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TRANSPORTATION COSTS IN INTERNATIONAL TRADE: STRUCTURE, INCIDENCE AND PROTECTION EFFECT WITH SPECIAL REFERENCE TO CANADIAN WHEAT EXPORTS

by

© HARI DUTT SHARMA

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Transportation costs in International Trade: Structure, Incidence and Protection Effect With Special Reference to Canadian Wheat Exports," submitted by Hari Dutt Sharma in partial fulfilment of the requirements for the degree of Master of Science.

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ABSTRACT

This study examines the level and structure of transportation costs in international trade with special reference to Canadian wheat exports. It also determined the incidence and protection effect of transportation costs.

The inland transfer costs during the period 1958-1971 have been favourable for shipments of prairie wheat via the West Coast--not only to Pacific rim countries, but also to European markets. Between 18 to 64 percent of total costs of moving wheat to overseas markets is accounted for by ocean transportation costs.

Investigation of the establishment of freight rates in the ocean freight market showed that freight rates on bulk grain cargoes were competitively determined prices. Quantity shipped, distance and the general demand-supply conditions in the world tramp market were the most important factors affecting freight rates on a particular route. Explanation of fluctuations in ocean freight rates was offered in terms of changes in active tonnage, scrapped tonnage, and laid-up tonnage; new launchings; tonnage diverted from one branch of shipping to the other; and sudden changes in ton-miles demanded.

Incidence of ocean transportation costs was determined by using the least-square regression method. Incidence of these costs fell almost equally upon the exporter and the importer in the case of Canadian wheat exports to the Rotterdam market. The protection effect of transportation costs was analyzed within the framework of the theory of tariffs. The rates of natural protection provided by total transportation costs to various import markets ranged between 19 and 36 percent. The rates of

natural protection due to ocean freight charges alone varied from 4 to 20 percent for different import markets.

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CHAPTER I

INTRODUCTION

Implications of Transportation Costs

Transportation costs have several implications in international trade. They have a marked influence on a country's competitive position in the world market. The magnitude of comparative cost advantage enjoyed by one country over the other--due to differences in basic production costs--may be reduced by any disadvantage created by transportation costs. Such costs can act to greatly alter the trade advantage, especially in the case of agricultural commodities. These commodities are particularly affected by transportation costs because the transportation cost component of their delivered prices is high, due to their low per unit value and the long distances which they must travel. Transportation costs, therefore, play an important role in the expansion and contraction of trade in agricultural commodities.

Transportation costs determine the export and import points for every commodity. Differences in transportation costs on different routes affect the competitive position of various shipping points in a particular exporting country as well as in the various countries chosen by the importing country as sources of supply. Transportation costs thus affect the extent of inter-country substitution. Similarly, inter-commodity substitution may be caused by transportation costs.[1]

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[1] Inter-country substitution would be analogous to Viner's trade creation and trade diversion when one country is substituted for another as the source of supply for the same commodity. Inter-commodity substitution occurs when one commodity is substituted, at least at the margin, for some other commodity as a result of relative price shift. See, R. Lipsey, "The Theory of Customs Unions: A General Survey," Economic Journal, Vol. 70 (1960), pp. 496-513.

The existence of transportation costs in international trade provides an inevitable element of natural protection. The pattern of protection provided by such costs is complicated because transportation costs lead to country discrimination as well as to commodity discrimination. Commodity discrimination occurs because different transportation costs are incurred on different commodities moving between the same import and export points. Country discrimination arises because the same commodity is subject to different transportation costs, the costs varying according to the country of origin.[1]

In fact, there is a host of problems--namely, influence of transportation costs on general price levels; terms of trade; relative factor prices, absolute and real; resource allocation; factor mobility; balance of payments; etc.--that may be associated with transportation costs. However, the various influences of transportation costs have been generally classified as those which do not merit serious discussion at the theoretical level. The resultant lack of theoretical framework is mainly responsible for the relative scarcity of empirical research on transportation costs in international trade. In addition to universally lamented shortcomings of published statistics, Munro has pointed out the difficulty that it is virtually impossible to provide definite guides to show how important transportation costs must be before they have a significant impact on international trade. The operational

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[1] The argument is derived from the proposition of the theory of customs unions. (The theory of customs unions may be defined as that branch of tariff theory which deals with the effects of geographically discriminatory changes in trade barriers.) Ibid., p. 496.

effects of transportation costs are very difficult to establish.[1] Variations in modes of transport employed in movement of a commodity from the production point to the final destination leads to the variations in the composite character of transport costs. Between certain points in transit, freight rates may be charged on the basis of weight and between others on the basis of value. Generally, the movement of commodities from one country to another involves land transport and the sea transport. The freight rates for land and sea transport differ in level and structure. The latter rates are more complex in composition and usually comprise a high proportion of total transportation costs. Sea transport also presents a multimode situation. The different kinds of vessels, the different kinds of services, the different terms of shipment, and different freight rates for the same commodity and same destination create complexities that have made research in this area unpopular. Even this study is not intended to deal with all the theoretical and empirical problems regarding transportation costs in international trade. Only a subset of these issues constitute the domain of this study.

Purpose of the Study

The main theme of the present study revolves around transportation costs in Canada's grain exports. The level and structure of transportation costs of bulk grain shipments are examined with a view to quantifying the protection effect and incidence of such costs. More

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[1] Munro, J.M. Trade Liberalization and Transportation in International Trade (Toronto: Private Planning Association of Canada, University of Toronto Press, 1969), p. 9.

specifically, the objectives of the study are:

1. To examine the composition of transportation costs of bulk grain shipments.

2. To analyze the level and structure of ocean freight rates in the ocean freight market that serves Canada's grain trade.

3. To quantify the impact of ocean transportation costs of Canadian grain exports and to determine the economic burden of such costs.

The structure of transportation costs in Canadian wheat exports will be analyzed in terms of the component margins. A comparison of transportation costs on different routes will be made to reveal the competitive position of various seaboards. An in-depth description of the characteristics of bulk ocean freight market will be developed. The process of ocean freight rate determination will be investigated by using the least-squares regression method. Regression analysis will also be used in determining the incidence of ocean transportation costs. The protection effect of total transportation costs as well as ocean transportation costs will be expressed as a nominal rate rather than effective rate of protection.

Justification of the Study

Problems associated with the movement of Canadian grains to the various export points have been the subject of numerous studies.[1]

[1] It is difficult to list all the studies on grain transportation. For a comprehensive, though outdated, survey of research on grain transportation, the reader is referred to: Tyechniewicz, E.W. and O.P. Tangri, Grain Transportation in Canada: Some Critical Issues and Implications for Research, Occasional Paper No. 2 (Winnipeg: Centre for Transportation Studies, University of Manitoba, 1968).

Studies dealing with the problems of grain movement have often recommended steps to "...increase quickly the capacity for exports, decrease delays and congestion, and reduce or hold transportation costs if possible."[1] However, there are several aspects of transportation costs that remain less researched. The cost of transporting grain to overseas destinations must be allowed for when assessing Canada's competitive position in the world grains market. Also, differences in transportation costs on different routes affect the competitive position of Canadian coasts as shipping points. An examination of total transportation costs in moving Canadian grains would throw light on the factors responsible for the existing structure and changes in the competitive position of various seaboards. Delineation of inland transfer costs and ocean transpotation costs would indicate the extent to which these costs can be affected by domestic policy measures. Analysis of ocean freight rate determination would promote understanding of the price making process and freight rate behaviour in the ocean freight market. Such information can be very useful for pricing decisions. Equally important is the question of incidence of transportation costs. The effect of changes in such costs upon the returns to producers depends upon who bears how much of the economic burden of transportation costs.

The existence of transportation costs in international trade acts as a constraint on trade policy. An adequate tariff policy can be designed only when the protective effect of transportation costs is taken into account. Omission of these costs is bound to provide an understatement

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[1] Kates, Peat, Marwick and Co., West Coast Commodity Study: Part I (Toronto: Prepared for Government of Canada, Department of Transport, May, 1967).

of the actual protection enjoyed by an industry--which may be much more than desired by a particular tariff structure. Evaluation of protection effect of inland transfer costs and ocean transportation costs may be of further help in delineating those elements of protection that may be influenced by domestic transport policy.

CHAPTER II

THEORY OF INTERNATIONAL TRADE AND TRANSPORTATION COSTS

Introduction

The traditional preoccupation of the theory of international trade has been with the explanation of what determines the patterns of trade between countries. Analysis of problems of international movements of factors and commodities continues to be solely within the domain of the theory of international trade. The problems of factor and commodity movements over national or international boundaries are ones of allocation of production and consumption in space. The economic effects of space arise because physical distance has attenuating influence upon movements of factors and commodities. This effect of spatial separation of demand and supply points is reflected by the transportation costs.[1] Thus, transportation costs have a definite role in determining the volume and structure of international trade. Yet the international trade theorists, in general, have found it convenient to expound their doctrines on the assumption of zero transportation costs so that they can focus on other aspects of international trade.[2] This abstraction regarding transportation costs has occassionally been made a basis for the criticism that the theory of international trade fails to account for effects of spatial

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[1] Location theorists maintain that space affects economic relationships through transportation costs and "neighborhood effects." For example, see M. Beckman, Location Theory (New York: Random House, 1968), p. 3.

[2] W. Beckerman, "Distance and the Pattern of Intra-European Trade," Review of Economics and Statistics, Vol. 38 (February 1956), p. 31.

separation of demand and supply in the world economy.[1] Trade theorists, on the other hand, argue that the study of the role of transportation costs, both of products and of factors of production in contributing to regional differences in prices, has not been historically the particular responsibility of the theory of international trade.[2]

Our primary interest is not in the historical debate between trade theorists and their critics, but to derive theoretical guidelines for evaluating the economic effects of transportation costs within the framework of the theory of international trade. This chapter reviews the treatment of transportation costs in the theory of international trade. Having traced the importance and role assigned to transportation costs by international trade theorists, the current state of empirical research on transportation costs and international trade is examined.

The Pure Theory of International Trade and Transportation Costs

Adam Smith believed that the "breadth of market is largely determined by the quality of transporation."[3] The price differential between two spatially separated points must, at least, equal the costs of moving

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[1] The first among location theorists to lament the treatment of location by the theory of international trade was Alfred Weber. See "Die Standortslehre Und Die Handelspolitik," Archiv für Sozialwissenschaft, Vol. 32 (1911), p. 667-668; Also Louis Lefeber, Allocation in Space: Production, Transport and Industrial Location (Amsterdam: North-Holland Publishing Co., 1958).

[2] For example, Jacob Viner, Studies in the Theory of International Trade (New York: Harper, 1937), p. 468. (Hereinafter referred to as Studies.)

[3] Adam Smith, The Wealth of Nations, edited by A.H. Jenkins (New York: Richard R. Smith, 1948), p. 40.

commodities from one point to another.[1] Although transportation costs are not separately treated in Smith's works, his concept of the natural price of a commodity includes the cost of the labour, profit, and rent that goes into bringing it to market. Obviously, the cost of transportation is included. However, it cannot be claimed that he analyzed the effect of transportation costs in the framework of the theory of international trade. It was left for Ricardo to formulate the theory of comparative costs.[2]

Ricardo's preoccupation with the formulation of the doctrine of comparative costs led to the ommission of transportation costs in his chapter on foreign trade.[3] Even M. Say, whom Ricardo credited for original, accurate, and profound discussion of principles of political

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[1] "The grain which grows within a mile of the town sells there for the same price as that which comes from twenty miles away. But the price of the latter must, generally, cover not only the expense of raising and *bringing* it to market, but the ordinary profits of agriculture to the grower. The proprietor and cultivators of land in the neighborhood of the town gain, not only the ordinary profits of agriculture, but in addition, the whole value of the *transportation of the produce* that is brought from more distant parts." (Italics mine.) Ibid., p. 220.

[2] Whether the doctrine was originally developed by Torrens or by Ricardo has been a subject of interesting discussion. See E. Seligmann and J. Hollander, "Ricardo and Torrens," Economics Journal, Vol. 21 (1911), p. 448.

[3] His chapter on foreign trade contains such remarks as these: "Gold would naturally be of greater exchangeable value in Poland than in England on account of the greater expense of sending such a bulky commodity as corn the more distant voyage." "The disadvantage of distance would probably be more than compensated by the advantage of having an exportable commodity of great value." D. Ricardo, Principles of Political Economy and Taxation, ed. by Gonner (London: G. Bell & Sons, 1919), pp. 108-30. (Hereinafter referred to as Political Economy.) These remarks show the lack of interest in and focus on transportation costs in that stage of the theory of international trade.

economy appears to be vague and somewhat confused.[1] He failed to identify and describe the role of costs of transportation in his discussion on trade. Thus, before J.S. Mill, the discussion of transportation costs in the context of international trade seldom went beyond casual and sometimes vague remarks.

The first systematic treatment of transportation costs was presented by J.S. Mill. Illustrating the process of price equalization, he makes the simplifying assumption of zero transportation costs.[2] Later on, however, the assumption of zero transportation costs is dropped to render the exposition more realistic. The result of introducing "the element of cost of carriage" in his example of comparative costs inhibits the exchange of cloth and linen at precisely the same rate in both countries. Linen, having to be transported to England, will be dearer there by its cost of transportation; and cloth will be dearer in Germany to the extent of the cost of carrying it from England. Under conditions of perfect competition, the price in one country could not exceed that in

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[1] "Commerce enables us to obtain a commodity in the place where it is to be found, and to convey it to another where it is to be consumed; it, therefore, gives us the power of increasing the value of the commodity, by the *whole difference between its price in* the first of these places and its price in the second." (Italics mine.) Ricarod, Political Economy, p. 126. Obviously the difference between prices in two different places consists of costs of transportation and other distribution costs. But Say, though aware of all this, seems to be wrong in mentioning this as an advantage of commerce as trade.

[2] "Supposing, therefore, for the sake of argument, that the carriage of the commodities from one country to the other would be effected without labour and without cost, no sooner would the trade open than the value of the two commodities estimated in each other would come to a level in both countries." J.S. Mill, Principles of Political Economy, Hadley's revised ed., Vol. II, Book III (New York: The Colonial Press, 1900), p. 102. (Hereinafter referred to as Principles.)

others by more than the 'cost of carriage'.[1] However, the cost tables employed by classical economists do not indicate whether the price difference between two countries for a certain commodity is sufficient to allow for international exchange in spite of the existence of transportation costs.

Sidgwick took a more definite position than Mill. He thought that a special theory of international trade is necessitated by the "fact of distance, which renders international exchange costly."[2] The sole difference between the theory of international values and the theory of domestic values is thus primarily attributed to the existence of transportation costs. Like Mill, however, Sidgwick does not deal explicitly with money costs of production and transportation. Sidgwick's claim to correction of classical theory of comparative costs has been criticised by J. Viner.[3]

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[1] It is evident from Mill's numerical example that quantities demanded and terms of trade under zero transportation cost-situation would differ from those cases where transportation costs are introduced. See Mill, Principles, p. 422.

[2] J. Viner, Studies, p. 470.

[3] "In an obscure and patently confused argument, Sidgwick attempted to show that the existence of transportation costs of commodities provided the sole basis for a theory of international values different from the theory of domestic values. (Henry Sidgwick, The Principles of Political Economy, 1st Ed., 1883, pp. 214-30; 2nd Ed., 1887, pp. 202-16, in somewhat different form.) Sidgwick refuses to go behind money costs of production and his argument I believe reduces itself to the proposition that the prices in any country of the products of any two (or more) countries, after allowances for transportation costs, are proportional to their money costs of production in the countries of origin, a proposition which no one would deny and which is embodied, implicitly when not explicitly, in the classical doctrine of comparative costs instead of, as Sidgwick supposed constituting a correction thereof." J. Viner, "The Doctrine of Comparative Costs," Weltwirtschaftliches Archiv, No. 11 (1932), pp. 373-377.

Marshall's treatment of the subject is "... in the main an exposition and elaboration ... of Mill's analysis."[1] Under the assumption of zero transportation costs, his approach forms an essential supplement to the theory of comparative costs. Marshallian reciprocal demand-and-supply curves elaborate Mill's reciprocal demand technique.

Yntema, in a mathematical reformulation, attempted to incorporate transportation costs into a general system of equilibrium equations.[2]

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[1] Jacob Viner, Studies, p. 541.

[2] T.O. Yntema, A Mathematical Reformulation of the General Theory of International Trade (Chicago: The University of Chicago Press, 1932), p. 35. In a three country - three commodity model, assuming given commodity routes and equality of (constant) international prices of transport services, the relations between prices in the three countries can be written as:

$$Z_{1/2} = \frac{Y_{21} + Y_{2t}\ (2 \rightarrow 1)\ 1}{Y_{11}}$$

$$Z_{1/2} = \frac{Y_{22} - Y_{2t}\ (1 \rightarrow 2)\ 2}{Y_{12}}$$

$$Z_{1/2} = \frac{Y_{23} - Y_{2t}\ (1 \rightarrow 2)\ 3}{Y_{13}}$$

$$Z_{1/3} = \frac{Y_{31} + (Y_{3t}\ (2 \rightarrow 1)\ i - Y_{3t}\ (2-3)_1)}{Y_{11}}$$

$$Z_{1/3} = \frac{Y_{32} - Y_{3t}\ (1 \rightarrow 3)_2}{Y_{12}}$$

$$Z_{1/3} = \frac{Y_{33} + (Y_{3t}\ (3 \rightarrow 2)\ 3 - Y_{3t}\ (1 \rightarrow 2)_3}{Y_{13}}$$

Where: $Z_{1/2}$ = net monetary factor (ratio)

Y_{21} = price of commodity 1 in country 2(B)

$Y_{2t}(2 \rightarrow 1)$ = transportation costs of commodity 1 from country B to A, i.e., $2 \rightarrow 1$

Y_{11} = price of commodity 1 in country 1(A) and so on.

Yntema's model provides a theoretical construct which can be generalized to include any number of countries and commodities. The model represents a refinement in the treatment of transport services by making transport service requirements a function of commodity movements; thus bringing in the idea of derived demand for transport services. However, based upon restrictive assumptions, Yntema's formulation represents neither the Walrasian General Equilibrium nor the general complexities that arise from relaxing the assumption of constant and equal transportation costs. Nor can the model be used to predict the trade direction in case of new commodities.

The classical doctrine of comparative advantage was criticized by Bertil Ohlin, who stated that "theory of international trade is only a part of general localization theory."[1] He argued that modification of the classical theory is necessary because of transfer costs as well as because of the immobility of productive factors:

> Naturally, if there were no such costs trade would take place in all or practically all commodities, whereas large groups of commodities are now excluded. In a word, costs of transfer reduce trade and weaken its effects upon ... a tendency towards an equalization of commodity and factor prices.[2]

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[1] Bertil Ohlin, Interregional and International Trade (Cambridge: Harvard University Press, 1933), p. vii. (Hereinafter referred to as Interregional Trade.) On Ohlin's statement, Viner has the following comment: "He must have in mind either a *standortslehre* or a theory of international trade (or both) which has but slight resemblance to what is to be found in the existing literature bearing this label." Viner, Studies, p. 468f. It is interesting to note here, in passing, that in spite of the awareness that transport costs arise essentially because of the spatial connection between different supply and demand points--a matter that really belongs to the location theory--the general location theories formulated by Weber, Englander, and Palander have laid negligible stress on transport costs in the context of international movement of factors and commodities. Weber lamented the treatment of location by the theory of international trade, but could not offer an alternative theory in terms of the *standortslehre* (location theory).

[2] Ohlin, Interregional Trade, p. 145.

Ohlin's work, however, should be evaluated separate from the so-called Heckscher-Ohlin theory. Based on several assumptions, including that of no transport costs, said theory builds the explanation of pattern of trade around differences in factor endowments between countries. As pointed out by Bhagwati, the Heckscher-Ohlin theory of comparative advantage intactly represents the theory distilled from the works of these two Swedish economists and would probably be repudiated by them as an emasculated version of their writings.[1] Since neither author had formalized the theory fully, they could discuss several factors such as transportation costs.

The relation of transportation costs to production costs and terms of trade has been discussed by Professor J. Viner.[2] With the aid of slightly modified Marshallian demand and supply curves, the effects of transportation costs upon the volume and terms of trade are analysed with the help of graphical techniques.[3] Viner's two country-two commodity model takes into account only the excess of international over domestic transportation costs from the point of production to the point of consumption. This implies that supply to a foreign market will be greater

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[1] J. Bhagwati, ed., International Trade (Baltimore: Penguin Books, Inc., 1970), p. 9; B. Ohlin, "Some Recent Trends in the Pure Theory of International Trade," in R. Harrod and D.G. Hague, eds., International Trade Theory in a Developing World (New York: Macmillan, 1963).

[2] J. Viner, Studies, pp. 467-470.

[3] These curves differ from those used by Marshall. The ordinates of Marshallian curves measures the total receipts from the sale of the quantity shown along the horizontal axis, while the ordinate in Viner's presentation measures the exchange ratio.

than to a domestic market if domestic transportation costs are higher than international transportation costs. The example of different transportation costs in two countries shows that such differences in transportation costs may create a comparative advantage which may otherwise not exist at all.

The point that the export capacity of a country does not depend solely upon its comparative cost of production, but also upon the costs of transportation, has successfully been made by Haberler.[1] The existence of transportation costs, depending upon their magnitude, may prevent complete specialization and the countries may produce only for their domestic markets. However, the implications of existence of transportation costs for a country's comparative advantage in one commodity relative to another (commodity) are left out because the comparative advantage is translated into absolute cost advantage when account is taken of wages, productivity, transport costs, demand conditions, and exchange rates.

Professor Graham, having charged Mill with ignoring transport costs,[2] suggested that all costs necessary to get the goods to the market be included in the cost of production. In an attempt to approximate the reality, he relaxes the assumption of costless transportation or equal cost of transportation in supplying to the domestic and foreign market. The conclusion reached is:

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[1] G.V. Haberler, The Theory of International Trade, trans. by A. Stonier and F. Benham (8th ed.; London: William Hodge and Co. Ltd., 1961), pp. 141-142. (Hereinafter referred to as International Trade.)

[2] F.D. Graham, The Theory of International Values (Princeton: Princeton University Press, 1948), p. 28. (Hereinafter referred to as International Values.) It should, however, be noted that Graham's criticism is invalid, as his own assumption of equal transport costs comes very close to Mill's position as outlined above.

> The ratio of exchange between any two of an indefinite number of commodities may then differ in any one country from that currently prevailing in any other by not more than the equivalent of the cost of outward transport of the commodity relatively undervalued in the given country plus the cost of inward transport of the commodity relatively undervalued in the other.[1]

The importance of Graham's contribution lies in his assertion that, as a result of transportation costs, countries may substitute one market for an other for their exports and one source of supply for the other for their imports. This substitution of import and export points tends, on one hand, to reduce the difference between potential exchange ratios and, on the other, to determine the variety of output within each country. Complete specialization is prevented by transportation costs and any two countries can have an indefinite number of common products. In case the reciprocal costs of transportation are too high, the countries will normally produce the full amount of their consumption of the commodity.

An extensive discussion of transport costs with respect to the transfer problem was provided by P. Samuelson.[2] Mundell treated the problem of transportation costs by considering their effects on the offer curves of a country.[3] Kindleberger, like Haberler, uses a partial equilibrium approach to illustrate the deterrant effect of transport costs in the process of price equalization.[4] Even the spatial price equilibrium

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[1] Ibid., p. 139.

[2] P.A. Samuelson, "The Transfer Problem and Transport Costs: The Terms of Trade. When Impediments are Absent," Economic Journal, LXII (June, 1952), pp. 278-304; and "The Transfer Problem and Transport Costs, II: Analysis of Effects of Trade Impediments," Economic Journal, LXIV (June, 1954), pp. 264-289.

[3] R.A. Mundell, "Transport Costs in International Trade Theory," Canadian Journal of Economics and Political Science (August, 1957), pp. 331-348.

[4] C. Kindleberger, International Economics (3rd ed.; Homewood, Illinois: Richard D. Irwin, Inc., 1963), p. 137.

models, using the technique of linear programming,[1] focus basically on the process of price equalization in spatially separated points. Such models, however, are rarely constructed in terms of a general equilibrium.[2] Consequently, they are hard put to explain the implications of spatial connection between different economies in general and the various aspects of transportation costs in particular.

Mention of the role of transportation costs in the commodity composition of trade has also been made in some of the other theories of international trade. The Kravis theory attempts to explain that exports tend to be limited to those commodities that are available at home and imports to those which are not available at home.[3] The transportation costs are included among factors that affect the availability of goods. Transportation costs may make some of the commodities available at home, although at a slightly higher cost. The theory appears attractive but has not been stated in a precise and systematic way.

Another approach--the Product Cycle Approach--is attributable to the suggestive ideas of S. Linder.[4] Essentially, Linder's argument is

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[1] The most important contribution in this area is that of Paul Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review, XLII (June, 1952), pp. 283-303.

[2] The exceptions, however, can be found in the works of W. Isard and Louis Lefeber, who used a general equilibrium approach. Isard contends that the inclusion of costs of transportation is bound to change price structure and therefore can actually distort the comparative advantage. Isard, Location and Space-Economy (Cambridge, Mass.: M.I.T. Press, 1956), pp. 207-220; Louis Lefeber, Allocation in Space: Production, Transport and Industrial Location (Amsterdam: North-Holland Publishing Co., 1958).

[4] S. Linder, An Essay on Trade and Transformation (New York: John Wiley and Sons, 1961).

that a country's range of exportable products is determined by internal demand for such products, which in turn depends upon per capita income. The more similarity between demand patterns and per capita incomes in the trading countries, the larger the volume of trade between them, although existence of transportation costs and other trade restrictions may reduce this volume of trade. Thus, Linder's thesis makes comparative advantage a condition brought about by the degree of industrialization and economic development in the trading countries.

Hirsch used Linder's approach to analyse a country's ability to compete in the foreign markets. His study specifically takes into account the trade braking factors--including transport costs--that affect a country's international competitiveness.[1] The product-cycle approach is applicable only to trade in manufactures. Linder, himself, recognizes that trade in primary commodities cannot be so explained. Such trade, he agrees, must be explained in terms of the Hecksher-Ohlin model of relative natural-resource endowments.

The foregoing discussion reveals that transportation costs have been vaguely treated in the theoretical apparatus of international trade. However, the following section will reveal that distance and transportation costs have frequently been used as explanatory variables in determining the trade flows among countries.

Transportation Costs In Econometric Models

Occasionally researchers have found it difficult to justify

[1] S. Hirsch, Location of Industry and International Competitiveness (London: Clardendon Press, 1967). (Hereinafter referred to as Location.)

the emphasis on transportation costs as the major natural obstacle to international trade.[1] It has been argued that the geographical distance between the countries gives rise not only to the transportation costs, but also to non-quantifiable effects that may be psychic as well as economic. Effects of transportation costs, as well as so-called non-quantifiable factors associated with geographical distance between the countries, have been measured by using the geographic distance as a proxy variable.

The importance of the distance to be traversed in international trade was first evidenced in an empirical study of the volume of ocean-going world transport by the German Central Bureau of Statistics.[2] It reported a negative correlation between the volume of trade and the distance over which the transportation takes place.

Econometric models designed for empirical research on balance-of-payments questions have largely given very scanty attention to transportation charges.[3] One of the structural models of balance-of-payments that considered a functional relationship between transport payments/receipts and the volume of imports/exports is that constructed by

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[1] H. Linnemann, An Econometric Study of International Trade Flows (Amsterdam: North-Holland Publishing Co., 1966), p. 15. (Hereinafter referred to as Trade Flows.)

[2] Der Guterverkehr der Weltschiffahrt, Vierteljahrshefte zur Statistick des Deutschen Reichs, 1928 (Berlin: Statistisches Reichsant, 1928). Quoted in Linneman, Trade Flows, p. 29.

[3] Empirical investigations testing the validity of certain hypotheses built along the classical and neoclassical versions of theories of comparative advantage are left out in this review because excellent reviews of literature on empirical tests of international trade theories are avilable. One such excellent review is in J. Bhagwati, Trade, Tariffs and Growth (Massechussets: Weidenfeld and Nicholson and M.I.T. Press, 1969).

Prachowny.[1] His equations for the foreign sector include transportation charges as a dependent variable. The major explanatory variables are taken to be the volumes of imports and exports. The lack of focus on other variables that should have been included to explain transportation charges is, however, justified in view of the objectives of his study. The model provides important guidelines for constructing a detailed model for dealing with problems of balance-of-payments.

The other concern of empirical research on international trade has been the determination of causal relationships between the volume and pattern of international trade and the major explanatory variables, such as income, population, trade obstacles, etcetera. Chenery's study of per capita imports during 1952-1954 for sixty-two countries determined per capita imports as a logarithmic-linear function of per capita income and population size.[3] The reported results were:[4]

$$\log M_i = 20.4 + \underset{(0.69)}{0.987} \log Y_i - \underset{(0.045)}{0.281} \log N_i$$

$$R^2 = 0.81$$

As suggested by Linnemann,[5] the negative influence of the population variable may be explained by the existence of trade obstacles,

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[1] M.F.J. Prachowny, A Structural Model of the U.S. Balance of Payments (Amsterdam: North-Holland Publishing Co., 1969).

[2] See Prachowny's equations (8) and (9) for foreign sector.

[3] H.B. Chenery, "Patterns of Industrial Growth," American Economic Review, Vol. L (1960), pp. 624ff.

[4] Where M = value of per capita imports; Y = per capita national income; N = population size in country i.

[5] H. Linnemann, Trade Flows, p. 15.

including transportation costs. The essence of his argument is that, in the face of trade obstacles, industries would prefer to locate in the larger markets to avoid higher transportation costs.[1] Given the per capita income, the size of market increases with increases in population. Therefore, industries would be located in the country in question and reduce dependence upon imports. Beckerman[2] used the concept of "economic distance" between countries. This was calculated on the basis of the difference between f.o.b. prices for particular commodities. Such a method, however, can be applied only to the observed trade flows, not to the potential trade that can be realized by lowering of transportation costs.

A similar hypothesis has been put to empirical testing by Tinbergen.[3] The trade flow equation included distance between two countries (i and j) as an independent variable on the assumption that transportation costs roughly correspond to the geographic distance.[4] The trade flow equation:

$$X_{ij} = A_o \, Y_i^{a1} \, Y_j^{a2} \, D_{ij}^{a3}$$

hypothesized that exports of country i to j (X_{ij}) depends upon the GNP of exporting country (Y_i), the GNP of the importing country (Y_i), and the distance between the two countries (D_{ij}). The following results

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[1] In passing, it is worthwhile to note a comment by Kindleberger, Foreign Trade and the National Economy (New Haven: Yale University Press, 1962), p. 9. (Hereinafter referred to as Foreign Trade.) "Samuelson has suggested that the existence of transport costs means that the average proportion of national income earned by exports or spent on imports will be less than 50 percent."

[2] W. Beckerman, "Distance and the Pattern of Intra-European Trade," Review of Economics and Statistics, Vol. 28 (1956), p. 38.

[3] J. Tinbergen, Shaping the World Economy (New York: The Twentieth Century Fund, Inc., 1962), pp. 263-293.

[4] Distance was measured in nautical miles.

were obtained by least square regression analysis using 1958 export data for eighteen more-developed countries.

$$\log X_{ij} = \underset{(0.0438)}{0.7338} \log Y_i + \underset{(0.0438)}{0.6238} \log Y_j - \underset{(0.0405)}{0.5981} \log D_{ij} - 0.378$$

$$R^2 = 0.8248$$

Also, the trade flow coefficients were estimated for forty-two countries, including some underdeveloped countries.

$$\log X_{ij} = \underset{(0.0270)}{1.0240} \log Y_i + \underset{(0.0269)}{0.9395} \log Y_j - \underset{(0.0455)}{0.8919} \log D_{ij} - 0.6627$$

$$R^2 = 0.8094$$

In both cases, the distance variable appears with a proper sign and reasonably small standard errors. The negative influence of distance on trade flows was statistically significant. Similar results have been reported by other researchers using slightly modified distance terms.[1]

Another approach to the distance variable is found in Glejser's work. Instead of using Tinbergen's method of a dummy variable for neighbouring countries or following the Poyhonen - Pulliainen method, Glejser used the "vicinity variable" to capture the effects of transportation costs. The vicinity variable was defined as:

$D_i = {}_j\Sigma_i \dfrac{X_j}{D_{ij}}$, and the following estimates of coefficients were obtained

[1] P. Poyhonen, "A Tentative Model for the Volume of Trade Between Countries," Weltwirtschaftliches Archiv, Vol. 90 (1963), pp. 93-99; and K. Pulliainen, "A World Trade Study," Ekonomiska Samfundets Tidskrift (No. 2, 1963), pp. 78-91. For comments on the models of these two Finnish economists also see: E. Leamer and R. Stern, Quantitative International Economics (Boston: Allyn and Bacon, Inc., 1970). Poyhonen tried to scale the distance D_{ij} by allowing for constant and variable effects. His estimate of r value using $(1 + r D_{ij})$ instead of D_{ij} came to be 0.00157/nautical mile, which can be interpreted as a very small influence of variable costs.

for the import equation and the export equation.[1]

For imports:

$$\log M_i = -0.3 + 0.87 \log Y_i - 0.14 \log N_i + 0.24 \log D_i + 0.05 \log P_i$$

and for exports:

$$\log X_i = -0.8 + 1.03 \log Y_i - 0.26 \log N_i + 0.2 \log D_i + 0.05 \log P_i$$

(where M and X = value of Imports and Exports; Y = GNP, N = population, D = vicinity variable, and P shows membership in a preference group). Glejser's results indicate that: "Belgium, which is realtively closest to large markets, would enjoy twice as much trade, *ceteris paribus*, as, say Australia which suffers the most from difference."[2]

A quasi-Walrasian model of international trade flows was employed by Linnemann. The reported results indicate that variations in trade flow sizes are largely explained by the two GNP variables and the distance variable.[3] The results are in harmony with those of earlier studies that

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[1] Reported in Leamer and Stern, Quantitative International Economics, p. 155.

[2] Ibid., p. 156.

[3] Linnemann, Trade Flows, pp. 82-83. The author reports the following results:

$$\text{Log } X_{ij} = a + a_1 \log Y_i + a_2 \log N_i + Q_3 \log Y_j + a_4 \log N_j + a_5 \log D_{ij}$$

$$0.13 + 0.99\ l_i Y_i \quad - 0.20 \quad + 0.85 \quad - 0.15 \quad - 0.81$$

$$(0.02) \quad (0.03) \quad (0.02) \quad (0.03) \quad (R = 0.79)$$

$$+ a_6 \log P_{ij}^4 + a_7 \log P_{ij}^F + a_8 \log P_{ij}^B$$

$$+ 0.94 \quad + 2.53 \quad + 6.83$$

where X = volume of trade export; Y_i, Y_j = nominal GNP in two countries; N_i, N_j = populations; D = distance in nautical miles; and P^4, P^f, and P^B refer to preference factors.

used only Y_i, Y_j, and D_{ij} as explanatory variables. However, the value of the distance parameter for individual countries ranged between +0.2 and -2.59. High values were found for Canada and Japan. The economic explanation of low distance parameters for certain countries was offered on two bases: 1. that imports are coming from all parts of the world without being influenced much by long distances and 2. that all countries are not equally served by an international transportation network. The countries with modern transport and regular direct connections were found to have the lowest distance parameters.

Summary

It is obvious from the foregoing review of literature on theoretical and empirical research on the various versions of the theory of international trade that transportation costs have not been treated with the vigor and analytical precision shown by economists in other fields of economics. The reason for this is the immense range of problems with which international trade theory has been concerned. However, implied in the various versions of the theory is the proposition that the existence of transportation cost reduces the volume of trade and affects the terms of trade. The exact role of transportation costs in creating and diverting trade depends upon the level of transportation costs and demand-supply relations. In empirical research, geographic distance has been used as an independent variable to determine the effect of space on volume of international trade.

Despite the statistical niceties and interesting results of econometric models used in determining a relationship between the volume of trade and geographical distance between countries, it seems justified to conclude that such models have little relevance for indicating the possible changes in the direction and volume of trade as a result of lower costs of transportation, while the geographic distance remains the same. The foregoing review indicates that there is much scope for integrating transportation costs into the theory of international trade and for research on transportation costs in international trade *per se*.

CHAPTER III

NATURE OF TRANSPORTATION COSTS

Introduction

As shown in the previous chapter, the existing state of theoretical and empirical research on transportation costs and international trade leaves much to be desired. The problem of investigating the structure of transport costs and evaluating their role in determining the pattern of international trade can be tackled at various levels of aggregation. One of the alternatives--and perhaps the most difficult--would be the investigation of the structure of transportation in world trade in order to examine the resultant impact of such costs on the pattern of international trade. Another approach would be to take aggregate trade flows between a number of countries and examine how the trade flows are affected by the existence of transportation costs. It would be easier yet to analyse the nature of transportation costs involved in movements of individual commodities from one country to the other. This is the approach used in this chapter.

The approach is divided into several parts. The first part involves the construction of a simple model of transportation costs involved in the transportation of a commodity from the production point in an exporting country to the consumption point in an importing country. Discussion is then extended to include all costs associated with movement of a commodity. Structure of total transfer costs is discussed in the second part of the chapter. Implications of existing level and structure of transportation costs for competitive position of various export points in Canada are brought out.

Transportation Cost Model

Movement of commodities in overseas trade involves various modes of transport. Different freight costs are incurred at different stages in the movement of a commodity from a production centre in the exporting country to a consumption area in the importing country. All or many modes of transport--railway, highway trucking, pipeline, ocean vessels, and air carriers--are employed over different distances within and without the trading country's boundaries. Thus, transport costs fall into a complex pattern and their relative magnitude varies for different commodities. Total costs of moving a commodity are comprised of several components that vary from route to route. In the case of moving wheat from Canada, for example, there are various costs associated with elevator inspection, inward inspection, weighing and registration, and selling charges that are incurred at the elevator level. Rail freight to the terminal accounts for another major component. Costs are also incurred on the seaboard for elevation, outward inspection and weighing, warehouse receipt cancellation, shipper's charges, superintendence, cargo rates, wharfage, forwarding brokerage, bank charges, etcetera.

Another set of costs associated with the carriage of goods over the seas can be termed ocean freight charges. The magnitude of ocean transportation costs depends largely on the level of freight charges for ocean shipping. The charges for insurance against damage, outturn, war, strikes, riots, and so on, account for a lesser proportion of total ocean transportation costs.

Unloading and transshipment costs, together with the costs of handling, etcetera, incurred in the country of destination comprise the remaining set of costs in the international movement of the commodity.

The costs incurred in the importing country fall into the same complex pattern as do those in the exporting country. However, the magnitude of various costs is likely to differ from country to country depending upon the domestic transport structure and labour cost conditions.

Total transportation costs are given by the sum of total costs associated with storage, handling and transportation of a commodity from production point to the port of loading, total costs of seaboard fobbing, total ocean freight rate, the costs of unloading in the importing country, and the total costs of storage, handling and transportation incurred in the importing country for movement of the commodity from port of unloading to the consumption point. In symbols:

$$T = \sum_{i=1}^{n} G_i C_x + \sum_{i=1}^{n} G_i H_x + \sum_{i=1}^{n} G_i I_x d_x + \sum_{i=1}^{n} G_i L_x + \sum_{i=1}^{n} G_i O_f D$$

$$+ \sum_{i=1}^{n} G_i U + \sum_{i=1}^{n} G_i I_m d_u + \sum_{i=1}^{n} G_i C_m + \sum_{i=1}^{n} G_i H_m$$

where: T = total transportation costs,

d_x = distance between port and production center in exporting country,

G = quantity of commodity transported,

L_x = total loading costs per ton in exporting country,

U_m = total unloading costs in importing country,

It_x = total inland transfer costs per ton in exporting country,

It_m = total inland transfer costs per ton in importing country,

I_x = inland per ton-mile costs in exporting country,

I_m = inland per ton-mile costs in importing country,

O_f = ocean freight per ton-mile from export point to port of destination, including insurance,

D = distance between port of loading and destination,

d_u = distance between port of unloading and consumption area i in importing country,

C_x = per ton-day cost of storage in exporting country,

C_m = per ton-day cost of storage in importing country,

H_x = per ton handling costs in exporting country,

H_m = per ton handling costs in importing country.

In seaborne trade the cost of handling, storage, transportation to the export point, and seaboard fobbing may be termed inland transfer costs to distinguish them from inland costs. In terms of the symbols:

$$It_x = C_x + H_x + I_x + L_x.$$

Similarly:

$$It_m = L_m + I_m + H_m + C_m.$$

Level and Structure of Transportation Costs of Canadian Wheat Exports

Table 3.1 shows the relative share of each cost margin in the total inland transfer costs of wheat moved via St. Lawrence ports, during the period 1951-1955. The composition of inland transfer costs incurred on wheat shipment via Pacific ports is shown in Table 3.2. The structure and magnitude of costs on the St. Lawrence route is different from those on the Pacific route. Rail freight and Lakehead transportation charges are the major components of the total inland transportation costs of moving wheat via St. Lawrence ports. In the case of movement to the Pacific seaboard, rail freight alone accounted for about 66 percent of total costs involved up to seaboard fobbing during the said years. The information provided by the Canadian Grain Commission on the magnitude of components of ocean transportation charges

TABLE 3.1

COST COMPONENTS AS PERCENTAGE OF TOTAL INLAND COSTS OF MOVING WHEAT FROM A MID PRAIRIE POINT TO FOBBING AT ST. LAWRENCE PORTS, 1951-1955

Cost Component	1951	1952	1953	1954	1955
Interior Handling					
Country Elevator Elevation	6.9091	6.9177	6.9246	5.2714	5.9426
Inward Inspection Weighing	.3948	.3952	.3956	.3491	.3935
Inward Registration	.0105	.0105	.0105	.0093	.0104
Selling Charges	4.5297	4.5353	4.5399	4.0053	4.5154
Rail Freight	36.3220	36.3670	36.4030	32.1170	36.2070
Lakehead Fobbing					
Terminal Elevation	5.5931	5.6000	5.6056	4.9456	5.5753
Outward Inspection	.5264	.5270	.5275	.4654	.5247
Outward Weighing	.2632	.2635	.2637	.2327	.2623
Warehouse Receipt Cancellation	.0105	.0105	.0105	.0903	.0104
Lakehead Transportation					
Lake Shipping Charges	.1052	.1054	.1055	.0930	.0149
Lake Freight	42.1130	42.1650	42.2070	33.5210	35.4200
Brokerage	.6580	.6588	.6594	.5818	.6559
Insurance - Lake Marine Outturn, Strike, Etc.	1.2633	1.1569	1.0446	.8546	.0576
Wharfage	.5211	.5217	.5223	.4608	.5194
Superintendence	1.0633	.1054	.1055	.0930	.1049
Bank Charges	.3448	.3294	.3429	.2816	.3148
Forwarding Broker	.3290	.3294	.3297	.2909	.3279
TOTAL	100	100	100	100	100

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1956).

TABLE 3.2

COST COMPONENTS AS PERCENTAGE OF TOTAL INLAND COST OF MOVING WHEAT FROM A MID PRAIRIE POINT TO FOBBING AT PACIFIC SEABOARD, 1933-1955

Cost Component	Average 1933-38	Average 1939-45	Average 1946-50	1951	1952	1953	1954	1955
Interior Handling								
Country Elevator Elevation	9.5518	9.4933	11.4549	10.8513	12.5436	12.5436	12.5436	12.5436
Inward Inspection Weighing	.7259	.6618	.6744	.7186	.7167	.7167	.7167	.7167
Inward Registration	.0218	.0216	.0205	.0191	.0191	.0191	.0191	.0191
Selling Charges	5.4582	6.0974	5.8690	8.2451	8.2238	8.2238	8.2238	8.2238
Rail Freight to Pacific Seaboard	75.3230	74.8620	71.0460	66.1140	65.9430	65.9430	65.9430	65.9430
Seaboard Fobbing								
Terminal Elevation	6.8227	6.7809	8.7520	10.1806	10.1543	10.1543	10.1543	10.1543
Outward Inspection	.5458	.5424	.7207	.9581	.9557	.9557	.9557	.9557
Outward Weighing	.5458	.5424	.5198	.4790	.4778	.4778	.4778	.4778
Warehouse Receipt Cancellation	.0218	.0216	.0205	.0191	.0191	.0191	.0191	.0191
Cargo Rates	.9824	.9764	.9266	.6898	.9461	.9461	.9461	.9461
TOTAL	100	100	100	100	100	100	100	100

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1956).

on wheat shipments from St. Lawrence and Pacific ports during the period 1933-1955 is summarized in Table 3.3. The table shows a breakdown of the ocean transportation costs of moving Canadian wheat to the United Kingdom through St. Lawrence ports and Pacific ports. During the war years the ocean freight charges registered a substantial upward jump, followed by doubling of cargo insurance charges. Relatively, the cost of outturn insurance remained almost stable. Therefore, the result is that variations in total ocean transportation costs are in main attributable to fluctuations in ocean freight rates. Such an inference is further supported by an overview of total costs of moving Canadian wheat to various import markets.[1] The behaviour of various cost items over the period 1956 to 1968 is shown in Tables 3.4, 3.5, 3.6, 3.7 and 3.8.

The share of ocean transportation charges in the total transportation costs of moving bulk grains from Canada to overseas destinations is exemplified by ocean freight charges involved in the movement of wheat, which is representative of costs involved in the movement of heavy grains from Canadian ports. Table 3.4 shows that ocean transportation costs accounted for about 53 to 70 percent of total costs in moving wheat from a mid-prairie point to the United Kingdom via Pacific ports. The share of ocean freight charges in total transportation costs on the St. Lawrence route (Table 3.8) is relatively lower because of higher total transportation costs on that route. Lake transportation costs also reduce the

[1] The lack of statistical information, which is very difficult to obtain, does not permit a detailed analysis of components of cost of unloading, handling, storage, and transshipment of Canadian wheat in the importing countries. However, it is plausible to conceive that the pattern of costs incurred in the importing country is likely to be similar to the inland transfer costs in the exporting country.

TABLE 3.3

OCEAN TRANSPORTATION CHARGES OF MOVING WHEAT FROM ST. LAWRENCE PORTS AND PACIFIC PORTS TO THE UNITED KINGDOM, 1933-1955

Cost Component	Average 1933-38	Average 1939-45	Average 1946-50	1951	1952	1953	1954	1955
				- Cents per Bushel -				
St. Lawrence Ports								
Ocean Freight	7.750	30.381	25.562	41.591	20.157	17.773	19.461	27.391
St. Lawrence Fobbing	.400	.400	.525	.600	.600	.600	.600	.600
Outturn Insurance	1.079	1.076	1.549	1.267	.818	1.124	1.080	1.111
Cargo Insurance	.215	.451	.640	.507	.436	.450	.432	.411
Agent's Commission	.375	.375	.375	.375	.375	.625	.625	.625
TOTAL	9.819	32.683	28.651	44.340	22.386	20.572	22.198	30.138
Pacific Ports								
Ocean Freight	13.645	59.507	50.443	63.806	42.272	26.414	29.878	45.540
Outturn Insurance	1.074	1.213	1.631	1.617	1.397	1.352	1.353	1.128
Cargo Insurance	.375	.754	1.032	.938	.671	.649	.712	.564
Agent's Commission	.375	.375	.375	.375	.375	.625	.625	.625
TOTAL	15.469	61.849	53.481	66.736	44.715	29.040	32.568	47.857

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1956).

TABLE 3.4

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO THE UNITED KINGDOM VIA PACIFIC PORTS, 1956/1957 to 1967/1968

Cost Component	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
						- Cents per Bushel -						
Interior Handling Costs	4.500	4.500	4.500	4.500	4.500	4.500	5.00	4.500	4.500	4.500	4.500	5.250
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Seaboard Fobbing	2.627	2.752	2.752	2.752	2.752	2.750	3.002	2.984	3.143	3.538	4.538	4.565
Ocean Freight Charges	49.290	24.276	25.054	25.101	23.567	26.153	24.852	33.759	30.011	35.598	30.448	31.35
Ocean Freight as Percent of Total	70.196	53.556	54.339	54.386	52.820	55.405	53.268	61.332	57.213	61.970	57.140	57.001
TOTAL	70.217	45.328	46.106	46.153	44.617	47.203	46.654	55.043	52.454	57.436	53.286	54.92

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1957 to 1968).

TABLE 3.5

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO THE UNITED KINGDOM VIA MARITIME PORTS, 1955/1956 to 1967/1968

Cost Component	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
						- Cents per Bushel -							
Interior Handling Costs	4.500	4.500	4.500	4.500	4.500	4.500	4.500	5.000	4.500	4.500	4.500	4.500	5.250
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Lakehead Fobbing	2.469	2.469	2.594	2.594	2.594	2.594	2.594	2.844	2.844	2.844	3.121	3.371	4.371
Lake Transportation	19.830	20.414	21.125	21.854	21.261	21.413	21.887	20.686	20.806	21.490	21.009	21.920	22.031
Seaboard Fobbing	2.538	2.539	2.539	1.913	1.940	1.940	1.940	2.065	2.065	2.065	2.235	2.485	2.485
Ocean Freight Charges	24.880	35.982	14.404	16.040	16.986	18.255	17.831	17.615	22.635	23.253	26.905	19.007	24.769
Ocean Freight as Percent of Total	44.708	45.144	25.689	26.424	24.588	29.207	28.505	28.406	33.960	34.219	37.592	29.204	34.067
TOTAL	78.017	79.704	59.962	60.701	61.081	62.502	62.552	62.010	66.650	67.952	71.570	65.083	72.706

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1956 to 1968).

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TABLE 3.6

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO UNITED KINGDOM VIA LAKEHEAD, 1958/1959 to 1967/1968

Cost Component	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
					- Cents per Bushel -					
Interior Handling	4.500	4.500	4.500	4.500	5.00	4.500	4.500	4.500	4.500	5.250
Rail Freight to Terminal	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Seaboard Fobbing	2.634	2.634	2.759	2.759	3.009	3.009	3.134	3.536	4.536	4.536
Ocean Freight Charges	30.855	31.926	31.728	34.287	29.154	34.428	36.146	39.097	34.648	34.426
Ocean Freight as Percent of Total	59.578	60.397	35.080	61.950	57.206	41.218	62.775	44.330	63.753	59.342
TOTAL	51.789	52.860	52.787	55.346	50.963	55.737	57.580	60.933	57.484	58.012

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1959 to 1968).

TABLE 3.7

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO UNITED KINGDOM VIA CHURCHILL, 1956/1957 to 1967/1968

Cost Component	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
						- Cents per Bushel -						
Interior Handling	4.500	4.500	4.500	4.500	4.500	4.500	5.000	4.500	4.500	4.500	4.500	5.250
Rail Freight to Terminal	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200
Terminal Diversion	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Seaboard Fobbing	2.904	3.027	3.027	3.027	3.051	3.051	3.176	3.176	3.301	3.748	4.748	4.748
Ocean Freight Charges	35.839	20.401	18.974	18.974	19.212	23.373	19.147	23.792	23.746	28.969	23.314	28.845
Ocean Freight as Percent of Total	61.852	47.858	74.888	59.431	46.149	51.229	45.563	51.433	51.346	55.798	49.329	53.872
TOTAL	57.943	42.628	41.201	41.201	41.463	45.624	42.023	46.168	46.247	51.917	47.262	53.543

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1957-1968).

TABLE 3.8

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO THE UNITED KINGDOM VIA ST. LAWRENCE PORTS, 1955/1956 to 1967/1968

Cost Component	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68
						- Cents per Bushel -							
Interior Handling	4.500	4.500	4.500	4.500	4.500	4.500	4.500	5.000	4.500	4.500	4.500	4.500	5.250
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Lakehead Fobbing	2.469	2.469	2.594	2.594	2.594	2.594	2.594	2.844	2.844	2.844	3.246	3.815	4.371
Lake Transportation	16.646	16.636	16.624	14.919	14.480	14.276	14.331	11.471	11.503	12.004	12.136	12.068	10.287
Seaborad Fobbing	.988	.989	.989	.363	.390	.390	.390	.390	.390	.394	.435	.435	.435
Ocean Transportation	34.388	30.256	16.511	16.093	17.435	18.518	19.581	18.549	22.974	25.389	27.012	23.957	26.054
Ocean Freight as Percent of Total	47.297	44.291	20.010	30.788	32.773	34.243	35.475	35.634	41.016	43.085	44.188	40.899	43.281
TOTAL	72.71	68.920	55.018	52.269	53.199	54.078	55.196	52.054	56.011	58.927	61.129	58.575	60.197

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1959-1968).

percentage share of ocean transportation on movements via St. Lawrence ports. However, they range between 30 to 44 percent of total transportation costs on that route. For shipments from the Maritimes, 24.5 to 45 percent of total costs of forwarding wheat to the said market was accounted for by the costs of ocean transportation (Table 3.5). Similar figures for movements via the Lakehead are presented in Table 3.6. Direct overseas shipments from the Lakehead involved ocean freight costs of the order 35 to 63.75 percent of the total costs. In the case of exports from Churchill, the range of ocean transportation costs as a percentage of total costs was 46 to 74.8 percent (Table 3.7).

On the average, the share of ocean transport charges in total costs of shipping wheat was 57.386 percent for Pacific ports; 37.973 percent for St. Lawrence ports; 54.069 percent for Churchill; and 31.417 percent for shipments via Maritime ports. The average share of ocean transportation costs amounted to 54.562 percent in direct overseas shipments from the Lakehead for the crop years 1958/1959 to 1967/1968.

However, costs involved in shipments to the United Kingdom are no longer very representative of the ocean transportation charges incurred for supplies to Europe. The reason for this lies in the fact that, for the last several years, there has been an increasing trend for large bulk movements of wheat to be sent to the Antwerp-Rotterdam Europort, followed by transshipments to the United Kingdom and other European countries. The share of ocean transportation costs in total transportation costs on this route are shown in Tables 3.9 and 3.10.

The relative importance of ocean transportation charges in total costs of moving wheat to Asian markets from British Columbia ports, as exemplified by the Pacific/Japan route, is shown in Table 3.11. On

TABLE 3.9

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO ANTWERP/ROTTERDAM
DURING THE PERIOD 1964/65 to 1970/71

Cost Component	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71
				- Cents per Bushel -			
Via Pacific Ports							
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Seaboard Fobbing	3.143	3.538	4.538	4.565	4.574	5.074	5.074
Ocean Freight Charges	22.826	25.128	17.904	19.172	15.273	25.520	28.899
Ocean Freight as Percentage of Total	51.562	53.502	43.955	45.601	39.104	50.893	53.993
Average Total Costs	44.269	46.966	40.742	43.327	39.147	50.144	53.523
Via Lakehead							
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Seaboard Fobbing	3.134	3.536	4.536	4.536	4.865	5.065	5.065
Ocean Freight Charges	26.649	28.279	24.442	28.246	18.937	29.692	22.672
Ocean Freight as a Percentage of Total	55.422	56.428	51.698	54.495	43.935	54.674	47.945
Average Total Costs	48.083	50.115	47.278	51.832	43.102	54.307	47.287
Via Churchill							
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.200	13.200	13.200	13.200	13.200	13.200	13.200
Terminal Diversion	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Seaboard Fibbing	3.301	3.748	4.748	4.748	4.748	5.287	5.287
Ocean Freight Charges	15.366	17.342	13.657	16.557	14.582	13.776	25.099
Ocean Freight as a Percentage of Total	40.578	44.422	36.316	38.646	36.852	34.811	49.372
Average Total Costs	37.867	41.290	37.605	40.255	39.569	39.513	50.836

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1965 to 1971).

TABLE 3.10

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO ANTWERP/ROTTERDAM DURING THE PERIOD 1964/1965 to 1970/71

Cost Component	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71
Via St. Lawrence							
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Thunderbay Fobbing	2.844	3.246	3.815	4.371	4.600	4.900	4.900
Lake Transportation	12.004	12.136	12.068	10.287	10.335	10.574	11.298
Seaboard Fobbing	.390	.435	.435	.435	.465	.465	.465
Ocean Freight Charges	15.286	14.772	11.466	14.527	10.174	18.212	11.101
Ocean Freight as a Percent of Total	31.308	30.215	24.837	29.847	22.672	38.280	23.462
Average Total Costs	48.824	48.889	46.084	48.670	44.874	53.701	47.314
Via Maritime Ports							
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Thunderbay Fobbing	2.844	3.121	3.371	4.731	4.400	4.900	4.900
Lake Transportation	21.490	21.009	21.920	22.031	23.148	22.511	22.546
Seaboard Fobbing	2.065	2.235	2.485	2.485	2.515	2.715	2.715
Ocean Freight Charges	14.213	14.608	10.018	11.210	11.671	20.557	12.233
Ocean Freight as a Percentage of Total	24.125	24.645	17.859	18.952	19.122	29.273	19.748
Average Total Costs	58.912	59.273	56.094	59.147	61.034	70.233	61.944

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1965 to 1971).

TABLE 3.11

AVERAGE COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO JAPAN VIA PACIFIC PORTS DURING THE PERIOD 1964/65 to 1970/71

Cost Component	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71
				- Cents per Bushel -			
Interior Handling	4.500	4.500	4.500	5.250	5.500	5.750	5.750
Rail Freight	13.800	13.800	13.800	13.800	13.800	13.800	13.800
Seaboard Fobbing	3.143	3.538	4.538	4.565	4.774	5.074	5.074
Ocean Freight Charges	23.430	24.764	22.972	26.572	24.336	31.884	28.962
Ocean Freight as a Percentage of Total	52.214	53.193	47.064	52.945	50.166	56.423	54.047
Average Total Costs	44.873	46.602	48.810	50.187	48.510	56.508	53.586

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1965 to 1971).

average, 52.289 percent of total costs are incurred from ocean transportation.

A comparison of total costs of moving wheat via various routes to different markets (shown in Tables 3.4 to 3.11) reveals that there has been a gradual shift in transportation costs in favour of Pacific seaboard. Figure 3.1 shows that, except for shipments through Churchill, the total costs of moving wheat to United Kingdom via Pacific ports have been lower than those on other routes. A similar situation (Figure 3.2) exists for shipments to the Rotterdam/Antwerp market. Except in 1970/1971, total costs on shipments via Churchill have been the lowest of all the routes. Pacific ports continued to offer lower transportation costs than the Lakehead, St. Lawrence and Maritime ports.

Here it should be pointed out that shipments via Pacific ports involve lower total costs because of relatively substantial savings on inland transportation costs, not because of lower ocean freight rates. In spite of the fact that ocean freight rates from Pacific ports to United Kingdom have been approximately three times greater than those from St. Lawrence and Maritime ports to the same destination, total costs were higher for shipments via St. Lawrence and Maritime ports mainly because of the lake transportation charges on these routes. Lake transportation charges for moving wheat to the Maritime seaboard were much higher than in the case of the St. Lawrence route. Thunderbay fobbing charges further add to the difference between transportation costs via Pacific ports, St. Lawrence ports and Maritime ports.

The information provided in Tables 3.4 and 3.11 also have implications on the performance of transport elements and other services involved in the movement of wheat. All the components of interior handling

FIGURE 3.1

AVERAGE TOTAL COST OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO U.K. VIA DIFFERENT PORTS, CROP YEARS 1956/57 - 1967/68

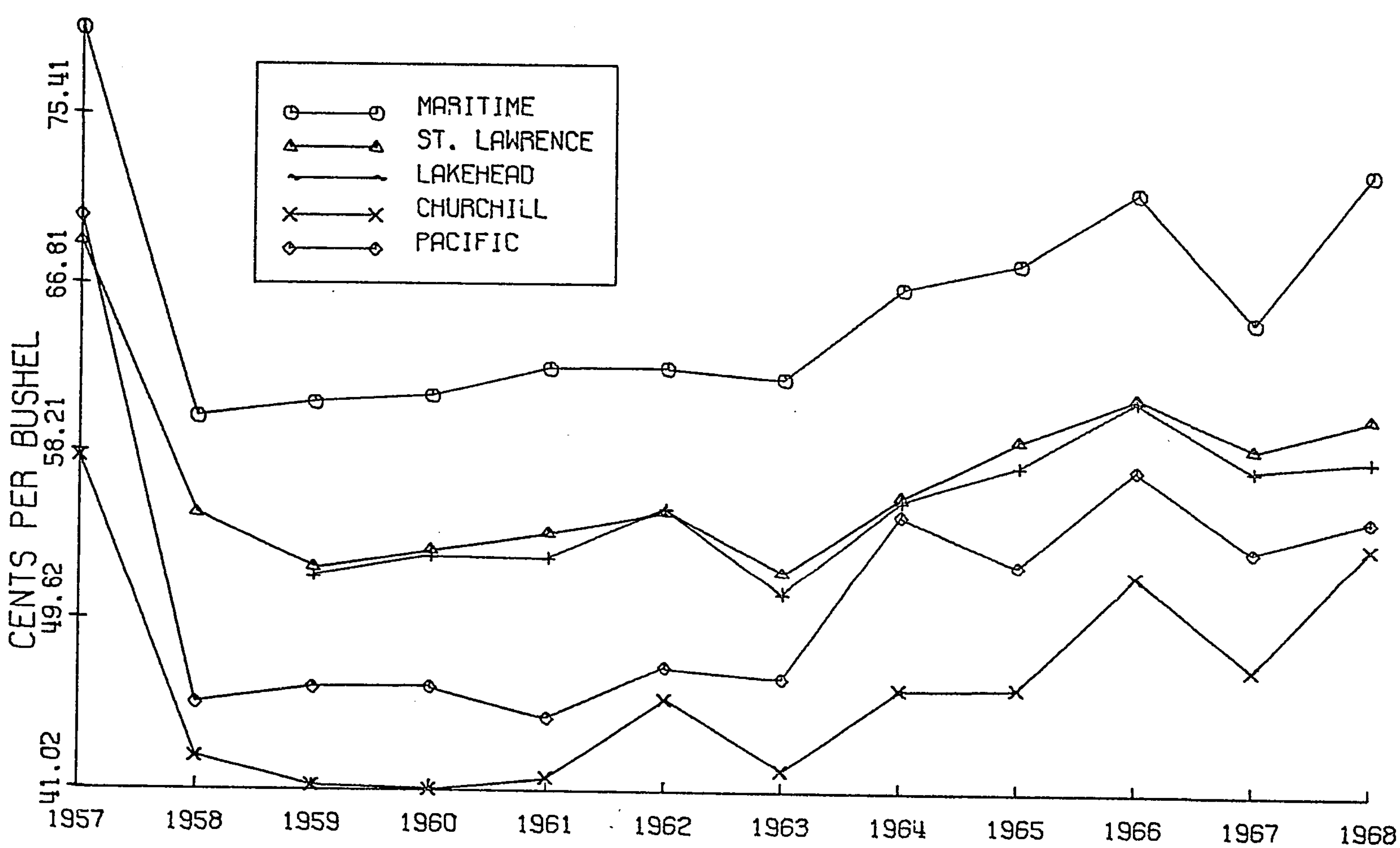
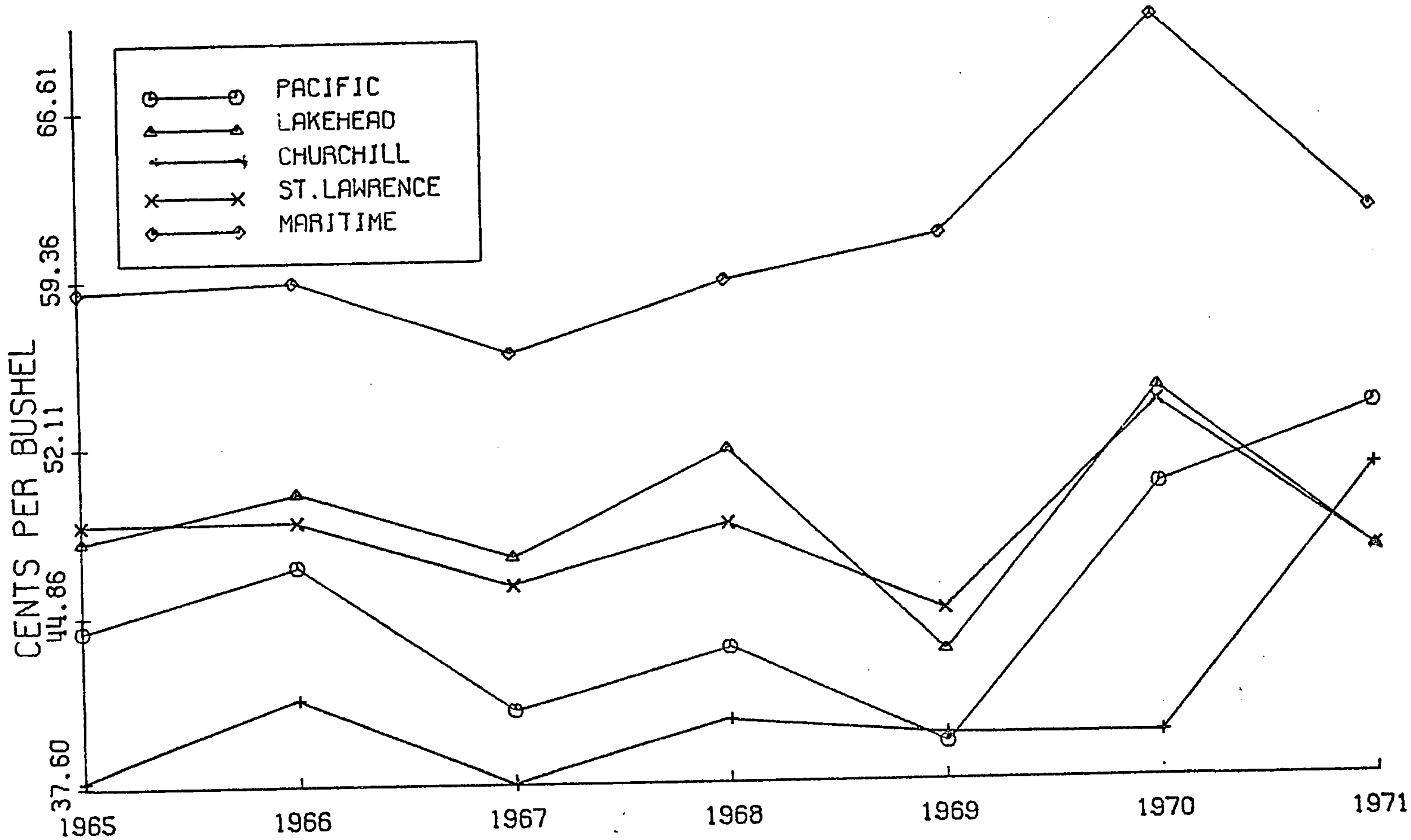


FIGURE 3.2

AVERAGE TOTAL COST OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO ANTWERP/ROTTERDAM VIA DIFFERENT PORTS, CROP YEARS 1964/65 - 1970/71



costs show almost complete stability. This is also true of the charges for inland transportation and seaboard fobbing.

The reasons for the stability of various cost margins (components) are not difficult to find. Worth noting is the fact that these costs are not quite exactly the prices determined by the interplay of market forces. The interior handling charges are determined as a result of collective bargaining between elevator companies and the Canadian Wheat Board. The rail freight charges applicable to all movements of grains for export shipments are set according to the Crow's Nest Pass rates. Lakehead transportation charges also belong to the category of administered prices because of their being supervised by the Canadian Transport Commission. Again, the fobbing charges are subject to the control of the Canadian Grain Commission. Consequently, costs associated with handling, transporting, and storing of Canadian grains are not reflective of the performance of the domestic transport network. Thus, the behavior of cost items reflected in Tables 3.4 to 3.11 are not indicative of what adjustments could have taken place over time had the system been left to the market forces.[1]

Summary

This chapter described the various components of total costs involved in the movement of commodities to overseas destinations. Discussion of inland and ocean transportation costs centered mainly around the costs of handling, storing and transporting bulk commodities such as

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[1] It has been claimed that the control exercised by Canadian Wheat Board, Grain Commissioners, and the country elevator system has resulted in high costs for handling and storage. See, Rapeseed Marketing Committee, Rapeseed Marketing: A Description and Evaluation of Alternative Systems (Ottawa: Information Canada, 1971), p. 101.

grains. Costs of moving Canadian wheat to import markets were analyzed in particular. Statistical information on total costs of transporting wheat showed that the structure of transport costs in Canada's grain trade is not entirely determined by the response of the transport system to the demand-supply conditions in the grain trade. Whether an unregulated and competitive system of transportation and handling grains would be more efficient and economical from producers and exporters point of view remains an exercise in speculation. But, given the amount of control exercised in movement of grains from country elevators to seaboard fobbing, the ocean transportation charges emerge as the main determinant of changes in transportation costs. Compared to other compoenets of transportation costs, ocean freight rates show the widest fluctuations that affect commodity prices in international trade.

CHAPTER IV

OCEAN FREIGHT MARKET

Introduction

Ocean freight rate is the price paid for the carriage of cargo. The term "freight rate" is used in general discussion to mean the cost of carriage irrespective of the characteristics of the market and the nature of service required. Such usage is not always very appropriate. Within the field of shipping there are several markets. The payment for the carriage of goods over the seas differs in each of the markets.

The field of shipping can be classified into several markets,[1] the number depending upon the type of classification used. The most important distinction is between the liner market and the charter market. The term freight rate has different applicability in each of these. Liner freight rates are determined on the basis of a measurement ton or a weight ton or value of the commodity. Liner rates are not fixed solely on the basis of distance or the time the ship's space is occupied. Outside the liner market, there exists a complex array of arrangements regarding the payment for the carriage of goods.[2] Transportation can be

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[1] Generally, studies dealing with the structure of the shipping industry divide ocean freight market into four separate branches or markets: tramp (charter) shipping, tanker shipping, cargo liners and special shipping. Tramp shipping implies the transportation of dry cargoes in whole shiploads; tankers mainly carry oil. Cargo liners carry consignments of various goods for various destinations and regularly ply predetermined routes. Special shipping refers to transportation of private companies' goods by their own fleets, state-owned naval and cargo ships, barges, etcetera. However, it should be noted that demarcation between the said branches of shipping is not perfect.

[2] United Nations Conference on Trade and Development (UNCTAD), The Level of Structure of Freight Rates, Conference Practices and Adequacy of Shipping Services, Pub. No. TD/B/C/4/38, Rev. 1 (New York: U.N., 1969), p. 3. (Hereinafter referred to as Structure of Freight Rates.)

acquired by means of voyage charters (also called free market charters), short-term charters, time charters, and long-term charters. A voyage charter rate (or trip charter rate) may be expressed in terms of the total tonnage to be carried on the voyage.

In case of time charters, the charter rate refers to a rate per deadweight ton of the vessel and is usually expressed in terms of rate per ton per month for the charter period. However, time charter rate can also be expressed in terms of a lump sum per day and not be linked to tonnage. Thus, charter rates for both voyage charters and time charters are closely related to the capacity of the vessel and tonnage to be loaded. These rates are, essentially, distance and time rates. In long-term contracts, the rate is specified simply as a price to be charged for carriage of certain quantities of bulk cargoes at a given monthly or weekly rate over the period covered in the contract. Total payments are thus related to the capacity to be supplied under the contract. The type, speed, and capacity of the vessel to be employed is not specified under the contract.

Variations in the meaning of freight rate in different markets depend also upon what is included in the frieght rate. Liner rates, in general practice, include the costs of loading, discharging and cargo insurance. The voyage charter rate may or may not include the said costs. A voyage charter rate may cover all such costs or it may include the costs of loading only. It may exclude the costs of loading but may cover the costs of trimming, may cover discharging but exclude trimming, and so on. The time charter rate, however, never includes these costs.

Understanding ocean transportation costs requires analysis of the characteristics of ocean freight market and the economic forces that determine the level of ocean freight rates. An extensive study of the international freight market dealing with all demand and supply factors remains too ambitious a task to be accomplished within the bounds of this study. However, an analysis of the ocean freight market relevant for heavy grains is presented in this chapter. Section I describes the economic characteristics of the freight market that serves the bulk commodity trade. This freight market has been termed " dry cargo bulk freight market."[1] The process of price-making in the ocean freight market is probed in Section II. Important relationships between demand and supply factors in the voyage charter market are derived from previous theoretical and empirical research on price-making in the shipping industry. An econometric model to test these relationships is developed in the third section of the chapter.

Price-Making in the Ocean Freight Market

Price-making in the shipping industry is subject to the same economic principles as in any other industry. Yet price theory has found only occasional applications in this field. Little research has been done on pricing behavior of firms in the shipping industry. The earlier studies in this field--though purely descriptive--were concerned with the structure and development of the industry. On the other hand, there are studies that are chiefly concerned with the available statistical data. In these studies, attempts have generally been made to relate freight rates to a number of variables. Conclusions based on available data are relevant to specific types of shipping activity and to specific sections of the industry.

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[1] UNCTAD, Structure of Freight Rates, p. 11.

The pioneers in this area studied the relationship between operating cost of vessel and distance. Estimates regarding the most suitable size of vessel under various assumptions regarding speed and loading and unloading conditions were made in response to the obvious needs of ship owners and shipbuilders. T. Jonson approached a higher degree of theorization by attempting to explain variations in cost with distance by using the following relationship.[1]

$$C_m = aP + \frac{dM}{V}$$

where: C_m = cost miles, that is, cost of transporting a cargo ton per n mile,

a = average in port days per ton cargo carried,

P = cost in port per day,

d = cost per dead weight n mile,

V = volume of cargo in relation to dead weight ton.

Using cost figures from Swedish shipping firms, Jonson developed a "diagram showing the cost prices of transport by cargo ships at different transport distances and size of vessel according to 1913 price levels."[2]

A more detailed formulation was presented by Prof. A. Stromme Svendsen. He tried to explain the variations in freight rates with size

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[1] For a summary of F. Jonson's study see: T. Thorburn, Supply and Demand of Water Transport (Stockholm: The Business Research Institute, Stockholm School of Economics, 1960), p. 2. (Hereinafter referred to as Water Transport.)

[2] T. Thorburn, Water Transport, p. 3.

of vessel, length of trip and speed.[1] However, his method does not take into account the interdependence between the size of the vessel and time spent in the port. Nor can the effects of time on freight rates be analyzed within this framework.

A major setp forward in application of economic theory to price-making in the shipping industry was Kojima's introduction of the concept of lay-up rates.[2] He showed that, once the freight rate fell to a certain point, the ship will be withdrawn from traffic. His formula for lay-up rate is:

$$r = \frac{(m-m^1) + n}{t}$$

where r = freight rate per cargo ton,

m = managing costs while ship is in traffic,

m^1 = managing costs when ship is withdrawn from traffic,

n = navigation and handling costs,

t = actual tons of cargo.

Once the freight rate has fallen to r, the vessel can be anticipated to be laid up from traffic. Kojima's article further analyzed the relation between freight rates and other variables, especially the amount of cargo.

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[1] A.S. Svendsen, Sea Transport and Shipping Economics (Bremen: Institute for Shipping Research, 1958), p. 193. His formula is: $C = \frac{1}{aL^3 - bL^2V^3}\frac{A}{V}[cL^2C^3\frac{A}{V} + dL^2\frac{A}{V} + eL^2]$. Where: C = costs (per registered ton and per trip with full cargo), A = distance, V = speed, L = length of vessel. a is constant for registered ton figures, b is a constant for the registered tonnage occupied by bunker space, c is constant for fuel costs, d is a constant for total ship costs at sea (except fuel), e is constant for all costs during stay in port.

[2] S. Kojima, "The Effect of Shipping Competition on Freight Rates," Kyoto University Economics Review, Vol. I (1926).

Exclusion of capital costs--on the ground that, since the vessel does not make any profit on the capital (of the ship) at given freight rates, the capital value of using the ship is zero--is very interesting. Kojima's concept of lay-up rate has come a long way and is included in most recent literature and has become a fundamental explanation of laid-up tonnage after drastic falls in freight rates. Kojima's ideas seem to be further developed by S.G.Sturmey. His work on the process of price-making in tramp shipping describes the behavior of ship owners in offering shipping services. Ship owners' decision are shown to be based on costs as well as possible returns from other alternative uses of the capital. Bringing the demand factor into the picutre, Sturmey argues that the level of freight rates are determined by "the volume of cargo to be carried, volume of tonnage and cost structure of the world's tramp fleet."[1]

Another group of studies deals with variations in freight rates in response to different demand conditions. Most of the studies use freight rate index and tonnage figures for different time periods to determine the correlation between freight rates and other factors, such as volume of cargo and type of cargo. Attempts have also been made to identify the industry's slack and boom periods resulting from world trade conditions by relating the volume of world seaborne trade to the total capacity of the existing cargo ships. Interesting studies dealing with the actual character of demand within certain sections of the industry and within certain trades have also been reported.[2] Mention must also

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[1] S.G. Sturmey, On the Pricing of Tramp Ship Freight Service (Bergen: Institute for Shipping Research, 1965), p. 15.

[2] For comments on the works of Hogbom, Humlum, Seland, Breaknus, Johasson and Hotcke, see Thorburn, Water Transport, p. 5.

be made of Koopman's pioneering work on tank ship building in response to freight rates. The study provides a typical example of cost minimization behaviour within given constraints of technology and market conditions.[1] Studies carried out in this tradition focus on explaining the prices of shipping servies in terms of the technical and cost conditions in the industry.[2]

In line with the allocation problem, transport models have been developed to determine the best economical use of a given number of vessels operating on given n number of routes with m cargoes; that is, with streams of goods. A case in point is the Koopman and Reiter model of transportation.[3] The model is cast in terms of allocation problems on the basis of assumption of central control. The authors use the technique of linear programming and the objective function is to minimize the amount of shipping in use for a given transportation program. Given the transformation function (production function), the opportunity cost of increase in shipping activity on one leg of the voyage is determined by considering the corresponding decrease in transportation on the other leg of the voyage. The equilibrium situation, or efficient point, is attained when the marginal cost of a unit increase in one of the cargo

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[1] T. Koopman, Tanker Freight Rates and Tankship Building (Haarlem: De Erven F. John, N.V., 1939).

[2] Zenon S. Zannetos, The Theory of Oil Tankship Rates (Cambridge: M.I.T. Press, 1966).

[3] T.C. Koopman and S. Reiter, "A Model of Transportation" in Activity Analysis of Production and Allocation (New York: John Wiley & Sons Inc., 1951). Also see M. Beckman, "A Continuous Model of Transportation," Econometrica, Vol. II (1952).

flows equals the marginal saving from a unit decrease in another direction. A price vector p, which is associated with the efficient point, is endogenous to the system. Such prices, called efficiency prices, are taken to be proxy for freight rates that would prevail in a state of perfect competition. The model, involving all linear relationships, has more relevance to traffic planning in cases where allocation decisions are controlled by a central authority, as would be the case with naval operations of a country or an absolutely monopolized shipping industry. The model does not cope with the problem of freight rate determination as such.[1]

Thomas Thorburn presents a formula of relationship between ship costs per ton cargo at different transportation distances, a number of primary costs, and efficiency factors.[2] Towards the end of the study some simple formulae for the demand for water transportation are also developed using total costs data. The study represents a very valuable attempt to theorize the process of price-making in water transport. Starting from assumptions of economic rationality and perfect certainty, it is postualted that the freight curves are given independent of ship owners' actions. The supply curve for cargo space is thus related to the technical and economic ship factors that include all cost and efficiency factors. Freight rate determination, however, is presumed to be analogous

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[1] A valuable attempt to develop techniques for quantitative assessment of the implications of seasonality and trends for forecasting trade and ship scheduling has been made by I.M. Datz. His model for profit maximization and effective utilization of existing cargo capacity is also developed within the framework of linear programming. See: I.M. Datz, Planning Tools for Ocean Transportation (Cambridge: Cornell Maritime Press, Inc., 1971).

[2] Thorburn, Water Transport.

to the proposition of full cost pricing in that the freight rates are equivalent to the lowest rates that any vessel can offer.

Very recently a portfolio selection model of shipping behaviour in tanker shipping has been offered by V.D. Norman.[1] Departure from previous studies is made by dropping the neoclassical assumption that under perfect certainty the firms in the industry maximize profits subject to some technological constraint and subject to a set of competitively determined freight rates and factor prices. Compared to other studies, Norman depicts a situation of decision-making under uncertainty by assuming that the Von Neuman-Morgenstern utility axioms are satisfied and that the firm has a well-defined probability distribution. Even though there are constant or increasing returns to scale, the optimal vessel and total fleet size becomes determinate because of the presence of risk. In spite of the analytical soundness of the model and its relevance to the tanker shipping firm, it has little relevance to price-making in tanker shipping and even less in aggregate shiping or shipping in general.

Given the variety of studies (ranging from analysis of short-run technical change in the industry to studies of reinvestment cycles and market behaviour),[2] it may be concluded that all of the studies are based on the neoclassical assumption that firms in the shipping industry maximize

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[1] Victor D. Norman, A Portfolio Selection Model of Shipping Behavior (Bergen: Institute for Shipping Research, 1971). For a similar approach based on Bayesian decision theory and Dynamic Programming, see J.W. Devanney III, Marine Decision Under Uncertainty (Cambridge: Cornell Maritime Press, Inc., 1971).

[2] For example: D.C. North, "Sources of Productivity Change in Ocean Shipping 1600-1850," Journal of Political Economy (1968), pp. 953-967; Johan Einarsen, Reinvestment Cycles and Their Manifestation in the Norwegian Shipping Industry, Pub. No. 14 (Oslo: University Institute of Economics, 1938).

Profits subject to some technological constraint and a set of competitively determined freight rates and factor prices. Their conclusions, however, fall short of yielding a cohesive theory of price-making in the ocean freight market. The reason for this lies in the multi-market situation existing in the industry, thus limiting the relevance of a particular study to a particular trade or market within the industry. Wide differences in structural and organizational characteristics of these markets make it difficult to draw from a particular study any inference that would be valid for the other freight markets in the industry.

Theoretical, as well as empirical, research on freight rate determination in the tramp market continues to be in an unsatisfactory state. The importance of research on ocean freight rates has been increasingly recognized by the United Nations Conference on Trade and Development, and a number of studies have been undertaken to analyze the structure and effects of ocean freight rates on international trade. But the completed studies relate only to the liner freight rates on a particular trade route.[1] Studies on freight rates in bulk freight market have so far been ignored, perhaps because of UNCTAD's immediate and

[1] See for instance, UNCTAD, The Maritime Transportation of Rubber, TD/B/C/4/60 Rev. 1 (New York: United Nations, 1970); UNCTAD, Route Study: The Liner Trades Between France and Morocco, Pub. No. TD/B/C/4/61, Rev. (New York: United Nations, 1970); UNCTAD, The Liner Conference System (New York: United Nations, 1970); UNCTAD, The West African Shipping Range (New York: United Nations, 1970); UNCTAD, Liner Shipping in India's Overseas Trade (New York: United Nations, 1967).

important concern with the less-developed countries whose export trade is more dependent upon liner conferences.

Dry Cargo Bulk Freight Market

Based on differences in the technical types of ships, cost structures, ownerships, qualities of service, and freight rate arrangements, ocean shipping may be divided into several branches. However, for the purposes of this study, it seems to be more appropriate to classify the ocean freight market into two categories on the basis of type of cargo. These categories are: liquid cargo freight market and dry cargo freight market. A great proportion of liquid cargo is carried in bulk by tankers, although cargo liners also carry some liquids in their deep tanks.

Dry cargo bulk freight market is characteristed by the use of tramp ships and bulk carriers.[1] The solitary exception is provided by bulk grain which is carried by all types of dry cargo vessels and by tankers. Tramps predominate in the bulk trades, while dry cargoes shipped

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[1] In general usage the expression "bulk carrier" implies a ship much larger than the conventional tramp. But a bulk carrier, as defined in Lloyd's register of shipping is "a single-decked ship over 400 feet in length with engine foom aft." (UNCTAD, Structure of Freight Rates, p. 8) In this definition, bulk carrier is not necessarily larger than a conventional tramp. The basic difference between the two types of ships lies in the fact that tramps may be two-decked and, therefore, suitable for many kinds of bagged and packaged goods for which single-decked bulk carriers are not suitable. However, in grain trade, both types of vessels are employed to carry homogenous full loads of cargo and are chartered in the same freight market. Thus, in spite of the picture of dereliction and dirt that the word 'tramp' conjures up to the mind of the landsman, there is very little to distinguish these ladies of the sea from the giants of the ocean. Hence, bulk carriers are covered under the tramp market, throughout this study.

other than in bulk are lifted by cargo liners. Thus, in spite of this overlapping, there are trades which are conventionally defined as tramp trades. The most important tramp trades from 1964 to 1967 are shown in Table 4.1. Although there are no available figures for liner liftings, it is worth noting that a number of these trades, especially ores, sugar, and timber, are also important for liner companies. The tramp market is important in the international trade of primary commodities as tramps predominate in bulk trades, especially in grains and seeds. The transportation costs of moving agricultural commodities in bulk are largely dependent upon affreightment arrangements in this market. Freight rates on tramp cargoes, settled in the tramp market, also determine the height of liner freight rates charged on these cargoes.

The tramp market is comprised of the international network of shipowners, their brokers, and charters in close and continuous communication. The services of the tramp ships can be hired for period of various duration. A chartering contract--called fixture--can be obtained for a period of less than one year in the open market. The fixtures for longer periods are usually negotiated. Open market fixtures may be for a single voyage between given ports, for consecutive voyages, or for a specified time. The single voyage charters and time charters for less than one year are necessarily arranged in the open market. The single voyage charter can be extended to cover a series of consecutive trips over the same route. A short-term charter can also be extended within the open market.

The open market serves the charterers who are not in a position to own ships or to hire them on long-term charter and whose needs cannot be effectively served by cargo liners. The major charterers in this market are the big grain operators who account for over 50 percent of

TABLE 4.1

CARGOES FOR WHICH TRAMP SHIPS WERE ENGAGED, 1964-67

Cargo Carried	Percentage (by weight) of Total			
	1964	1965	1966	1967
Grain and Seeds	54.2	60.08	58.45	53.45
Ores	12.88	10.03	11.14	11.29
Coals and Coke	11.54	10.55	7.39	10.00
Metals/Scrap	5.84	3.74	5.34	6.26
Fertilizers	2.33	2.78	4.14	5.40
Phosphate Rock	3.25	3.13	3.11	4.05
Sugar	4.00	4.16	4.09	3.61
Sulphur	1.65	1.78	2.20	2.76
General Cargo	0.84	1.20	1.50	.94
Timber/Wood Products	1.77	0.99	1.16	.94
Copra	0.58	0.78	0.77	0.66
Cement	0.84	0.42	0.50	0.46
Pyrites	0.18	0.15	0.11	0.15
Esparto	0.70	0.21	0.10	0.03

Source: United Nations Conference on Trade and Development (UNCTAD), Structure of Freight Rates, p. 4.

the total tramp charterings each year.

The tramp market is nearly a perfect competitive market on an international scale and its freight rates are subject to the laws of demand and supply. A very low degree of concentration of ownership is the principal characteristic of this market. It was noted in 1953 that most of the tramp companies owned less than four ships.[1] Freedom of entry is reflected by the fact that minimum requirement for going into tramp business is one vessel. As evidenced by the workings of the system on the floors of exchanges in various maritime centres--the largest of which is the "Baltic Exchange" of London--the keynote of this market is the quick and easy communication between the international network of shipowners, shipbrokers and charterers linked by global telecommunication services.

The first task of charterers or their brokers is to find the shipowners (or their brokers) who have tonnage appropriate for the cargo to be shipped. Shipowners, similarly, seek out the charterers who have cargo to fit their ships. Location of ships is a very important consideration in this regard. Having married the right ship to the right cargo, bargaining commences with one side making a firm offer to the other. The process of making offers and counter-offers continue until a compromise is reached. A simple spoken word "done" or "fixed" is sufficient to close the deal. Formal contracts may take several days or even weeks to be drawn and signed.

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[1] C. O'Loughlin, The Economics of Sea Transport (New York: Pergamon Press, Inc., 1967), p. 66. (Hereinafter referred to as Sea Transport.)

Freight Rate Determination in the Tramp Market

The tramp freight rates are determined by the free interplay of demand and supply forces. The interrelationships between demand and supply factors that affect the demand for a supply of cargo space in this market are depicted in Figure 4.1 These relationships are especially relevant for rate determination of the voyage charter rates in the short run.

The demand for a particular mode of transport, at a particular level of freight rates, is dependent upon the physical characteristics of cargo to be carried and the competition from other modes of transport. The effectiveness of competition from other modes of transport is reflected by the relative price of the competitive modes. In actuality, however, ocean transportation provides the cheapest mode of moving low value, bulk commodities over the world seas. The only alternative is air transportation, which is uneconomic in comparison with movements through ocean-going vessels. Ocean freight rates, themselves, affect the demand for cargo space because, at any particular level of demand, there is a certain elasticity with respect to price. But under conditions of free international trade, freight rates will influence the source of supply chosen by purchasers rather than the total quantity demanded in the market. Consequently, from an overall point of view, the world demand for commodity ton-miles is more sensitive to variations in freight rates than is the demand for total volume of cargoes.

The elasticity of demand for shipping services depends upon two factors.[1]

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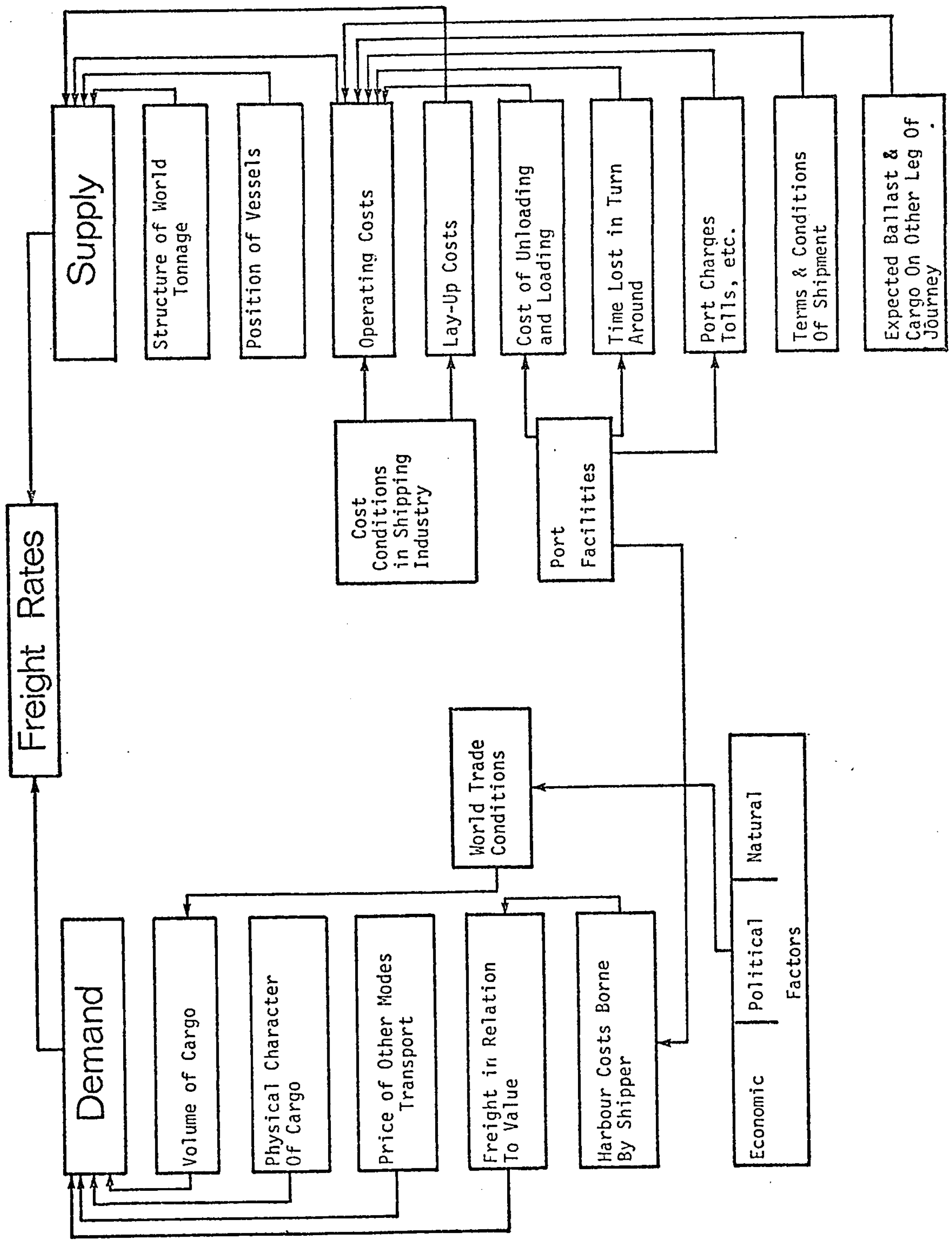
[1] For algebraic formulation of the relationships between elasticity of demand for transport, and elasticities of demand, production and export supplies, see Appendix A.

Figure 4
VOYAGE CHARTER MARKET



The first factor is the elasticity of demand for the commodities. The second factor is the substitution of sources of supply. It means that, in case of higher freight rates, domestic supplies or supplies from contiguous territories are used, thus eliminating or reducing the need for sea transport. However, changes in sources of supply are unlikely to occur on any large scale in the short run.

The main cause of short-term inelasticity is the effect of freight rates on the prices of commodities concerned; that is, the incidence of changes in freight rates. The magnitude of such an effect depends on the height of rates in relation to the value of the commodities. But, as long as the freight rates are less than the value of the goods shipped, the elasticity of demand for carriage will be lower than elasticity of demand for the goods transported. Since the commodities that move in tramp ships are bulk raw materials for which the price elasticity is generally relatively low, the elasticity of demand for tramp ton-miles can safely be assumed to be low in the short run.

The supply of bulk cargo space is the volume of unfixed tonnage in the world available for chartering. The total tramp tonnage depends upon the structure and composition of the world fleet. The number and size of vessels sailing as tramps are the most important determinants of the tramp tonnage--although, at times, the use of tankers for bulk grain cargoes may exert a marginal influence on the supply of cargo space. The volume of tonnage offered for charters at given freight rates depends upon the cost conditions in the shipping industry. The operating costs along with the lay-up costs of the vessel determine whether it will be laid up or offered for chartering at the given rates. While lay-up costs are determined mainly by the cost structure of the world's tramp fleet, operating costs are functionally related to the ship owner's expenses in loading and unloading, the time losses in turnaround and the distance to be traversed. Most of the operating costs are accounted for by what takes place while the ship is at the dock. It has been estimated that 60 to 70 percent of the cost of transporting cargo by sea is accounted for by what happens at the dock.[1] The port facilities exercise a definite constraint in this context because port expenses and ship turnaround time are directly related to the availability of port facilities. Port expenses and costs directly related to cargo handling constitute a predominant and increasing proportion of total ship operating costs.[2] Expected time in ballast before the next voyage with cargo is a major consideration in the ship owner's chartering decision.

In the short-term, the total supply of shipping is inelastic at all rates below the lay-up rate of the ship with highest voyage costs per ton. The lay-up rate is defined as the rate which will yield a revenue equal to the level of voyage costs minus the costs of lay-up. This is the absolute floor rate which the ship owner will accept.[3] In the range

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[1] D.C. MacMillan and T.B. Westfall, Competitive General Cargo Ships (Society of Naval Architects and Marine Engineers, Nov. 1960), p. 2, cited in B. Abrahamson, Developing Nations and Ocean Transportation, Research Paper #20 (Washington: A.I.D. project on Economic Interdependence in Southeast Asia, Sept. 1967), p. 32.

[2] UNCTAD, Ocean Shipping, Freight Rates and Developing Countries, Vol. V: Financing and Invisible Institutional Arrangements (New York: U.N., 1964), p. 259.

[3] Lay-up rates are different for different ships and are determined by several technical and economic factors. However, lay-up decisions *per se* are not our primary concern here. The topic has been widely discussed in: J. Mossin, "An Optimal Policy for Lay-up Decisions," Swedish Journal of Economics, I (1968), p. 1970: A.A. Svendsen, "Factors Determining the Laying-up of Ships," Shipbuilding and Shipping Record, June 19, (1958), p. 805; W. Alan, "Dynamic Programming of a Charter Market Model" (Unpublished Master's Thesis, Department of Ocean Engineering, M.I.T., Mass., 1971.)

of inelasticity below lay-up rates there is near zero responsiveness. Obviously, ships can switch from one shipping branch to the other or tankers can be cleaned out for the carriage of bulk grains. These circumstances, however, do nothing more than prevent the assumption of zero elasticity and provide for relatively greater elasticity of supply in particular trades and on particular routes.

The level of freight rates at any given time depends on the volume of cargo to be carried, the volume of tonnage and the cost structure of the world's tramp fleet. Once the rates are such that the supply curve is inelastic, the cost structure of the world's fleet is of no consequence. Demand conditions and the lay-up rates of different vessels determine the course of freight rates.

As supply is relatively inelastic in the short run, variations in freight rates in bulk freight market are mainly due to changes in demand conditions that occur because of seasonal variations in demand for commodities as well as factors such as war, crop failures, and other natural disasters. Thus the tramp freight rates are, in the short run, "demand-determined."

Tramp Freight Rate Model

Based on the preceding analysis, economic models of freight rate determination in the dry bulk cargo freight market can be formulated with different degrees of detail. One such example is the following simple model which shows the relationship between freight rates and demand-supply conditions for ocean transporation on particular routes.

$$F = f(Q,V,T,R,D,I)$$

where: F = ocean freight rate between two points,

Q = quantity of commodity moving between two points,

V = volume of bulk cargoes competing for ocean transportation,

T = total tonnage available for chartering,

R = possibility of securing cargo at the point of destination,

D = distance between point of origin and destination, and

I = index of general tramp freight rates for the given commodity.

The model implies a simple functional relationship between freight rates and the explanatory variables. Although the model can be further elaborated by explicit introduction of other variables, the basic factors that affect the voyage charter freight rates are taken into account by this simple model.

Freight rate on a commodity varies with the demand for shipping quantity services to transport it from origin A to destination B. Total volume of tramp cargoes moving from A to all destinations affects total demand for tramp tonnage at the port of origin. Total unfixed tonnage available for transporting tramp cargoes from port A to various destinations in the world constitutes the total supply of cargo space. The opportunities for securing cargo after reaching the destination affect freight rates by influencing the ship owner's estimates of the profitability of undertaking a voyage or laying-up the ship. Operating or voyage costs of the ship are directly related to the distance between the ports of origin and destination. Due to the greater time and expense required on longer runs, the freight rates are affected by the distance to be traversed. The inclusion of distance as an explanatory variable, therefore, provides a proxy for operating costs. The index of general tramp freight rates reflects the general demand-supply conditions in the international tramp market, of which the freight rates on any particular route are not independent.

With the objective of investigating the structure of ocean freight rates on Canadian grain exports via Pacific ports, the model was slightly revised to meet the constraint enforced by available data. In the revised form, the freight function became:

$$F = f\ (Q,V,T,D,I)$$

It will be noted that the availability of cargo after reaching the port of destination was excluded from among the explanatory variables. The basic reason remains that the data on volume of tramp cargo available in the ports of destination are rather inaccessible. The difficulty is increased by the fact that some vessels are chartered for consecutive voyages and consequently cannot accept cargoes from the port of destination unless the destination for such cargo coincides with their return route.

Data Sources

Ocean freight rates for heavy grains were taken from the annual issues of World Wheat Statistics published by the International Wheat Council, London. The freight rates are yearly weighted averages of the reported fixtures. The rates (reported in U.S. dollars per metric ton) were converted into U.S. dollars per ton (2,000 lbs.).

The figures for yearly exports of Canadian wheat to the different destinations via Pacific Coast ports were derived from data in Part I, Table 1 of Shipping Report which is published by Statistics Canada, Ottawa. Total volume of tramp cargoes shipped via the Canadian Pacific seaboard was calculated for each year from commodity export figures given in Part I, Table 2 of Shipping Report. Commodities grouped under the category of tramp cargoes are: Barley, Corn, Oats, Rye, Wheat, Grain

Feeds, Flaxseed, Mustard Seed, Rapeseed, Soyabeans, Oilseeds, Aluminimum Ore and Concentrate, Copper Ore and Concentrates, Iron Ore, Lead Ore, Manganese Ore, Nickel Ore, Zinc Ore, Metallic Ores, Iron and Steel Scrap, Slags Drosses, Coal, Asbestos, Limestone, Sand Sulphur, Fertilizers, Coke and Cement. The selection of these commodities for calculating total volume of bulk cargoes competing for ocean transport from Pacific ports is consistent with the Statistics Canada classification of bulk cargoes.[1] They also correspond to the nature of cargoes for which tramps are employed in the international freight market.[2]

Difficulties were encountered in obtaining information on the supply of tramp tonnage available during any year at the Pacific ports. The data necessary to calculate total tonnage arriving in ballast; that is, with no cargo, at the said ports were obtained from Part II, Table 8 in Shipping Report. This table gives the number and registered net tonnage of vessels arriving at and departing from Canadian ports in international seaborne shipping.

The source of information used in deriving an index of general freight rates for voyage charter rates was the Monthly Bulletin of Statistics, published by the United Nations. The freight index, based on official records of the Government of Federal Republic of Germany, was

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[1] Statistics Canada, Shipping Report, Part V, Table 25 (Ottawa: DBS, various years). Gives tonnage of selected commodities loaded at Canadian ports for foreign countries and includes seven commodities that fall into the bulk cargo category.

[2] United Nations Conference on Trade and Development, Structure of Freight Rates, p. 4.

preferred to that of U.K. Chamber of Shipping for the reason that the latter classifies freight rates by the size of the vessel. Sea distances between British Columbia ports and specific destinations were obtained from Distance Between Ports 1965, H.O. Publication No. 151, U.S. Naval Oceanographic Office, Washington. Distances between Vancouver and Rotterdam, London, and Yokohama were measured in nautical miles.

Data Limitations

Data on the total volume of bulk cargoes assumed to be competing for bulk transportation were obtained by summing the exported tons of several commodities for which tramps can be employed. The figures so derived are, in fact, very likely to be overstated because not all of these commodities are carried by tramps alone. Liners do pick up a part of these cargoes, but no exact figures for the liners' share in these cargoes can be obtained. Secondly, the figures for total tonnage arriving in ballast provide only a crude estimate of supply of shipping space. The tonnage arriving in ballast is defined on the basis of registered net tonnage of the vessels which do not unload any cargoes, irrespective of the cargoes they may have aboard. Moreover, it was impossible to derive figures for tramp tonnage from the total tonnage figures. It could have been more satisfactory to identify the supply of tonnage on a given route, especially for the vessels seeking cargoes on their return leg of the voyage to a foreign port of origin. For this purpose, it was speculated that the volume of imports from the foreign port of origin could be used as a proxy. But the reliability of such a proxy variable also became dubious in view of the fact that, at times, the destination of commodities from foreign ports is U.S. Pacific ports, and the vessels may seek return cargoes at British Columbia ports.

Results

Two forms were specified for the freight function:

1. $F = \beta o + \beta_1 Q + \beta_2 V + \beta_3 T + \beta_4 D + \beta_5 I + U$

$\hat{F} = \hat{\beta} o + \hat{\beta}_1 Q + \hat{\beta}_2 V + \hat{\beta}_3 T + \hat{\beta}_4 D + \hat{\beta}_5 I$

2. $F = \beta o \; Q^{\beta 1} \; V^{\beta 2} \; T^{\beta 3} \; D^{\beta 4} \; I^{\beta 5} \; U$

$\hat{F} = \hat{\beta} o \; Q^{\hat{\beta} 1} \; V^{\hat{\beta} 2} \; T^{\hat{\beta} 3} \; D^{\hat{\beta} 4} \; I^{\hat{\beta} 5}$

$\hat{F}$ denotes the estimate of F.

The function specified in equation 1 assumes linear dependence of freight rates on explanatory variables. In equation 2 the non-linear function indicates that there is not necessarily a direct proportionality between freight rates and the independent variables (Q,V,T,D, and I). Such direct proportionality would exist only if the summation of all $\hat{\beta}$ coefficients equals 1.

The unknown values of β coefficients in both functions were estimated by using the ordinary least-squares method. Linear regression results did not indicate a good fit. Statistical tests revealed that calculated R^2 values were not significant at the 90 percent level. However, tests on R indicated that R was significantly different from zero at 99 percent level.[1] The non-linear regression results obtained by using time series data for a cross-section of three different routes from British Columbia ports are given in equation (1) in Table 4.2.

Significance tests showed that only coefficients for quantity and distance were significant at 97.5 percent level. All the variables except

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[1] See Appendix B.

TABLE 4.2

FACTORS DETERMINING OCEAN FREIGHT RATES FOR WHEAT

$$F = \beta_o Q^{\beta_1} V^{\beta_2} T^{\beta_3} D^{\beta_4} I^{\beta_5}$$

Equation Numbers	Explanatory Variable	Intercept	Q	V	T	D	I	R^2	D-W	V-value
i)	Coefficient	-3.5906	0.1081	-0.1389	0.4019	0.4438	0.6807	37.51%[e]	2.369	2.52[e]
	Standard Error		(0.0471)	(0.1181)	(0.4343)	(0.1886)	(0.7581)			
	T-Value		2.3[c]	-1.18[f]	0.93[f]	2.35[c]	0.90[f]			
ii)	Coefficient	-2.9650	0.1021	-0.0929	---	0.4230	1.1540	34.96[e]	2.366	2.96[d]
	Standard Error		(0.0465)	(0.1068)	---	(0.1866)	(0.5578)			
	T-Value		2.2[c]	-0.87[f]	---	2.27[c]	2.07[c]			
iii)	Coefficient	-2.8843	0.0995	---	---	0.4141	0.9441	32.72[e]	2.273	3.73[d]
	Standard Error		(0.0461)	---	---	(0.1853)	(0.5003)			
	T-Value		2.16[c]	---	---	2.23[c]	1.89[d]			

Q = quantity shipped
V = volume of competing cargoes on all routes
T = tonnage supplied
D = distance
I = index of voyage charter rates in the world market
F = freight rate.

[a]Significant at 99.5 percent level
[b]Significant at 99 percent level
[c]Significant at 97.5 percent level
[d]Significant at 95 percent level
[e]Significant at 90 percent level
[f]Significant at 80 percent level

competing bulk cargoes had the expected signs. However, the negative sign of β_2 is negligible because of its insignificance. Moreover, the simple correlation between freight rates and this independent variable was only 0.07, although positive (Table 4.3).

Although there was no indication of autocorrelation, the problem of multicollinearity was obvious. As shown in Table 4.3, the simple correlation between V and T is 0.58. Also, the supply variable (T) was highly correlated with the overall freight rate index. High negative correlation between quantity moved and the distance variable also showed the existence of multicollinearity.

Consequently, the evaluation of the impact of other variables except distance was attempted. The results showed a substantial deterioration. All the coefficients calculated were insignificant. R^2 dropped to 21.03, indicating the importance of distance as a determining factor. Another exercise including the distance variable and dropping the quantity shipped resulted in almost similar insignificance. Hence, in view of high correlation between tonnage supply and freight rate index (0.746), it was deemed necessary that either of the two variables be excluded. Tonnage supply was excluded because of its relatively weak influence upon freight rates. The results obtained are given by equation (ii) in Table 4.2. Compared to the results of equation (i), the index variable showed a substantial improvement thus indicating that inclusion of tonnage was depressing the effect of freight rates in the international market. The total demand for bulk cargo space remained insignificant throughout. The negligible correlation between this variable and the dependent variable led to the reasoning that the inclusion of the bulk cargoes was unimportant and was strengthening the influence of other

TABLE 4.3

SIMPLE CORRELATION COEFFICIENTS

Variable	F	Q	V	T	D	I
F	1.0000					
Q	0.1246	1.0000				
V	0.0769	0.0810	1.0000			
T	0.3428	0.0549	0.5813	1.0000		
D	0.1252	-0.8600	0	0	1.0000	
I	0.4188	0.1174	0.4520	0.7467	0	1.0000

F = Freight rate.
Q = Quantity of wheat.
V = Volume of bulk cargoes.
T = Total tonnage supply.
I = Index of general charter rates.
D = Distance.

variables. With this expectation, both tonnage and quantity shipped were dropped. The results, however, indicated an even further deterioration in the values of β coefficients. This confirmed that the effect of demand for bulk cargo space and supply of tonnage was being reflected by the general freight index--which indeed it does. This consideration warranted the exclusion of both demand for and supply of tonnage from the original function.

The results presented in equation (iii), Table 4.2 show that the impact of these two variables is insignificant. The three most important determinants of freight rates appear to be the geographic distance, quantity shipped, and the general demand-supply conditions in the international bulk freight market.

Fluctuations in Charter Rates

The general movement of charter rates is governed by the available supply of vessel space as compared with the demand in a particular trade.[1] The charter rates are fully competitive and fluctuate freely. Rates may change many times in the course of a single day.[2] The volatility of the tramp rates, whether voyage or charter, can be explained in terms of the preceeding theoretical framework. In reality,however, the arguments should be extended to account for the dynamic working of the market. Total tonnage, then, is not absolutely fixed. New ships continue to be built and delivered; old ships are continuously being retired and scrapped. New

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[1] In each specific instance, the nature of the trade route and the character of the cargo exert important influence on freight rates. A. Berglund, Ocean Transportation (Toronto: Longmans, Green and Co., 1931), p. 217.

[2] E.R. Johnson and G.G. Huebner, Principles of Ocean Transportation (New York: D. Appleton & Co., 1929), p. 325.

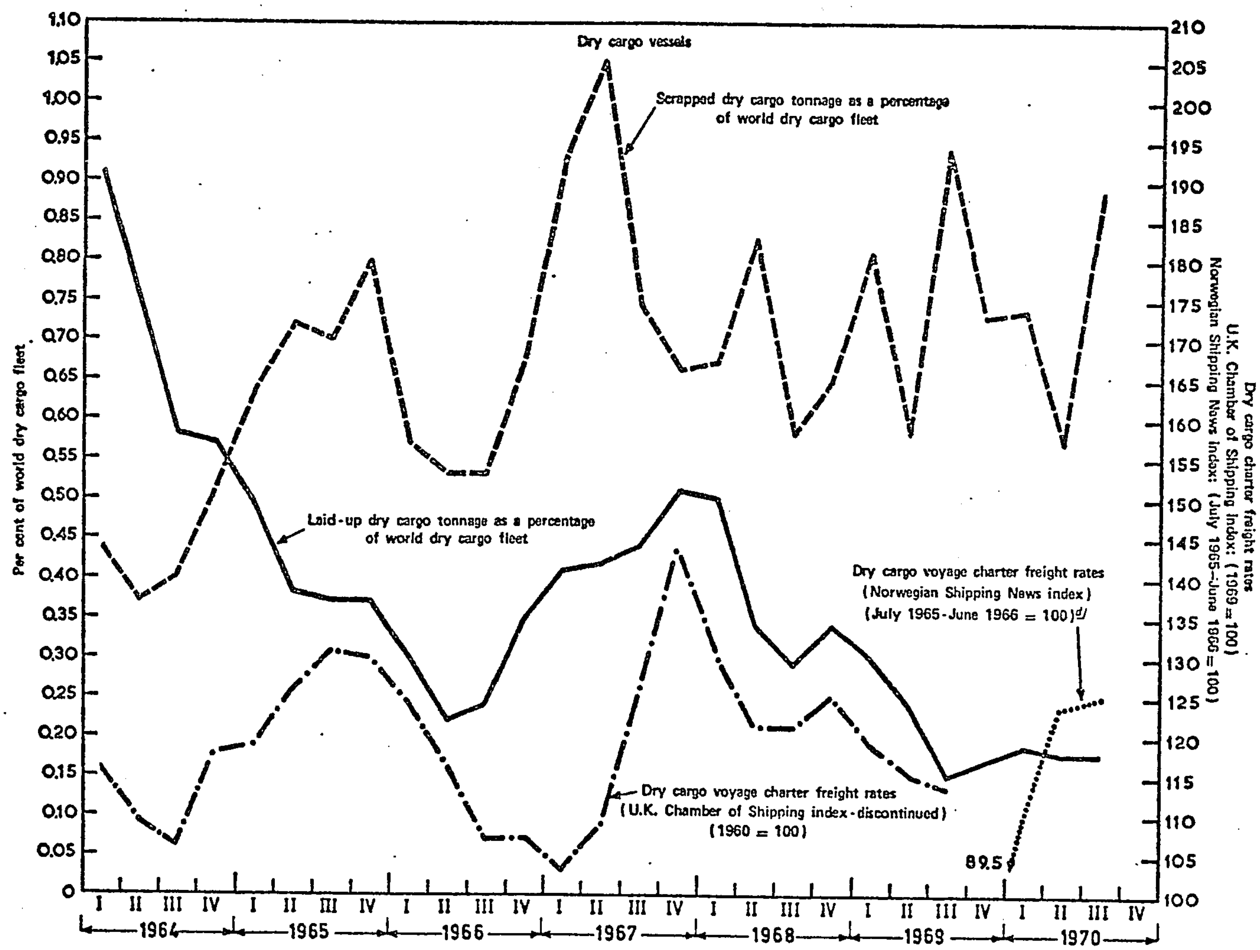
ships differ in size and have different voyage costs. Thus, the lay-up rate may be significantly different from the old ships, whether in service or scrapped. The difference in lay-up rates of big vessels implies change in the point at which the supply becomes elastic. In practice, the degree of optimism or pessimism prevailing in the market also influences the supply of tonnage in the charter market. Changes in freight rates receive a lagged response from reactivated tonnage, tonnage on order, tonnage under construction, and tonnage launched. As was noted by Leslie Jones: "Changes in freights are echoed, to some extent, almost immediately in tonnage commenced, and that fluctuations here are reflected a few quarters later in tonnage under construction and through its tonnage launched."[1] The course of voyage charter rates, laid up tonnage and scrapped tonnage is shown in Figure 4.2. It shows that the periods of falling freight rates were accompanied by high levels of scrapped tonnage and laid-up tonnage.

The tramp rates are volatile because of changes in demand more than because of changing supply conditions. On at least five occasions during the past twenty-five years a falling trend in freight rates has been reversed and followed by a sharp rise. The Korean War increased the demand for tramp tonnage for carriage of military stores to Korea. Other examples are: the European Fuel crises of 1954-1956 and the closure of Suez Canal in 1956. In each of these cases, freight rates were increased by some 300 percent or more on major tramp routes. In 1963 grain crop failures turned a renewed slump into temporary prosperity and a further increase in freight rates was registered with the closure

[1] O'Laughlin, Sea Transport, p. 88.

FIGURE 4.2

THE COURSE OF FREIGHT RATES, LAYING-UP AND SCRAPPING, 1964-1970



Source: UNCTAD, Review of Maritime Transport, 1970, Pub. No. TD/B/C.4/82 (New York: U.N. 1971), p. 28.

of the Suez Canal in 1967.

The revival in the ocean freight market after closure of the Suez Canal in June, 1967 was shortlived, however, because of a supply of new tonnage, the return of tankers to grain trade, and also because of a continued shift towards the use of larger vessels on most of the major routes. In addition, the market was faced with a falling off of demand for tonnage for wheat and other grains. It is interesting to note that, during the same period, world tonnage on order for construction increased from 35.3 million -ross tons to 40.8 million gross tons at the end of June, 1968. The bulk-carriers tonnage was actually increased by 6.7 million tons while tanker tonnage increased by 5.5 million tons.[1] However, the laid-up tonnage remained low because the Vietnam war continued to keep some of the U.S. tonnage tied up.

There was once again some decline in demand for grain-carrying tonnage and a further rise in supply of new tonnage. The increasing use of larger vessels, including bulk-carriers, contributed to lowering of freight rates for grain cargoes. The world tonnage on order increased to 54.8 million gross tons at the end of June, 1969,[2] while the world level of laid-up tonnage remained relatively low indicating virtually full employment (taking all commodities together) in the freight market. Increased rates were observed during the period July-December, 1969. In the early part of 1970, some freight rates rose to their highest levels

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[1] International Wheat Council, Review of the World Grains Situation, 1967/68 (London: I.W.C., 1968), pp. 34-39.

[2] International Wheat Council, Review of the World Grains Situation, 1968/69 (London: I.W.S., 1969), pp. 41-44.

since 1956/57. This was the result of movement of tankers out of the dry cargo market and increased demand for tonnage in ores, coal and feeding stuffs trades. The volume of laid tonnage decreased.[1]

The freight rates on grain cargoes showed a rising trend in July, 1970.[2] The trend continued until October due to a sudden pressure for tonnage to cover shipments fo alternative feedgrains resulting from the outbreak of leaf blight in the United States maize crop. However, in the month of October, Japan made a drastic reduction in her chartering for coal, ores and scrap. This weakened the freight market which was further hurt by the release of vessels which were previously on time charter. The lack of propsect for a recovery in demand of tonnage and the declining freight rates made ship owners lay up more and more vessels.

Thus, the tramp rate fluctuations are the result of interaction of supply and demand forces. On the supply side, tonnage under construction, new launchings, scrapped tonnage, cost structure and size of new vessels, and ease with which vessels can be transferred from one trade to the other are important factors affecting the level of freight rates. Variations in demand for tonnage, however, remain at the root of freight rate fluctuations. Besides seasonal variations in demand for tonnage to move agricultural commdoties, there are sudden changes in demand for tonnage in other trades. Obviously, demand conditions can change because of any economic, political or natural factor. In fact, these changes are the rule, not the exception. The effect of changes in

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[1] International Wheat Council, Review of the World Grains Situation, 1969/70 (London: I.W.C., 1970), pp. 35-39.

[2] International Wheat Council, Review of the World Grains Situation (London: I.W.C., 1971), pp. 38-40.

demand for tonnage in a particular trade and/or on a particular route may be more severe on some routes, as the effects of supply/demand imbalances are rarely spread equally over all types of ships and sectors of the freight market.[1] In the case of an upward movement of rates, the routes with greatest pressure are marked by the steepest increase in freight rates. A case in point is the rates on coal shipments from Hampton Roads to the United Kingdom and continental Europe which registered a steep increase during 1954-1956. Rates on other routes increased only after enough tonnage had been diverted to the pressure points, thus creating a relative shortage of tonnage on these routes.[2] The course of ocean freight rates (for wheat) on major routes for the period July 1970/June 1971 is shown in Figure 4.3. The freight rates referred to in the figure are averaged over all fixtures (trip charters and time charters) reported in each month. However, it does not distort the preceeding explanation of fluctuations in freight rates as time charter rates are linked with voyage charter rates, both on the supply side and on the demand side. On the supply side, the ship owner has the alternative of seeking a time or a voyage charter. On the demand side, some merchants are indifferent as between time and voyage charter rates and even if this were not so, speculators would take ships and re-let them on voyage charter if the former rates were out of step. The two rates must therefore move together.[3] In this connection, another recent development with respect

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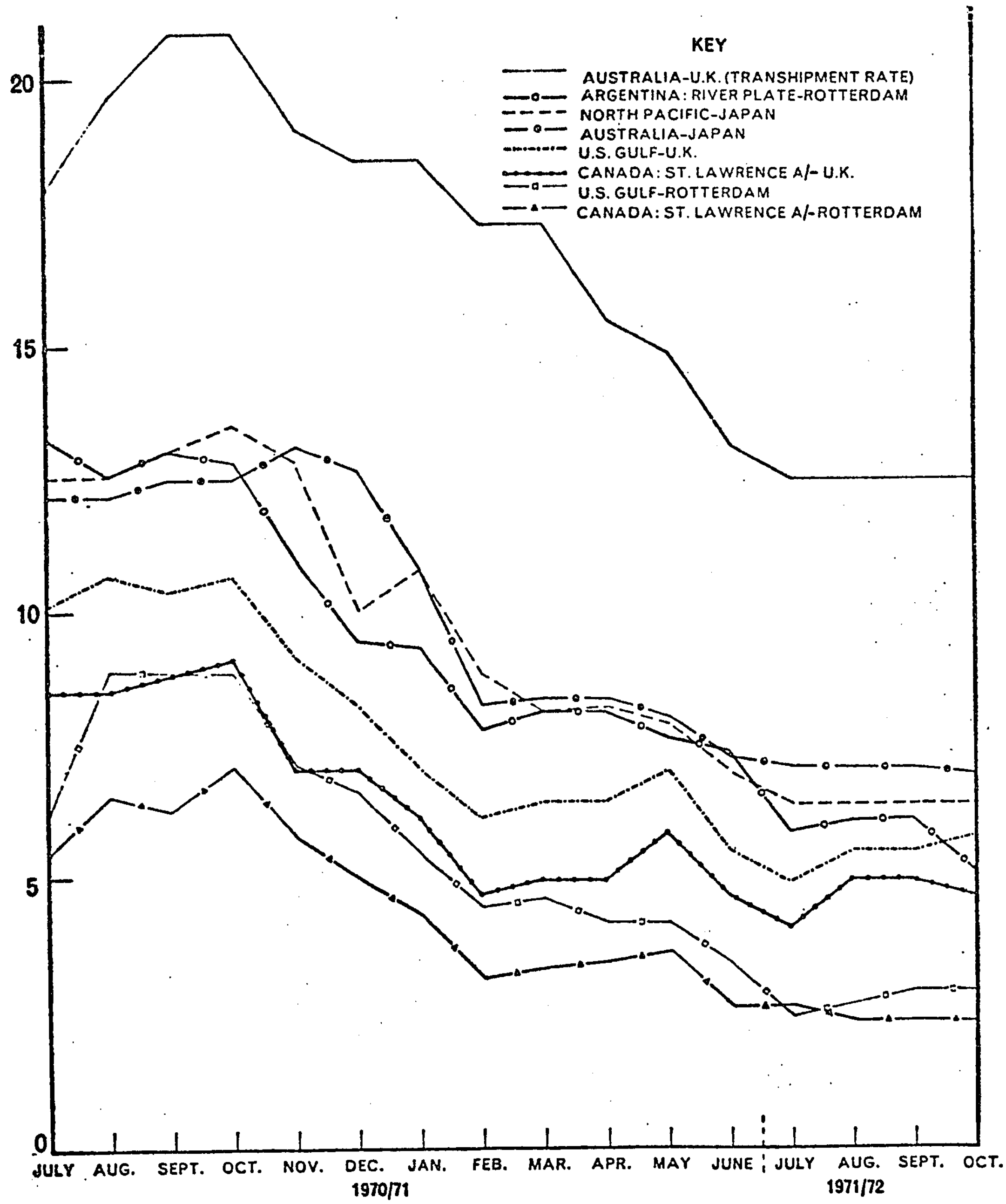
[1] See Appendix C.

[2] UNCTAD, Structure of Freight Rates, p. 13.

[3] W.A. Lewis, Economics of Overhead Costs (New York: Rinehard, 1949), p. 91.

FIGURE 4.3

SELECTED OCEAN FREIGHT RATES FOR WHEAT
MONTHLY, JULY, 1970 - OCTOBER, 1971



Source: International Wheat Council, Review of the World Grains Situation, 1970/1971 (London: I.W.C., 1971), p. 39.

to voyage charters should also be pointed out. This type of chartering has considerably declined in its share of total dry cargo movements.[1] Many commodities are now being transported on short-term and medium-term contractual bases. The voyage charters are therefore obtained for the residual quantities. These residual quantities are subject to wide fluctuations depending upon demand/supply conditions in trades that suffer from seasonal variations.[2] This element of unpredictability prevents the use of time charters in such trades. In recent years, fluctuations in demand for tramps have also been increased by the sudden entry and exit of liner companies who hire tramps for single trips, consecutive voyages and short periods of up to twelve months in order to lift all additional and unpredictable tonnages offered for shipment over their routes. Thus, the inherent instability of the tramp market is attributable to the versatility of the market organization and the flexibility which is necessary for meeting unforeseen contingencies in the ocean freight market. Unpredictability is the result of the versatility and flexibility provided by the open market. The desirability of paying this price is well described by Hector Gripaios:

> The continual changing of both the source and destination of cargoes is one of the principal justifications for the existence of the tramp ship, since liner tonnage with their fixed schedules are not easily able to deal with developments of this nature. The flexibility and versatility of

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[1] During 1968, for example, single voyage charters totalled only 8 percent of the total dry cargo movements. Organization for Economic Cooperation and Development (OECD), Maritime Transport 1969: A Study by the Maritime Transport Committee (Paris: OECD, 1970), para. 37.

[2] UNCTAD, Review of Maritime Transport, 1970, Pub. No. TD/B/C. 4/82 (New York: U.N., 1971), p. 25.

> the tramp ship are always available in times of economic or political crisis, and the vital role of tramp ships when unusual movements of cargo are required is very often overlooked by the world at large.[1]

Summary

The firms in the charter market that serve bulk grain trade behave as if there is perfect competition. The ocean freight rates for heavy grains in said market are competitively determined prices. The freight rates for wheat were shown to suffer from day to day fluctuations. The analysis of available empirical evidence indicated that the most important variables explaining the level of freight rates on specific routes are the level of freight rates in the world tramp market, distance to be traversed, and the quantity of cargo-seeking shipping space. The results of the regression model, being not very conclusive, point out the need for more effort in terms of time and resources for investigating the relationships between all demand and supply factors.

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[1] O'Laughlin, Sea Transport, p. 68.

CHAPTER V

INCIDENCE AND PROTECTION EFFECT OF TRANSPORTATION

Introduction

The effects of transportation costs in international trade are analogous to those created by other trade impediments. They have the effect of causing simultaneous movements along the demand and supply curves for the commodity traded. The effects of shifts in demand and supply curves would manifest themselves in changes in production of the commodity in the trading countries. Consumption in the importing country may also be affected. There is a redistribution effect between the consumers and producers in both countries. Higher landed price in the importing country leads to higher domestic prices (than would otherwise prevail) and higher returns to factors of production. The reduction in the import demand is reflected in the supply price of the exporting country. The returns to factors of production in the exporting country will be decreased. In the context of a macro-model, these changes may have a multiplier effect on the national income and employment. The list of direct and indirect influences of transportation costs may be further extended to include balance-of-payments and terms of trade effects. The analysis of these influences depends upon how much disparity between export supply price and import demand price is created by transportation costs and how the economic burden of these costs is shared by the trading partners.

The difference between transportation costs and other trade barriers is that transportation costs are a natural consequence of separation of sources of demand and supply while other trade barriers, such as tariffs, quotas and currency restrictions etc., are the result of deliberately designed policy measures which favour the importing country. Transportation costs in international trade on the other hand, are not a policy variable. However, this does not provide sufficient grounds for disregarding the protective effects and incidence of these costs. Of course, there are numerous empirical problems involved in quantification of the operational effects of transportation costs, but these problems only point out the need for serious efforts at the theoretical as well as empirical, level of investigation.

This is what is attempted in this chapter. It consists of three major parts. In the first part, an attempt is made to evaluate the incidence of transportation costs of Canadian wheat exports. This is preceeded by an analytical discussion of incidence of transportation costs. The rates of natural protection provided by total transportation costs are calculated in the second part of this chapter. The third part of the chapter is devoted to evaluation of the protection effect of ocean freight charges.

Incidence of Transportation Costs

The difference between f.o.b. prices and c.i.f. prices is always equal to costs of transportation, if they include other costs such as insurance etc. The question of incidence is one of the distribution of the impact of transportation costs on f.o.b. and c.i.f. prices, respectively. The share of economic burden of transportation costs borne by the exporter and importer does not depend upon who makes the payment for services of transport system.

The argument that transportation costs reduce exporter's comparative advantage has sometimes led to the opposing fallacious conclusions that: transportation costs are borne by the exporter; transportation costs are borne solely by the importer.

Adam Smith's argument implied that such costs are finally paid by the consumer "to whom it must always be charged in the price of the goods."[1] Ricardo, however, seems to have a different opinion. His discussion of "changes in the channels of trade" indicates that he believed that such costs are borne by the exporting country. The comparative advantage of a country in production of a commodity may be destroyed by a rise in "the freight and insurance on its conveyance, that it can no longer enter into competition with the home manufacture of the country to which it was before exported."[2] Mill argued that no verdict regarding the incidence of transportation costs could be given without considering the demand conditions:

> No absolute rule, therefore, can be laid down for the division of the cost, no more than for the division of advantage: and it does not follow that in whatever ratio the one is divided, the other will be divided in the same. It is impossible to say, if the cost of carriage could be annihilated, whether the producing or the importing country would be most benefitted. This would depend upon the play of international demand.[3]

Mill's position was upheld by Professor Viner.[4]

Professor Graham took a position closer to Smith's--that international transportation cost will almost always be borne solely by the

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[1] Adam Smith, Wealth of Nations, p. 261.

[2] Ricardo, Political Economy, p. 248. Bertil Ohlin, Interregional Trade, pp. 282-283, ascribes a similar opinion to Mr. Senior.

[3] Mill, Principles, p. 107. For Mill's criticism of H.C. Carey, who believed that "the whole of the cost of carriage" is "a direct burden on the producers", see: Ibid., p. 424.

[4] J. Viner, Studies, p. 470.

importer.[1] If the transport costs were to be borne by the exporting country A, it would be advantageous for A to divert its resources to alternative products that are not exportables. Implied in Graham's argument is the assumption that countries, in reality, import only when the cost ratios differ from the international ratio of exchange (net after abstracting transport costs) by more than costs of transport. Otherwise, the importing country would be producing the good at home. Hence, full transport charges will have to be borne by the importing country because there is no profitable alternative into which resources could be diverted in country B. Obviously, Graham's position is more vulnerable than Mill's because his assumption of inelastic demand is more objectionable than Mill's demand equation.[2] In fact, the incidence of transportation costs is determined by the elasticities of demand and supply. The general price level approaches to the burden of transportation costs have no relevance to trade in particular commodities.[3] The incidence of transportation costs of individual commodities can be better determined using a partial equilibrium approach.[4]

The incidence of the cost of transporting a commodity depends upon the elasticities of demand and supply for the commodity in question.

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[1] F. Graham, International Values, p. 145.

[2] J.S. Mill, Essays on Some Unsettled Questions of Political Economy (Reprint; New York: A.M. Kelly, Publishers, 1968), p. 20-21.

[3] "Strictly speaking, it is not correct to say that changes in freight affect commodity prices. It would perhaps be better to say that ... all prices of services and goods hang together in a mutual interdependence price system." Bertil Ohlin, Interregional Trade, p. 531f.

[4] Haberler, International Trade, p. 172, uses a similar method to show the direct effects of tariffs and prohibitions.

The incidence of freight charges is determined by the relation between the c.i.f. and f.o.b. prices and the price that would prevail in a zero transportation cost situation. The incidence of transportation costs would fall entirely upon the exporter if the price in the importing country did not change with the introduction of such costs or with the annihilation of such existing costs. This, of course, would be possible only in the case of a perfectly inelastic supply. The whole burden of freight charges would be borne by the importer if the demand was completely inelastic. The cost of transportation would be equally shared by the importer and exporter if the elasticities of both demand and supply at the equilibrium price were equal.

In actuality, completely inelastic demand and supply are limiting cases. The same is true of equal elasticities of demand and supply. In international trade, the incidence of transportation costs falls both upon the buyer and the seller. The precise extent of sharing such costs depends, among other things, upon the elasticities of demand and supply.

An attempt was made to determine the incidence of ocean transport costs on wheat exports from Canada to United Kingdom and Antwerp/Rotterdam. The analysis was concerned only with incidence of changes in transportation costs. It is virtually impossible to determine the original incidence of transportation costs because the sale and purchase prices cannot be calculated in the absence of transportation costs. While considering changes in transportation costs, the inland transfer costs were excluded because they have been quite rigid over the period covered herein. Behaviour of various components of the total costs of moving wheat, discussed in Chapter III, showed that changes in these costs were mainly due to fluctuations in ocean freight rates. The selection of routes was purely a matter of convenience as accurate data on freight rates and c.i.f. prices in the said markets were available for these trade routes.

Any change in ocean freight rates must be absorbed by movements either in export prices, c.i.f. prices, or both. This hypothesis was put to test by regressing export prices against freight rates in order to indicate the interrelationship between movements in freight rates and export prices. Using the same data, the c.i.f. prices were regressed against freight charges to indicate the dependence of import prices on freight charges. The relationship between the two sets of prices and freight charges was assumed to be of the following forms:

$$P_x = f(F) \quad \text{or} \quad P_x = b_o + b_1 F + u$$

$$P_m = f(F) \qquad\qquad P_m = b_o + b_1 F + u$$

where: P_x = export price

P_m = c.i.f. price in the importing country

F = freight.

The above specification for the functional relationship between prices and freight charges is most simplistic from a statistical point of view. The objective was not to explain the determination of export and import prices, but to investigate the movements of these prices in response to changes in ocean transport charges. Moreover, the two price sets belong to the category of constantly administered prices due to national policies in the importing and exporting countries and because of price ranges determined by the International Wheat Council. Quantification of such policy variables poses tremendous difficulties. Inclusion of other variables in the above function was also prevented by difficulties in obtaining accurate information on factors affecting the two price sets for different countries.

The export prices and import prices for every trade couplet were expressed in U.S. dollars per metric ton. Freight rates were also measured in U.S. dollars per metric ton. The export prices are in store prices of Canadian No. 2 Northern Manitoba, while the import prices are c.i.f. London prices for the same grade in the case of the United Kingdom and c.i.f. Rotterdam price of No. 2 Northern Manitoba in the case of Rotterdam.

The figures for export prices were taken from the export price data on No. 1 Northern Manitoba published by the International Wheat Council and were adjusted for spread between monthly prices of No. 1 and No. 2 Manitobas. The ocean freight figures are the monthly weighted average freight rates for heavy grains based on information provided by U.K. Chamber of Shipping and on reports from importing and exporting countries to the International Wheat Council. The source of information for c.i.f. prices at the ports of destination was World Wheat Statistics which is published by the Wheat Council and is based on reports from member countries.

From data on monthly average figures for crop years 1959/60 to February, 1972, the values of coefficients b_1 and constant b_0 were estimated by least square regression analysis. The results from the first set of calculations relating to the dependence of export price and import price on ocean freight charges in the case of wheat exports from St. Lawrence ports to Rotterdam are given in Table 5.1

An inspection of the value of the coefficient in the export price equation (Equation 1) reveals that changes in ocean freight rate exercises a negative influence on export price. The regression coefficient for the

TABLE 5.1

INFLUENCE OF OCEAN FREIGHT CHARGES ON EXPORT AND C.I.F. PRICES FOR ROTTERDAM

1. $P_x = \beta_0 + \beta_1 F$

2. $P_m = \beta_0 + \beta_1 F$

Explanatory Variable / Equation Number	Intercept	Freight Charges (F)	R^2	D-W	F-Value
1. Coefficient	66.970	-0.4499	2.9[e]	0.182	4.42[d]
Standard Error		(0.2140)			
T-Value		-2.1[c]			
2. Coefficient	73.77	+0.4275	3.03[e]	0.185	4.62[d]
Standard Error		(0.1988)			
T-Value		2.15[c]			

P_x = Export Price of No. 2 North Manitoba

P_m = Import Price (C.I.F. Rotterdam)

F = Ocean Freight Charges from St. Lawrence to Rotterdam

[a] Significant at 99.5 percent level.
[b] Significant at 99 percent level.
[c] Significant at 97.5 percent level.
[d] Significant at 95 percent level.
[e] Significant at 90 percent level.
[f] Significant at 80 percent level.

(Number of observations = 150.)

import price equation (Eqn. 2) has a positive sign implying that an increase in freight charges is corresponded by an increase in Rotterdam c.i.f. prices. The signs of two coefficients are consistent with *a priori* reasoning that an increase in freight rates, other things remaining the same, will increase the import prices in direct equal proportion, thereby reflecting a case of cent percent incidence on the importer, or will decrease export prices by an equivalent amount, thereby reflecting the total incidence of marginal change in ocean freight. The real world situation was expected to be confirmed by a negative coefficient for the freight rate term in the export price equation and by a positive sign for the regression coefficient in the case of import price because incidence of changes in ocean transportation cost will not solely rest upon the importer or exporter. Cent percent incidence on either of the two were anticipated to be the only limiting cases.

The accuracy of the estimates was tested by evaluating the F-value. The test indicated that F-values in both cases were above the critical values of the relevant F-distribution. A T-test was made to evaluate the significance of the regression coefficients. The computed T-values show that both of the estimated coefficients are significant at 97.5 percent level.

However, the hypothesis of zero autocorrelation could not be accepted because of the low values of Durbin-Watson Statistic in both cases. This prompted an effort to use first differences to avoid the autocorrelation. But there was no improvement in the results for the export price equation. Only the results for the import price equation showed a slight improvement. The T-value and R^2 rose to 2.96 and 5.64, respectively. Further exercises (Appendix D) were undertaken with the introduction of an additional explanatory variable in view of the low values for R^2. The results, however, did not indicate substantial improvements.

A comparison of regression coefficients in equations 1 and 2 provides an interesting clue to the incidence of transportation charges. Despite the reasons for statistical skepticism, as far as wheat exports to the Rotterdam market are concerned, it appears that the burden of changes in freight rates has been falling approximately equally upon the export and import prices.

Protection Effect

The protective effect of transportation costs is a "natural"[1] consequence of the separation of sources of demand and supply. International and interregional trade occurs only because the production and consumption points are separated by geographic distance. Transportation costs are, therefore, necessarily incurred in international trade. Hence, their protection effect may be called natural and inevitable.[2]

The industry situated near its market enjoys a comparative advantage over its foreign competitors by virtue of transportation costs. The local producers are protected against outside suppliers by the

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[1] "Cost of carriage is a natural protecting duty which free trade has no power to abrogate." Mill, Principles, p. 424.

[2] The word protection is used in this study in what H.G. Johnson calls "a very loose sense" to denote a state of affairs in which prices of a commodity, expressed in the same currency, are different in each market. For Johnson's definition of protection, see: J. Bhaqwati, ed., International Trade (Baltimore: Penguin Books Inc., 1970), p. 187.

transportation costs.[1] In international trade, home markets are protected against the foreign suppliers by transportation costs.

The protection enjoyed by domestic producers against their foreign rivals depends upon the magnitude of the costs of transporting the goods, which each of the foreign suppliers must incur. As the transport costs from all the exporting countries to the import market cannot be equal, there will be differences in the protection enjoyed by the home market against each of them. By the same reasoning, foreign suppliers would enjoy different amounts of natural protection against each other.[2]

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[1] Theoretically, it is not the national borders that are of importance in determining the protection effect of transportation costs. Under conditions of free trade, the physical distance and mode of transportation determines the magnitude of such costs and the protection thereby provided. For example, haulage charges from Detroit to Toronto are likely to be lower for every commodity than from Vancouver to Toronto. Thus, foreign producers could supply peripheral areas in a given foreign country more cheaply than the domestic producers. Thus, it is the difference between transportation costs from two centres of production that should be considered. The argument is based on: F.A. Fetter's, "The Economic Law of Market Areas," The Quarterly Journal of Economics, Vol. 38 (1924), pp. 520-529. For a brief summary of Fetter's argument, see: F. Graham, International Values, p. 141-143.

[2] Following the recent developments in the theory of tariff structures, the protection effect of transportation costs discussed so far can be termed "nominal protection," as distinguished from "effective protection." In the case of final commodities, the nominal protection is equal to the effective protection provided by the costs of transportation, if the inputs used in the industry are not imported or if all the tradable inputs used have the same level of *ad valorem* transportation cost of any input be different from that of the final product, the effective protection will differ from nominal protection, as indicated by the transport charges for the final product.

An important contribution to the development of the idea of effective protection is: W.M. Corden, "The Structure of a Tariff System and the Effective Protective Rate," Journal of Political Economy, Vol. 74 (1966), pp. 221-237. Corden traces the origin of the main idea to: J.E. Meade, Trade and Welfare (London: Oxford University Press, 1955), pp. 162-163. For an original discussion of the concept with regard to trade policies in Canada, the reader is referred to: C.L. Barber, "Canadian Tariff Policy," Canadian Journal of Economics and Political Science, Vol. 21 (1965), pp. 513-530. For empirical investigations see: B. Balassa, "Tariff Protection in Industrial Countires: An Evaluation," Journal of Political Economy, Vol. 73 (1965), pp. 573-594; and G. Basevi, "The U.S. Tariff Structure: Estimates of Effective Rates of Protection of U.S. Industries and Industrial Labor," Review of Economics and Statistics, Vol. 48 (1966).

Making the simplifying assumptions that per unit cost of production is the same among trading partners and that there are no other trade impediments, it can be shown that the amount of protection provided by transportation costs equals the difference between transport costs from domestic and foreign sources of supply to a given market in the importing country. Let:

$$T_m = \sum_{i=1}^{n} G_i d_m I_m$$

$$T_{1m} = \sum_{i=1}^{n} G_i d_{x_1} I_{x_1} + \sum_{i=1}^{n} G_i L_{x_1} + \sum_{i=1}^{n} G_i O_f D_{1_m} + \sum_{i=1}^{n} G_i U_m + \sum_{i=1}^{n} G_i I_m dU$$

$$T_{2m} = \sum_{i=1}^{n} G_i d_{x_2} I_{x_2} + \sum_{i=1}^{n} G_i L_{x_2} + \sum_{i=1}^{n} G_i O_f D_{2m} + \sum_{i=1}^{n} G_i U_m + \sum_{i=1}^{n} G_i I_m dU$$

$$T_{3m} = \sum_{i=1}^{n} G_i d_{x_3} I_{x_3} + \sum_{i=1}^{n} G_i L_{x_3} + \sum_{i=1}^{n} G_i O_f D_{3m} + \sum_{i=1}^{n} G_i U_m + \sum_{i=1}^{n} G_i I_m dU$$

$$T_{km} = \sum_{i=1}^{n} G_i d_{x_k} I_{x_k} + \sum_{i=1}^{n} G_i L_{x_k} + \sum_{i=1}^{n} G_i O_f D_{km} + \sum_{i=1}^{n} G_i U_m + \sum_{i=1}^{n} G_i I_m dU$$

where: T_m = total costs of transportation from domestic production center to ith market in the imprting country,

T_{km} = total costs of transportation in movement of commodity G from a production center in kth country to the ith market in the importing country m,

d_{x_k} = distance between production area and port of loading in kth exporting country,

I_{x_k} = inland per ton-mile costs in exporting country,

L_{x_k} = loading costs per ton in exporting country k,

U_m = unloading charges per ton in imprting country,

I_m = inland per ton-mile costs in importing country,

O_f = per ton-mile ocean freight charges (including insurance),

D = distance between port of loading and destination,

d_u = distance from port of unloading to a given market in the importing country, and

d_m = distance between domestic production center and a given market in the importing country,

and:

$$d_{x_1} \lesseqgtr d_{x_2} \lesseqgtr d_{x_3} \lesseqgtr d_{x_k} \lesseqgtr d_m \lesseqgtr d_u$$

$$I_{x_1} \lesseqgtr I_{x_2} \lesseqgtr I_{x_3} \lesseqgtr I_{x_k} \lesseqgtr I_m$$

$$L_{x_1} \lesseqgtr L_{x_2} \lesseqgtr L_{x_3} \lesseqgtr L_{x_k} \lesseqgtr U_m$$

$$O_f D_{1_m} \lesseqgtr O_f D_{2_m} \lesseqgtr O_f D_{3_m} \lesseqgtr O_f D_{k_m} .$$

The magnitude of protection enjoyed by producers in the importing country against each of the exporters would depend upon whether:

$$T_m \lesseqgtr T_{1m} ; \quad T_m \lesseqgtr T_{2m} ; \quad T_m \lesseqgtr T_{3m} ; \quad T_m \lesseqgtr T_{km} .$$

The protection enjoyed by each foreign supplier against the other will be given by:

$$T_{1m} \lesseqgtr T_{2m} \lesseqgtr T_{3m} \lesseqgtr T_{km} .$$

Thus, even without tariffs, there is an element of protection from foreign competitors. The domestic price of import-competing goods can exceed the foreign price (expressed in the same currency) of import goods by an amount equal to the transportation costs on foreign goods.

To approximate reality, however, the assumption of equal costs of production must be relaxed. The effect of the difference between f.o.b. and c.i.f. prices created by transportation costs is similar to the effect of difference in the production costs in the foreign and domestic centres of production. Given the initial disparity between costs of production in the two countries, the producers in the importing country would be in the more advantageous position if there are transportation costs to be incurred. The introduction of such costs would have an effect equivalent to the costs of production in the foreign country rising by an equivalent of the amount of transportation costs or to an equivalent tariff being imposed on import supplies.

Similarly, the effect of increase or decrease in such costs would be similar to increase or decrease in the production costs in the exporting country.[1] In this sense, existence of transportation costs increases the competitive strength of the domestic producers by insulating the home market from foreign competition.[2]

Ideally, one should estimate the magnitude of various cost factors involved in the structure of transportation costs incurred between production center in the exporting country and consumption point in the importing country. However, due to the long-blamed scarcity of statistical information on the costs associated with movement of commodities over various distances within countries and over the ocean, this is difficult. Even in the case of ocean freight alone, complexity is not reduced.

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[1] In the classical parlance, the transportation costs prevent the allocation of production (based on comparative advantages), especially in the case of commodities where the relative costs of production in two countries differ so little that the cost of transportation would absorb more than the whole gains from trade. As a consequence of protection provided by transportation costs, there are many goods which are produced by domestic producers in almost every country. A similar argument is given by: Mill, Principles, p. 107.

[2] The term "competitive strength" is borrowed from Seeve Hirsch and is used here to avoid the implications of the Johnson-type definition of "protection" for relative prices or production costs of commodities. This is also the reason for the use of "competitive advantage."

Loading and unloading charges are a function of costs associated with labour, handling equipment, time lost in port, the extent of pilferage and damage, the port facilities, and so on. Arrangements for bearing such costs further complicate the task of gathering information establishing the bearers of and the extent of the burden of such costs. There are several private and government agencies involved.

Methods of Evaluating the Transportation Costs

One method of evaluating the impact of transportation costs is to compare the magnitude of such costs relative to the value of several commodities. However, this is only a proxy for relative effect of transportation costs in international trade. Transportation costs are considered to be more important if they constitute a relatively higher proportion of the value of a commodity. Freight charges, including insurance, expressed as percentage of the value of the commodity are considered to be indicators of the importance of transportation costs. The method was first used by the United States Tariff Commission in 1940. Transport costs, estimated as percentage of value of principal imports, were reported to range from 1 percent for raw silk from Japan to 255 percent for iron ore from Chile.[1] C. Moneta estimated the size of freight costs relative to the value of imports from some German trading partners.[2] Moneta examined c.i.f. prices of several SITC commodity classifications and found that freight factor ranged from .2 percent to more than 64

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[1] United States Tariff Commission, Transportation and Value of Principal Imports (Washington, D.C.: G.P.O., 1940).

[2] Carmella Moneta, "The Estimation of Transportation Costs in International Trade," Journal of Political Economy (February, 1959), pp. 42-56.

percent for the commodities examined.[1] Also, the results reported by Karreman confirm the existence of variation in freight ratios for different commodities from different countries.[2] He gives freight rates in terms of percentages of the c.i.f. value for a number of bulky commodities. They range from 71.5 percent for fuel oil from Indonesia to the Netherlands to 20 to 30 percent for a number of bulk cargoes such as coal, fertilizers, and iron ore. The freight ratios for wheat and lumber are reported to range between 7 and 10 percent. Karreman's estimates of freight as a percentage of total c.i.f. import values range from 12 percent to 3.2 percent for different countries. A similar approach was employed in an UNCTAD study relating to the developing countries.[3] Another study by the United States Tariff Commission estimated the freight charges as percentage of c.i.f.value in the United States. The Commission reported that freight ratio varied from 1 percent to 109 percent for U.S. imports.[4]

More often than not, freight factors have been calculated to develop freight and shipping accounts from commodity trade statistics

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[1] Ibid., pp. 57-58. Freight factor = (Freight charge/c.i.f. value) x 100.

[2] H.F. Karreman, Methods for Improving World Transportation Accounts, Applied to 1950-1953, Technical Paper 15 (New York: National Bureau of Economic Research, 1961), pp. 14-15. (Hereinafter referred to as Methods.)

[3] United Nations Conference on Trade and Development, Ocean Shipping, Freight Rates and Developing Countries, pp. 223-226.

[4] United States Tariff Commission (USTC), C.I.F. Value of U.S. Imports (Washington: USTC, 1967). Freight ratio is the same as freight factor used by Moneta.

in order to improve balance of payments statistics.[1] for analysis of protection effects due to the existence of ocean transportation costs, it would be more appropriate to construct freight factors using the price of a commodity in the exporting country because it is the export price of a commodity from which the producer in the importing country is protected. Moreover c.i.f. prices include costs of transportation and export prices. The use of c.i.f. values in estimating the significance of total costs of movement of a commodity leads to an understatement of the protection effect of such costs.

Natural protection effect of total costs of movement of Canadian wheat to different markets via different routes are shwon in Tables 5.2 and 5.3. Natural rate of protection is expressed as the ratio of transportation costs to export prices. Table 5.2 shows the rates of natural protection provided by transportation costs of moving wheat from a mid-

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[1] J.M. Munro, Trade Liberalization and Transportation in International Trade (Toronto: Private Planning Association of Canada, 1969), p. 11. Also see, Karreman, Methods, and J. Viner, Canada's Balance of International Indebtedness 1900-1913 (Cambridge: Harvard University Press, 1924), pp. 63-79. The conventional procedure for constructing freight and shipping accounts is to takefreight charges as being 10 percent of the c.i.f. value. Moneta, however, improved over this procedure by taking into account the differences in freight factors for different commodities and origins. Moneta used actual ocean freight rates (excluding all inland transportation costs) on German ocean-borne imports in 1951 and reported an average freight factor of 14.3 percent. Moneta, "The Estimation of Transportation Costs in International Trade," Journal of Political Economy (February 1959), p. 42. However, the use of an average freight factor to adjust f.o.b. export values and c.i.f. import values yields far less adequate results. The average freight factors do not account for the fact that magnitude of transportation cost changes over time as does the commodity composition of trade and the import value statistics. Even if such freight factors were used solely at specific commodity levels, they cannot reveal accurately the protection effect of transportation costs.

TABLE 5.2

RATES OF NATURAL PROTECTION OF TOTAL TRANSPORTATION COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO THE UNITED KINGDOM DURING THE PERIOD 1958/1959 to 1967/1968

Crop Year	Route Via:			
	Maritime Ports	St. Lawrence	Thunder Bay	Pacific Coast
1958-59	32.352	27.975	31.151	26.271
1959-60	33.061	29.250	31.867	26.833
1960-61	33.043	29.450	31.538	25.260
1961-62	29.982	26.777	29.148	23.870
1962-63	29.198	24.802	25.984	23.138
1963-64	30.433	25.886	27.406	26.478
1964-65	31.623	27.746	29.007	25.887
1965-66	33.057	28.851	30.504	28.051
1966-67	28.312	25.775	27.147	24.669
1967-68	34.234	28.888	29.903	27.563

Source: Calculated from Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1959 to 1968); International Wheat Council, World Wheat Statistics (London: I.W.C., 1959 to 1968).

TABLE 5.3

RATES OF NATURAL PROTECTION OF TOTAL TRANSPORTATION COSTS OF MOVING WHEAT FROM A MID-PRAIRIE POINT TO ANTWERP/ROTTERDAM DURING THE PERIOD 1964/1965 to 1970/1971

Crop Year	Route Via:			
	Maritime Ports	St. Lawrence	Lakehead	Pacific Coast
1964-65	27.081	22.989	24.223	21.847
1965-66	21.693	22.858	25.088	22.938
1966-67	24.401	20.278	22.327	18.862
1967-68	27.850	23.356	26.717	21.745
1968-69	28.604	21.509	22.047	19.721
1969-70	35.769	27.433	22.798	27.326
1970-71	31.745	24.310	26.491	29.776

Source: Calculated from Canadian Grain Commission, Canadian Grain Exports (Ottawa, Queen's Printer, 1965 to 1971); International Wheat Council, World Wheat Statistics (London: I.W.C., 1965 to 1971).

prairie point to the United Kingdom during the crop years 1958/1959 to 1967/1968. In the case of shipments via Maritime ports, the transportation costs provided natural protection to the order of 28.31 to 34.23 percent. Protection effect of the costs of moving wheat through the St. Lawrence route ranged between 24.8 and 29.4 percent during the said years. Rates of natural protection on exports from Thunder Bay were slightly higher than those in the case of the St. Lawrence route and were close to those found for shipments via Maritime ports. They ranged from 27.14 to 31.86 percent. These rates were lowest on exports through the Pacific coast. The rates of protection of transportation costs varied from 23.13 to 28.05 percent.

For shipments to the Antwerp/Rotterdam market during 1964/1965-1967/1968, the rates of protection of transportation costs are given in Table 5.3. These rates varied from 21.693 to 35.71 percent in the case of the Maritime ports. Similar rates for transportation via the St. Lawrence route were between 20.27 and 27.43, which were slightly lower as compared to those for Maritime ports. The protective effect of costs of movement via the Lakehead were higher than those in the case of St. Lawrence throughout these years, except in 1969/1970. Protection effect was lowest on wheat movements through the Pacific ports, except for the year 1970/1971, when it amounted to 29.776 percent.

The picture that emerges from this analysis is that the effect of existence of transportation costs was similar to as if there were additional ad valorem duty on wheat exports to the United Kingdom. The rates of natural protection were never less than 23 percent in the case of the United Kingdom and about 19 percent in the case of the Rotterdam market, during the period under consideration.

The costs considered above, however, do not take into account the costs incurred in the importing country. Even the costs of unloading at the port of destination is included only for certain years when freight rates were on free discharge terms. Nor are the costs associated with transshipment in the importing countries included in the above calculations, thereby resulting in an understatement of the magnitude of total costs involved in the movement of grains from production points in Canada to markets in the importing countries.[1]

The protection effects of transportation costs in the above discussion have been claimed to be natural. But these effects are not completely inevitable as inland transfer costs are subject to domestic transport policy and other institutional arrangements. Even the costs associated with loading and unloading at port of loading, as well as the port of destination, are affected by domestic actions. Policy makers can affect these costs by investing or not investing in various port facilities. Methods for pricing the services of port facilities can also affect the level of costs incurred at the ports. These statements are substantiated by the findings in Chapter III. The unknown factor in the level of transportation costs was found to be introduced by ocean freight rates--which are determined in the open competitive international bulk cargo freight market. The amount of protection arising from ocean transportation costs may therefore be called inevitable. Ocean transportation

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[1] Lack of similar data for exports of other grains from Canada prevents the estimation of the magnitude of forwarding costs relative to their export prices. However, cost of moving heavy grains are likely to show a similar effect as costs of inland transportation, handling, and ocean freight charges are almost the same for all heavy grains.

cost truly act as a trade policy restraint and cannot be affected by domestic policy measures. It is therefore useful to determine the amount of this inevitable protection which must be considered in tariff negotiations.

Rates of natural protection arising due to ocean freight charges on cargoes of wheat moving from various Canadian ports to different markets were calculated. Table 5.4 shows the protection effects of ocean freight charges on Canadian wheat (No. 2 Northern Manitoba) moved to the United Kingdom during the period 1958/1959 to 1967/1968. The rates of protection, calculated for shipments from Maritime ports, ranged from a minimum of 8.268 percent in 1966/1967 to a maximum of 12.427 percent in the year 1965/1966. In the case of loadings at St. Lawrence, these rates were very close to those on exports from the Maritime ports. The former increased from 8.693 percent in 1958/1959 to a maximum of 12.719 percent in 1964/1965 with slight variations in other years. The protection effect of ocean freight charges was highest for wheat shipped directly from Thunder Bay to the United Kingdom.[1] The ocean freight charges continued to provide protection in the order of about 17 percent consistently throughout this period. The protection effects of ocean freight charges for wheat exported from Pacific coast are shown in the last column of Table 5.4. The natural protection rate decreased from

[1] This, however, does not establish the superiority of St. Lawrence or Maritime ports over Thunder Bay, as some of the costs of moving wheat via the former routes are classified as inland transportation costs. Also, as a result of this, the export prices charged for these ports have been substantially higher in comparison to Thunder Bay export prices. For details on competitive position of various coasts as shipping points, see Chapter III.

TABLE 5.4

RATES OF NATURAL PROTECTION OF OCEAN TRANSPORTATION COSTS ON WHEAT EXPORTED TO UNITED KINGDOM DURING THE PERIOD 1958/1959 to 1967/1968

Crop Year	Port of Shipment			
	Maritime Ports	St. Lawrence	Thunder Bay	Pacific Coast
1958-59	9.139	8.693	18.559	14.275
1959-60	9.194	9.586	19.247	14.593
1960-61	9.807	10.084	18.956	13.342
1961-52	8.546	9.499	18.057	13.225
1962-63	8.294	10.817	17.554	12.325
1963-64	10.335	10.617	17.773	16.240
1964-65	10.821	12.719	18.209	14.811
1965-66	12.427	11.201	19.572	17.386
1966-67	8.268	10.542	16.362	14.096
1967-68	11.662	12.503	17.745	15.711

Source: Calculated from Canadian Grain Commission, _Canadian Grain Exports_ (Ottawa: Queen's Printer, 1959 to 1968); International Wheat Council, _World Wheat Statistics_ (London: I.W.S., 1959 to 1968).

TABLE 5.5

RATES OF NATURAL PROTECTION OF OCEAN TRANSPORTATION COSTS ON WHEAT EXPORTED TO ANTWERP/ROTTERDAM DURING THE PERIOD 1964/1965 to 1970/1971

Crop Year	Port of Shipment				
	Maritime Ports	St. Lawrence	Lakehead	Pacific Coast	Pacific Coast to Japan
1964-65	6.614	7.197	13.425	11.265	14.422
1965-66	6.747	6.906	14.169	12.272	12.094
1966-67	4.358	5.502	11.542	8.288	10.635
1967-68	5.495	6.971	14.539	9.893	13.336
1968-69	5.469	5.197	9.686	7.694	12.177
1969-70	10.468	9.303	16.291	13.907	17.375
1970-71	6.269	5.703	12.701	16.077	16.112

Source: Canadian Grain Commission, Canadian Grain Exports (Ottawa: Queen's Printer, 1965 to 1971); International Wheat Council, World Wheat Statistics (London: I.W.C., 1965 to 1971).

14.275 percent in 1958/1959 to 12.325 percent in 1962/1963, with variations in later years.

The protection rates found in the case of exports to the United Kingdom are an indication of the protection effect of ocean transport costs enjoyed by the western European countries. However, in view of the increasing importance of the Antwerp/Rotterdam Europort in recent years, natural protection rates on wheat exports from Canadian ports to the said destination provide a better guide to the magnitude of protection provided by ocean freight charges. As a larger part of exports destined for other western European countries are transshipped via Antwerp/Rotterdam, the rates of natural protection shown in Table 5.5, can be interpreted as the minimum protection enjoyed by the European countries because the calculated rates do not take into account the freight charges from Europort to countries of final destination. Similarly, natural protection on wheat exports from Pacific ports to Japan (Column 6, Table 5.5) can be interpreted as the minimum natural protection provided by ocean transportation costs to production in Asian Countries.

Summary

The economic burden of ocean transportation costs is determined by the elasticities of demand and supply. Contractual obligations and pre-negotiated terms between nations may set a range within which the export and import prices may vary. Nevertheless, within the range for price and quantity variations established through international agreements, the incidence of ocean freight rates is determined by the forces of demand and supply. The protection effect of transportation costs is there irrespective of the incidence. The existence of transportation tends to insulate the domestic market from foreign suppliers. The competitive position of foreign competitors *vis-a-vis* each other depends upon the differences in transportation costs. The empirical evidence examined in this chapter revealed that ocean transportation costs of exporting Canadian wheat provide substantial protection to producers in the importing countries.

CHAPTER VI

SUMMARY, CONCLUSIONS AND IMPLICATIONS

This chapter presents a brief summary of the sequence of development and major implications of this study. Possible dimensions in future research are also included.

This study has examined the role of transportation costs in determining the volume and direction of international trade flows within the framework of the theory of international trade. Empirical research was examined to determine the possible effects of transportation costs. The influences and issues arising because of transportation costs were discussed in Chapter II.

Given the general importance of transportation costs in international trade, especially for commodities that move in bulk, it becomes necessary that all costs associated with the movement of a commodity from the point of origin to the final destination be delineated in order to find the relative magnitude of various cost components. This was undertaken in Chapter III, wherein the structure of transportation costs of moving Canadian wheat to different overseas markets via different routes was scrutinized. The structure of dry cargo bulk freight market was examined to identify the factors that determine the level and structure of tramp freight rates. An econometric model was used for analyzing the level of freight rates on bulk wheat cargoes.

Least-squares regression method was used to analyze the incidence of ocean transportation costs. The effect of ocean transportation costs was discussed in the framework of the theory of protection. Rates of natural protection were calculated to show the protection effects of ocean transportation costs on wheat exported to various foreign markets.

Statistical evidence examined in the study showed that cost margins associated with inland movement of Canadian wheat to various seaboards showed a marked rigidity during the period 1956/1957 to 1970/1971. This may be interpreted as implying that the structure of inland transportation costs in Canada's grain trade is not determined entirely by the response of the transport system to demand-supply conditions in the grain trade. Whether an unregulated and competitive system of transportation and handling grains would be more efficient and economical from producers' and exporters' point of view remains an exercise in speculation until further research is conducted.

It has been cheaper to ship wheat through Pacific ports, not only to expanding markets in the Far East, but also to the United Kingdom and other European countries. The lower transportation costs and increasing demand for Canadian grains in the Pacific markets have been responsible for increasing shipments through the Pacific ports.[1] Grain exports via these ports have encountered several and frequent problems. As a result, the whole system of grain transportation has been a subject of serious discussion with the result that there have been various suggestions for expansion and reorganization of the existing facilities on the West Coast ports. Such proposals involving huge capital outlays aim mainly at ensuring physical movement of grain through the West Coast ports.

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[1] In fact, in 1966-1967 winter session, the Canadian Wheat Board had to embargo all wheat shipments from the Pacific ports to Atlantic destinations, with the objective of meeting export commitments with other countries.

Desirability of making huge capital expenditures can be better examined by assessing the costs of such undertakings and by assessing the benefits that may accrue in terms of savings in transportation costs of grain shipments through these ports.

A substantial portion of cost of moving Canadian wheat to overseas markets was accounted for by ocean freight charges. These rates showed wide fluctuations during the period 1956 to 1971, mainly due to demand-supply conditions in the international charter market. The results of the freight rate model, however, indicate the need for developing a detailed model of freight rate determination that may also be used for predictive purposes. Better knowledge of ocean freight market is necessary because ocean freight charges add an element of variability to Canada's comparative advantage. Changes in ocean freight rates on various routes also mean changes in the competitive position of a particular seaboard over other Canadian export points.

The preceding argument is further supported by findings on the incidence of ocean freight charges. It was found that the incidence of ocean freight charges fell almost equally upon Canada's f.o.b. prices and c.i.f. prices in the import market. These costs, therefore, do affect the Canadian grain export prices. Hence, the dictates of pricing efficiency cannot be followed without accurate and sufficient information about the ocean freight market.

Analysis of the pattern of protection provided by the existence of ocean transportation costs revealed that these costs provide a reasonably high rate of natural protection to the domestic agriculture of the importing countries against the Canadian grain industry. The rates of natural protection on Canadian wheat provide a clue regarding the magnitude of protection effects of transportation costs for other grains. However, further attempts to quantify these effects on other grains are required. A particularly important avenue for further research would be to examine the cumulative effects of transportation costs and tariffs and to investigate the discrepancies between the patterns of protection created by the varied transportation costs and the tariff structures of importing countries.

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APPENDIX A

ELASTICITY OF DEMAND FOR TRANSPORTATION

The demand for transport services is a derived demand. Price elasticity of demand for transport services can be shown to depend upon the elasticity of demand as well as the elasticity of supply for the product.

Subject to certain assumptions, the market demand for a good is represented by the monotonic decreasing function:

$$Q = D(P) .$$

In general, the demand curve can also be written as:[1]

$$P = P(Q) .$$

For our purposes, let Pc be defined as the c.i.f. price of a product, and Q, as the quantity. The inverse demand function becomes:

$$P_c = P_c(Q) . \qquad (1)$$

Similarly,

$$P_f = P_f(Q) , \qquad (2)$$

where Pf is the f.o.b. price.

Assume that the difference between f.o.b. supply price and c.i.f. delivered price exists solely because of transportation costs (denoted by T). Thus,

$$P_c = P_f + T \qquad (3)$$

From equations (1) and (2), equation (3) can be written as:

$$P_c(Q) = P_f(Q) + T .$$

Differentiating with respect to T:

$$\frac{dP_c(Q)}{dQ} \frac{dQ}{dT} = \frac{dP_f(Q)}{dQ} \frac{dQ}{dT} + 1 .$$

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[1] J.M. Henderson and R.E. Quandt, Microeconomic Theory (2nd edition; Toronto: McGraw-Hill Book Co., 1971), p. 26. The function P = P(Q) is also called "inverse demand function." See: R.G.D. Allen, Mathematical Analysis for Economists (Reprint: Toronto: The Macmillan Co. of Canada, 1968), p. 255.

Therefore:

$$\frac{dQ}{dT} = \left[\frac{dP_c(Q)}{dQ} - \frac{dP_f(Q)}{dQ} \right]^{-1} . \qquad (4)$$

Following the standard definition of elasticity of demand, let elasticity of demand for transport be:

$$Et = \frac{dQ}{dT} \frac{T}{Q} .$$

Substituting the value of $\frac{dQ}{dT}$ from equation (4),

$$E_t = \frac{T}{Q} \left[\frac{dP_c(Q)}{dQ} - \frac{dP_f(Q)}{d(Q)} \right]^{-1}$$

$$= \frac{T}{P_c} \left[\frac{dP_c(Q)}{d(Q)} \cdot \frac{Q}{P_c} - \frac{dP_f(Q)}{d(Q)} \cdot \frac{Q}{P_c} \right]^{-1} .$$

Given that $P_c = P_f + T$

$$= \frac{T}{P_c} \left[\frac{dP_c(Q)}{dQ} \cdot \frac{Q}{P_c} - \frac{dP_f(Q)}{dQ} \cdot \frac{Q}{P_f + T} \right]^{-1}$$

As $P_f + T = (1 + \frac{T}{P_f}) P_f$,

$$E_t = \frac{T}{P_c} \left[\frac{dP_c(Q)}{dQ} \cdot \frac{Q}{P_c} - \frac{dP_f(Q)}{d(Q)} \cdot \frac{Q}{(1 + \frac{T}{P_f}) P_f} \right]^{-1} . \qquad (5)$$

Note that $\frac{dP_c(Q)}{dQ} \cdot \frac{Q}{P_c}$ is elasticity of price with respect to demand - reciprocal of elasticity of demand (Ed).[1] Similarly, $\frac{dP_f(Q)}{dQ} \cdot \frac{Q}{P_f}$ is the reciprocal of elasticity of supply (Es). Therefore,

$$E_t = \frac{T}{P_c} = \left[\frac{1}{E_d} - \frac{1}{E_s} \cdot \frac{1}{(1 + \frac{T}{P_f})} \right]^{-1} .$$

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[1] R.G.D. Allen, Mathematical Analysis, p. 255n.

Now
$$\left(1 + \frac{T}{P_f}\right) = \left(1 + \frac{T}{P_c - T}\right) = \frac{P_c}{P_c - T} .$$

Then,
$$E_t = \frac{T}{P_c}\left[\frac{1}{E_d} - \frac{1}{E_s} \cdot \frac{1}{\frac{P_c}{P_c - T}}\right]^{-1}$$

$$= \frac{T}{P_c}\left[\frac{1}{E_d} - \frac{1}{E_s} \cdot \frac{1}{\frac{P_c}{P_c - T}}\right]^{-1}$$

$$= \frac{T}{P_c}\left[\frac{1}{E_d} - \frac{1}{E_s}\left(\frac{1-T}{P_c}\right)\right]^{-1}$$

$$= \frac{T}{P_c}\left[\frac{E_s - E_d\left(1 - \frac{T}{P_c}\right)}{E_d E_s}\right]^{-1}$$

$$= \frac{T}{P_c}\left[\frac{E_d E_s}{E_s - E_d\left(1 - \frac{T}{P_c}\right)}\right]^{-1} . \qquad (6)$$

The use of "supply elasticity" in deriving elasticity of demand for transport in the above formulation refers implicitly to the responsiveness of exports with respect to price. The elasticity of supply of exports may be defined as:[1]

$$E_s = E_p \cdot \left(\frac{Q}{S}\right) + E_{dh} \cdot \left(\frac{D}{S}\right) ,$$

where:

E_p = elasticity of production in exporting country,

$\frac{Q}{S}$ = ratio of production to export supplies,

E_{dh} = elasticity of demand in the exporting country,

$\frac{D}{S}$ = ratio of domestic demand (in the exporting country) to export supplies.

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[1]Esra Bennathern and A.A. Walters, The Economics of Ocean Freight Rates, p. 115.

Substituting the value of E_s would give:

$$E_t = \frac{T}{P_c}\left[\frac{E_d(E_p.(\frac{Q}{S}) + E_{dh}(\frac{D}{S}))}{(E_p.(\frac{Q}{S}) + E_{dh}(\frac{D}{S})) - E_d(1- \frac{T}{P_c})}\right] -1 \quad . \quad (7)$$

APPENDIX B

RESULTS OF LINEAR FREIGHT FUNCTION

TABLE 1

FACTORS DETERMINING OCEAN FREIGHT RATES FOR WHEAT

$$F = \beta_0 + \beta_1 Q + \beta_2 V + \beta_3 T + \beta_4 D + \beta_5 I$$

Equation Number	Explanatory Variables	Intercept	Q	V	T	D	I	R^2	D-W	F-Value
i)	Coefficient	-9.712	.00314	-.0004	.00006	.0009	.0777	26.39[n]	2.426	1.51[n]
	Standard Error		(.00254)	(.0007)	(.00024)	(.0006)	(.0539)			
	T-Values		1.24[f]	-.541[g]	2.4[c]	1.35[e]	1.44[e]			
ii)	Coefficient	-1.502	-.004	-.0006	.0011	--	.07806	20.02[n]	2.551	1.38[n]
	Standard Error		(.004)	(.0007)	(.0024)	--	(.0549)			
	T-Values		-5.70[a]	-.850[f]	.45[g]	--	1.42[e]			
iii)	Coefficient	-10.302	.00345	--	.001	.00102	.0800	25.37[n]	2.391	1.87[n]
	Standard Error		(.00243)	--	(.0002)	(.00066)	(.052)			
	T-Values		1.42[e]	--	-.04[g]	1.53[e]	1.51[e]			

Q = Quantity Shipped.

V = Volume of Competing Cargoes on All Routes.

T = Tonnage Supplied.

D = Distance.

I = Index of Voyage Charter Rates in the World Market.

F = Freight Rate.

[a] Significant at 99.5 percent level.
[b] Significant at 99 percent level.
[c] Significant at 97.5 percent level.
[d] Significant at 95 percent level.
[e] Significant at 90 percent level.
[f] Significant at 80 percent level.
[g] Not Significant at 80 percent level.
[n] Not significant at 90 percent level.

APPENDIX C

INTERCORRELATION OF FREIGHT RATES

The analysis in Chapter IV indicated that the tramp market was competitive. General levels of charter freight rates in the world tramp market were found to influence the charter rates on a particular route. This finding raised the expectation that changes in ocean freight rates on a particular route imply simultaneous changes in freight rates on other trade routes. To test this hypothesis, changes in monthly average rates for grains on each trade route were compared with the changes in average monthly rates on every other trade route. Intercorrelation of rates was assumed to exist if at least fifty percent of the variation in rate changes on one route was explained by the variation in rate changes on the other trade route.

Coefficients of determination for those route couplets which showed R^2 of .50 or more are given in Table 1. An examination of the R^2 values shows that interrelationships between rates on different routes in the world grain trade do exist. The rates on shipments originating in the same region and/or cetering to the same region are fairly competitive. For example, the following trade route couplets showed an R^2 equal to or more than .90:

Atlantic - U.K. and U.S. Gulf - U.K.

St. Lawrence - U.K. and Atlantic - U.K.

St. Lawrence - Rotterdam and Atlantic - Rotterdam

St. Lawrence - Rotterdam and Gulf - Rotterdam

Atlantic - Rotterdam and Gulf - Rotterdam

Australia - Japan and North Pacific - Japan

Gulf - Rotterdam and North Pacific - India

Australia - Japan and North Pacific - India

TABLE 1

INTERRELATIONSHIP OF FREIGHT RATES

COEFFICIENTS OF DETERMINATION

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	--																		
2.	*	--																	
3.	*	*	--																
4.	.5592	*	*	--															
5.	.5644	*	.5373	.9677	--														
6.	.57	*	.5949	.9528	.9829	--													
7.	.8974	*	*	.6063	.6099	.6161	--												
8.	*	.7483	.6222	*	*	.5345	*	--											
9.	.4161	.734	.6532	*	*	*	*	.8026	--										
10.	.7239	*	*	.6348	.6741	.6712	.711	.6721	.6066	--									
11.	.6741	*	*	.5812	.6416	.6242	.662	.6354	.6063	.952	--								
12.	.7166	.5126	.4845	.5758	.6372	.6381	.682	.7055	.6757	.9541	.9607	--							
13.	*	.7815	.5611	*	*	*	*	.715	.7813	.639	.6502	.6988	--						
14.	.6699	.6477	.5181	*	.504	.5287	.669	.7404	.7688	.8565	.8575	.9056	.8293	--					
15.	.7687	*	*	.5011	.509	.5005	.7531	*	*	.5914	.5780	.6134	*	.5525	--				
16.	.8437	*	*	*	.5033	*	.809	*	*	.5492	.5540	.5599	*	*	.7933	--			
17.	.6876	.6056	.5205	*	*	*	.6623	.6783	.7199	.7740	.7552	.8235	.7996	.9038	.5489	.5209	--		
18.	.7605	.5443	*	*	*	*	.6863	.6507	.6917	.7983	.7824	.8628	.6998	.8877	.5815	.6116	.9461	--	
19.	.6432	*	*	.697	.699	.6506	.5444	*	*	.6696	.6864	.653	*	*	.6132	.6313	.3828	*	--

Trade Route	Code
Argentina - U.K.	1
Australia - U.K.	2
North Pacific - U.K.	3
St. Lawrence - U.K.	4
Atlantic - U.K.	5
Gulf - U.K.	6
Argentina - Rotterdam	7
Australia - Rotterdam	8
North Pacific - Rotterdam	9
St. Lawrence - Rotterdam	10
Atlantic - Rotterdam	11
Gulf - Rotterdam	12
Australia - India	13
North Pacific - India	14
Gulf - India	15
Argentina - Japan	16
Australia - Japan	17
North Pacific - Japan	18
Gulf - Japan	19

*Coefficient of determination (R^2) below .50.

Source: For data on monthly average rates on heavy grains on these routes for March 1966/1967 to February 1971/1972: International Wheat Council, World Wheat Statistics (London: I.W.C., 1967–1972).

A negligible interrelationship was found to exist between the following trade route couplets:

Australia - U.K. and St. Lawrence - U.K.

Australia - U.K. and Atlantic - U.K.

Australia - U.K. and U.S. Gulf - India

Australia - U.K. and Argentina - Japan

Australia - U.K. and U.S. Gulf - Japan

In all these cases, R^2 varied around .01. R^2 values for other trade route couplets, though omitted in the table as they were below .50, varied between .20 and .498.

APPENDIX D

INFLUENCE ON OCEAN FREIGHT CHARGES ON EXPORT AND C.I.F. PRICES FOR ROTTERDAM AND THE UNITED KINGDOM

The functional relationship between freight rates and import and export prices in wheat trade flow between Canada and the Rotterdam market was explained in Chapter V. Failure to reject the hypothesis of some autocorrelation provided reasons for taking the findings less seriously. Consequently, an attempt was made to treat autocorrelation by using the first differences. The results obtained are given in Table 1.

Statistical tests showed that the estimates obtained for the export price equation, using first differences, are insignificant. Acceptance of zero autocorrelation was warranted by the d-w statistics, but no reliance can be placed on the value of estimates because of the insignificance of b_1. The results for c.i.f. prices showed some improvement, making the estimates more significant when compared to those in Table 5.1.

Verification of impact of ocean freight rates on export and import prices was sought by testing the similar model for wheat trade between Canada and the United Kingdom. For maintaining similarity with the previous analysis, the data were gathered on ocean freight rates between St. Lawrence ports and London. Export prices of No. 2 Northern Manitoba were selected because of the availability of c.i.f. London prices for the same grade. Monthly average figures for the period August 1959 to February 1972 were used to calculate b_i coefficients by least-square regression analysis. The results are given in Table 2. The regression coefficients turned out to be significant at the 99.5 percent level, and F-value for the two estimates was well above the critical value for F distribution. However, the indication of the existence of autocorrelation makes one skeptical about the reliability of the above estimates. The use of first differences (equations 3a and 3b, Table 2) substantially

TABLE 1

INFLUENCE OF OCEAN FREIGHT CHARGES ON EXPORT AND C.I.F. PRICES FOR ROTTERDAM

1a. $P_x = \beta_o + \beta_1 F + T$; 2a. $P_{x_t} - P_{x_{t-1}} = \beta_o + \beta_1 F_t - F_{t_2}$

1b. $P_m = \beta_o + \beta_1 F + T$; 2b. $P_{m_t} - P_{m_{t-1}} = \beta_o + \beta_1 F_t - F_{t-1}$

Equation Number	Explanatory Variable	Intercept	Freight Charges (F)	Time (T)	R^2	D-W	F-Value
1a.	Coefficient	67.216	-0.4715	-0.0018	3.18[d]	0.184	2.4[e]
	Standard Error		(0.2158)	(0.0059)			
	T-Value		-2.18[c]	-0.75[g]			
1b.	Coefficient	74.86	+0.3917	-0.0124	6.22[d]	0.192	4.84[b]
	Standard Error		(0.197)	(0.0054)			
	T-Value		1.98[c]	-2.27[c]			
2a.	Coefficient	0.0162	-0.1217	--	0.38[n]	1.872	.56[n]
	Standard Error		(0.1627)				
	T-Value		-0.75[g]				
2b.	Coefficient	-0.0057	0.4580	--	5.64[e]	1.909	8.79[a]
	Standard Error		(0.1545)				
	T-Value		2.94[a]				

P_x = Export Price of No. 2 North Manitoba.

P_m = Import Price (C.I.F. Rotterdam).

F = Ocean Freight Charges from St. Lawrence to Rotterdam.

[a] Significant at 99.5 percent level.
[b] Significant at 99 percent level.
[c] Significant at 97.5 percent level.
[d] Significant at 95 percent level.
[e] Significant at 90 percent level.
[f] Significant at 80 percent level.
[g] Not significant at 80 percent level.
[n] Not significant at 90 percent level.

(Number of Observations = 150.)

TABLE 2

INFLUENCE OF OCEAN FREIGHT CHARGES ON EXPORT AND C.I.F. PRICES FOR UNITED KINGDOM

1a. $P_x = \beta_o + \beta_1 F$; 2a. $P_x = \beta_o + \beta_1 F + \beta_2 T$; 3a. $P_{x_t} - P_{x_{t-1}} = \beta_o + \beta_1 F_t - F_{t-1}$

1b. $P_m = \beta_o + \beta_1 F$; 2b. $P_m = \beta_o + \beta_1 F + \beta_2 T$; 3b. $P_{m_t} - P_{m_{t-1}} = \beta_o + \beta_1 F_t - F_{t-1}$

Equation Number / Explanatory Variable		Intercept	Freight Charges (F)	Time (T)	R^2	D-W	F-Value
1a.	Coefficient	61.89	0.4922	--	5.21[e]	0.091	8.14[b]
	Standard Error		(0.1725)				
	T-Value		2.85[a]				
1b.	Coefficient	71.50	1.107	--	24.25[c]	0.442	47.38*
	Standard Error		(0.1685)				
	T-Value		6.88*				
2a.	Coefficient	61.89	0.4923	-.001	5.24[d]	0.091	4.06[c]
	Standard Error		(0.1731)	(.005)			
	T-Value		2.84[a]	-0.21[g]			
2b.	Coefficient	69.8765	1.104	0.02	32.46[b]	0.496	35.33*
	Standard Error		(.1524)	(0.005)			
	T-Value		7.25*	4.23*			
3a.	Coefficient	-0.0121	-0.0719	--	0.33[n]	1.882	0.49[n]
	Standard Error		(0.102)				
	T-Value		-0.7[g]				
3b.	Coefficient	-0.0122	0.079	--	0.1[n]	2.43	0.14[n]
	Standard Error		(.21)				
	T-Value		.38[g]				

P_x = Export Price of No. 2 North Manitoba.

P_m = Import Price (C.I.F. London).

F = Ocean Freight Charges from St. Lawrence to London.

* Significant at 99.9 percent level.

[a] Significant at 99.5 percent level.

[b] Significant at 99 percent level.

[c] Significant at 97.5 percent level.

[d] Significant at 95 percent level.

[e] Significant at 90 percent level.

[f] Significant at 80 percent level.

[g] Significant at 80 percent level.

(Number of Observations = 151.)

decreased the accuracy and significance of the results. Experiments were made by introducing time as an explanatory variable to account for the effect of time but no definite improvement was evident (equations 2a and 2b, Table 2).

The inescapable conclusion from this analysis of the behavior of export prices and import prices in two import markets is that the impact of freight rates on export prices and c.i.f. prices is very difficult to determine in a quantitative manner and with any precision. One of the reasons is that statistical information on the rates and terms of chartering for long-term charters is virtually inaccessible. Unknown factors are also introduced by the lack of information about the vessels owned and employed by large grain companies.

There are other elements that may substantially affect c.i.f. prices in the import markets. At times, wheat held at second hand may be offered during the later time periods at a price below the prevailing equivalent export prices.[1] This may cause serious discrepancy in the export price data. In 1962/1963, for example, c.i.f. prices of Canadian Manitobas showed little change because of low ocean freight rates and because of unsold stocks at shippers' hands, although the f.o.b. prices reported were higher than in 1961/1962.[2]

The results obtained in the case of exports to the United Kingdom would imply the positive influence of changes in ocean freight rates on both export and c.i.f. prices. The results, although surprising at first

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[1] International Wheat Council, Review of the World Wheat Situation, 1970/71 (London: International Wheat Council, 1971).

[2] International Wheat Council, Review of the World Wheat Situation, 1962/63 (London: International Wheat Council, 1963), p. 38.

lend themselves to the interesting economic explanation that sharp changes in demand conditions affect the demand for tonnage in the same direction. This can result in increases in both export prices and ocean freight rates, both of which cause an increase in c.i.f. prices in the import market. Such a situation was observed in the early months of crop year 1963/1964 when export prices and ocean freight rates both started increasing in anticipation of very large wheat sales from the U.S. to the U.S.S.R.

Thus, the question of incidence of ocean freight charges cannot be adequately answered without taking into account the overall demand and supply conditions in the international market. The need for detailed and more refined econometric models and accurate data becomes obvious.