather than monthly as used here, it may not be an ideal methodology to compare

\(^2\) Jones, *op. cit.* p. 38.
TABLE XXVI

Correlation between Index of Freight Rates and Tonnage Launched

1920 - 1939

<table>
<thead>
<tr>
<th>Lags in Quarters</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freights preceding Launchings</td>
<td>0.51</td>
<td>0.53</td>
<td>0.52</td>
<td>0.51</td>
<td>0.36</td>
<td>0.32</td>
<td>0.11</td>
</tr>
<tr>
<td>Launchings preceding Freights</td>
<td>0.51</td>
<td>0.48</td>
<td>0.47</td>
<td>0.40</td>
<td>0.13</td>
<td>0.08</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Source: Jones, op. cit. p. 39.

the two results. However, any positive or negative relationship would be revealed using comparable techniques regardless of this difference.

With reference to Tables XV and XVI on pages 123 and 124 of this thesis, quite a strong negative relationship between launched cargo ships and charter rates is observed, rather than a positive relationship as revealed by Jones' results. This might be due to significant differences between the two time periods. Jones was observing data
between the years 1919 and 1939, and it is not inconceivable
to suggest that the effects of increased technology and
consequent reduction in the time required to build a vessel,
could very well have altered the effects of this variable.

This writer does feel however, that correlation
analysis alone is a very unsophisticated method of research
for drawing any conclusions about the effects of one variable
on the other. This statement does not purport to cast any
dispersions on the validity of Jones’ work *per se*, but, as
has been observed in the testing performed here, it does
point out the inherent limitation of correlation analysis
of time series. For, as shown in Chapter IV, if the relation­
ships as shown by correlation analysis of time series are
not put to further testing, and attention paid to autocor­
relation in the residuals, any conclusions drawn on initial
correlation tests could be very misleading.

REGRESSION ANALYSIS AS PERFORMED BY THOMAS BATES

Another study which enforced interest in the nature
of tramp shipping rates was a regression analysis of ocean
tramp rates as performed by Thomas Bates. The purpose of

3 Thomas H. Bates. *A Linear Regression Analysis of
Ocean Tramp Rates*. Transportation Research. Vol. 3 No. 3.
Bates' study was through a multivariate regression analysis to better understand the nature of ocean tramp shipping rates and to discover how these rates are influenced by various important factors such as distance of haul, volume of shipment, trade route, season, year (i.e., the forces of demand that existed in a given year) and the terms upon which a rate is quoted.

The analysis done by Bates is not strictly analogous to the one done in this paper due to the fact that Bates concentrated on one commodity and confined his observations to two separate years - 1959 and 1963. His work was on a method of cross-sectional data rather than time series as used in this study. Consequently, he couldn't have encountered problems of autocorrelation in the error term, since these arise with time series only. Moreover, his analysis made no reference to the statistical phenomenon so it can be assumed he did not. However, his conclusions did enforce one of the major assumptions mentioned in the introduction to this thesis - that exogenous forces (political and economic) were one of the prime contributors to tramp freight rate fluctuations.
ANALYSIS OF TANKERSHIP RATES AS PERFORMED BY Z.S. ZANNETOS

We have mentioned that the tanker market is inextricably associated with the tramp shipping market and, as such, it was felt that the book by Zannetos, *The Theory of Oil Tankership Rates*, would include some empirical tests whose results could be compared with those performed on the data for tramp shipping rates used in this study.

Zannetos went so far as to construct, by means of correlation and multiple regression analysis, a model for the formulation of long term tanker rates in the short run. He considered his results to be very satisfactory and concluded:

"It is shown that under periods of low rates the most significant factors affecting the level of long term rates under depressed market conditions are the size of the vessel (negative impact), the changes in idle capacity (negative), and the level of outstanding orders for new vessels (positive). Under periods of high rates, the most important factors shown by the regression model to affect long term rates are the outstanding orders for new vessels (positive relation), the size of the chartered vessel (negative), the level of spot rates (positive), the duration of the charter (negative), and the load time from contract to delivery (negative). The quantitative significance of these factors as well as the ranges and extent of their applicability were intensively analyzed."  

Considering the fact that Zannetos was working with a time series using 1,048 observations over the period 1950 - 1957, it would be interesting to discover if he had considered the problems of autocorrelation as discovered in our empirical testing in this paper. If he had not, the inclination would be to look at the significance of his results and his predictive models with some apprehension.

**SUMMARY**

As we mentioned at the beginning of this chapter, it is not the intention here to disparage the results of the aforementioned studies. The primary purpose for mentioning them was simply to point out, and possibly justify somewhat, the reasons that such poor results were obtained by the analysis in this paper as compared to the results obtained by other authors in the area. In the empirical work performed on the data in this study, the problem of autocorrelation was a highly significant factor, and the validity of the regression results was eliminated by using a method to cope

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with this problem. It would be fair to say that results obtained without consideration of the autocorrelation in the error terms would, in the opinion of this author, be highly suspect.
CHAPTER VII

SUMMARY

The attempt to investigate the relationships between supply and demand variables and freight rates in the shipping industry is not an original undertaking. This investigator did feel however, that the area of tramp shipping per se had not received any great consideration 'empirically. The results of such an investigation, if positive, would hopefully be of benefit to management responsible for the chartering of tramp vessels, insofar as they may be able to better understand forces which affect freight rates and possibly assess the future behaviour of voyage and time charter rates.

On the other hand, it is an interesting empirical question in itself to see if the behaviour of tramp rates can be explained and economic hypothesis about shipping can be verified or rejected.

By means of rigorous empirical testing of various data intrinsic to tramp shipping, the author attempted to accomplish just this. On the basis of initial tests on the absolute levels of the data, it was felt that some progress was made. However, first tests revealed a high incidence
of positive autocorrelation in the residuals which is common to most time series data and it was found necessary to use a transformation of the data to first differences in an effort to establish statistically valid results in all respects.

It was very surprising to the author to find the very great disparity between results obtained through the use of absolute levels of the data and those obtained through the use of first differences. It was anticipated that results would be somewhat poorer, for as Fisser states:

"...first difference regressions often yield correlation and significance apparently a good deal lower than the corresponding figures reported when other methods of trend removal are used (or when no trend adjustment is made); however, this is largely the reward of honesty." ¹

But it was not expected that the results would lose their statistical significance entirely. The economic hypotheses tendered in Chapter IV were based on what seem to be valid arguments and it is most revealing to find that they could not be supported statistically by our data.

Assuming that all of the conditions of regression analysis have been met in the method of estimation used in this study, the original hypothesis as set out at the beginning of this thesis must be rejected because of the lack of significant results.

SUGGESTIONS FOR FURTHER RESEARCH

The author feels that there must be some explanation for the complete lack of statistical significance encountered in the empirical testing of our data and the following are put forth for consideration and possible suggestions for further research in the area.

First, and the most obvious observation that could be made is that improper variables of supply and demand were used in the tests performed. This does not necessarily mean that the variables used are in no way related to the fluctuations in freight rates but rather that they may be completely interdependent on some other motivating force for which no quantitative data were available. Among these may be the following:
(a) the cost of shipbuilding
(b) the rate of technological obsolescence and the age distribution of the existing vessels. Technology and age determine remaining economic life, consequently, they reflect retirements and replacements of vessels.
(c) monthly categorization of size groups in the fleet that is available for lifting.
(d) a more refined delineation of world trade with regards to types of commodities carried and the time periods during which they are carried. Included here also would be the volume and length of haul of these commodities.
(e) the pattern of ownership within the industry as coloured by the existing institutional considerations.

Category (e) above creates some insurmountable difficulties in data collecting. The increase in long-term chartering and private ownership of vessels has been discussed previously, but the segregation of these types of vessels from the available published figures of vessels ordered, launched
or completed is an impossible task. This problem causes a distortion in the data which in turn is reflected in the significance of the regression equations insofar as these vessels should have very little direct influence on the short-term fluctuations of tramp shipping rates. Indirectly, they do affect the amount of liftings available for tramp ships but their short-run effects would be minimal.

Secondly, and recalling the discussion in Chapter III concerning the nature of competition in the tramp shipping industry, it is possible, allowing a liberal use of assumptions, that the supply of and demand for shipping space in response to changes in freight rates, or even vice versa, possibly occur faster than we imagine and the implication of "perfect competition" in the tramp shipping industry is more fact than fiction. Under such a supposition, data would have to be gathered on a weekly, or even a daily basis to produce any meaningful results. This assumption might receive further substantiation from the fact that tests run on quarterly averages of the data (both absolute levels and first differences) provided results that were no more significant (and in cases less significant) than those provided
by the monthly data.

A third point for consideration is concerned with the use of first differences in the regression tests. Referring again to Figures V and VI the practically zero slope of the regression line indicates that monthly changes or differences in the dependent and independent variables are completely independent events. The relationship shown when absolute levels are used merely reflects the fact that the dependent and independent variables move together over time; but as has been previously deduced, this is merely the dependency of one month's observations on the previous month's observations and not a deterministic relationship.

Speculation could become endless however, and there would still be many questions left unanswered about tramp shipping freights. This investigator feels that a small step has been made in this thesis towards starting to answer some of these questions. At least, if nothing else, this study has shown that "good" statistical results are not necessarily "valid" statistical results.
BIBLIOGRAPHICAL ENTRIES

A. BOOKS


Jones, Leslie M.A. Shipbuilding in Britain (mainly between the two world wars). Cardiff: University of Wales Press, 1957.


B. PERIODICALS


C. REPORTS, MONOGRAPHS AND THESES

British Shipping Assistance Act 1935.


NOTES ON CONSTRUCTION OF FREIGHT INDICES

UNITED KINGDOM CHAMBER OF SHIPPING TRAMP
FREIGHT INDEX (VOYAGE CHARTER)\textsuperscript{1}

Publication of this monthly index started in 1921, and after an interruption during the Second World War, was resumed in 1948.

The present index is the result of a revision in 1961 in which 1960 was adapted as the base year. The information supplied by British tramp owners showed that on more than 93 percent of the total freight on voyage was earned in the carriage of coal, grain, sugar, ore, fertilisers, timber and sulphur, and these are the commodities used in the calculations.

The criteria adapted in determining whether or not a particular trade should appear in the calculations were: (1) that the freights earned by the United Kingdom tramps in that trade in 1960 was large enough to make the trade sufficiently important for inclusion and (2) that the reported fixture of

\textsuperscript{1} Chamber of Shipping of The United Kingdom, Tramp Freight Index, Revised, Base (1960 = 100) London: May 1961, p. 11.
ships in that trade appear with reasonable regularity.

For each of the commodities, the main movements of traffic are ascertained. In certain cases in which the loading or discharging area covers a large range of ports, a particular route is chosen by the Chamber for the purpose of measuring changes in freight rates. The Chamber of Shipping index utilizes 27 routes.

The method of calculation of the index is as follows:

1. For each trade route, the arithmetic mean of the freight rates for fixtures reported each month is calculated. The arithmetic mean for the year 1960 of these monthly averages forms the basis of comparison of freight rates in that trade route.

2. To each commodity is attached an index number which is the weighted arithmetic mean of the price relatives for the trade routes in which fixtures were reported in the month.

3. The index number of tramp shipping freights is the weighted arithmetic mean of the commodities for the month.
CHAMBER OF SHIPPING OF THE UNITED KINGDOM
TIME CHARTER INDEX

This index is meant to supplement the voyage charter freight index; the first assessment was calculated by the Chamber of Shipping of the United Kingdom in 1953 and revised in 1961 using a base year as 1960.

Detailed calculation of the index is as follows:

1. Fixtures for steamers, for vessels of less than 9,000 deadweight tons, for periods of longer than about nine months, or where the ports of delivery and re-delivery are widely separated are not used in the calculations.

2. The arithmetic mean of the rates for fixtures for motor ships reported in each month is calculated, and the arithmetic mean for the year 1960 of these monthly averages forms the basis of comparison.

NORWEGIAN SHIPPING NEWS -- TANKER CARGO, TRIP CHARTER

This index is based on the price relatives derived by

2 Ibid.
comparing current fixtures, not with those reported in a base period as in the case of dry cargo, but with a precisely defined standard as set down by the International Tanker Nominal Freight Scale Association Limited (Intascale).

Fixtures in the tanker trade are reported as Intascale minus or plus as the market may be at the time of fixing, and the index is finally calculated by taking the arithmetic averages of these pride relatives.
DURBIN-WATSON TEST FOR AUTOCORRELATION

The Durbin Watson d-statistic is used to test for autocorrelation in least squares regression, usually when the "variables" involved in the regression are actually time series.

If the residual derived from mathematically fitted regression is Z, then the coefficient of autocorrelation is calculated as follows:

\[
r_a = \sum_{i=1}^{n} \frac{z_i z_{i-1}}{\sum_{i=1}^{n} z_i^2}
\]

Where \( n \) is the sample size and Z again a residual, the formula for calculating the Durbin Watson d-Statistic is:

\[
d = \sum_{i=2}^{n} \frac{(z_i - z_{i-1})}{\sum_{i=1}^{n} z_i^2}
\]

where \( z_i \) is the i th residual. That is, \( z_i \) is the i th observed value of Y minus the i th predicted value of Y.
It is not possible, according to Durbin and Watson, to obtain critical values of $d$ exactly. However, upper and lower bounds for the critical values can be obtained. They are denoted by $d_U$ and $d_L$ respectively, and depend on the significant level, the number of observations, and the number of independent variables.

**ONE SIDED TEST FOR POSITIVE AUTOCORRELATION**

If the calculated value of $d$ is less than $d_L$ ($\alpha$), $d$ is significant at the $\alpha$% level, and it is concluded there exists significant evidence of positive autocorrelation.

If the calculated value of $d$ is between $d_L$ ($\alpha$), and $d_U$ ($\alpha$), the test is inconclusive.

If the calculated value of $d$ is greater than $d_U$ ($\alpha$), $d$ is not significant at the $\alpha$% level, and it is concluded there is no significant evidence of positive autocorrelation. The critical points used in this study are listed in Table XXVII.
TABLE XXVII

Five and One Per Cent
Significance Points for $d_L$ and $d_U$

1 Independent Variable

<table>
<thead>
<tr>
<th>N</th>
<th>Value of $d_L$</th>
<th>Value of $d_U$</th>
</tr>
</thead>
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<td>$P = .05$</td>
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</tr>
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<td>1.64</td>
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<tr>
<td>100</td>
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<td>1.65</td>
</tr>
</tbody>
</table>

$N = \text{Number of observations.}$

**ONE SIDED TEST FOR NEGATIVE AUTOCORRELATION**

The value of $d$ is significant at the $\alpha \%$ level if it is greater than $4 - d_L (\alpha)$, insignificant if it is

less than \( 4 - d_U (\alpha) \), and the test is inconclusive if \( d \) is between \( 4 - d_U (\alpha) \) and \( 4 - d_L (\alpha) \). The critical points used in this study are listed in Table XXVIII.

**TABLE XXVIII**

Five and One Per Cent

Significance Points for \( 4-d_L \) and \( 4-d_U \) \(^2\)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Value of ( 4-d_L )</th>
<th>Value of ( 4-d_U )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( P = .01 )</td>
<td>( P = .05 )</td>
</tr>
<tr>
<td>80</td>
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</tr>
<tr>
<td>100</td>
<td>2.48</td>
<td>2.35</td>
</tr>
</tbody>
</table>

\( N = \) Number of observations.

**TWO SIDED TEST FOR AUTOCORRELATION**

The value of \( d \) is significant at the \( \alpha \% \) level if it

\(^2\) Calculated from Table XXVIII.
is greater than $4 - d_U (\alpha)$ or less than $d_L (\alpha)$. The value of $d$ is insignificant at the $\alpha\%$ level if it is between $d_U (\alpha)$ and $4 - d_U (\alpha)$. The test is inconclusive otherwise.
NOTES ON SOURCES OF STATISTICS

1. SHIPS: NEW ORDERS, LAUNCHINGS, AND TRIALS AND COMPLETIONS

These statistics were drawn on a monthly basis from the commercial journal: The Shipping World and Shipbuilder.

Each category is further broken into sub-categories and monthly totals of deadweight tonnage:

a. Cargo.

b. Tanker.

c. Bulk Carriers and Specialized Vessels.

Vessels of less than 1000 D.W. Tons were excluded. The reason for this exclusion was the fact that this thesis is intended to represent primarily vessels which trade internationally and, although vessels of less than 1000 D.W.T. do trade internationally, for most practical purposes they are of a regional rather than international interest. In addition, all military, fishing and passenger vessels were also excluded based on the premise that these vessels had no bearing on the shipping of ocean freights (particularly with respect to tramp trades).
NEW ORDERS

These figures refer to new contracts let to shipbuilding firms by various owners. There is no indication whether building was commenced at the time of ordering.

LAUNCHES

These figures refer to the launching of the hull of the vessel but minus the superstructure.

COMPLETIONS

These figures constitute actual tonnage delivered to owners -- trial runs having been completed.

2. WORLD TRADE

These statistics are based on monthly totals (in metric tons) of international seaborne trade as compiled in the United Nations Monthly Bulletin of Statistics. The monthly figures were adjusted slightly on a monthly percentage to overcome the disparity between monthly totals and aggregate yearly totals as listed in the United Nations Statistical Year Book.
3. LAID UP TONNAGE (CARGO AND TANKER)

These figures (in deadweight tons) refer to the total tonnage laid up monthly through lack of employment. Totals drawn from monthly issues of Fairplay International Shipping Journal.

4. FREIGHT INDICES -- VOYAGE, TIME AND TANKER

See Appendix A.
FUNCTIONAL RELATIONSHIPS TESTED IN
REGRESSION ANALYSIS

The following are some of the relationships tested but not reported in the text of this thesis:

LAID UP CARGO AS A FUNCTION OF:

1. World Sea Trade
2. Indices and World Sea Trade
3. Laid Up Tanker
4. Ship (Launchings, Completions)

RATE INDICES AS A FUNCTION OF:

1. Ship Completions (Cargo, Bulk Carrier, Tanker)
2. Ship Launchings (Cargo, Bulk Carrier, Tanker)
3. World Sea Trade; Laid Up Cargo
4. World Sea Trade; Laid Up Cargo; Ship (Completions, Launchings, New Orders)
5. Laid Up Cargo; Ship Completions
6. New Orders
7. Index; Laid Up Cargo; World Sea Trade; Ship (Completions, Launchings, New Orders)
NEW ORDERS (CARGO, TANKER, BULK CARRIER)

AS A FUNCTION OF:

1. Rate Indices
2. World Sea Trade

Most of the tests were performed with a series of leads, lags, trend removal, seasonally adjusted (some) and tests were on both original values and first differences.