AN ABSTRACT OF THE THESIS

MARIA LUCIA D'APICE PAEZ for the degree of DOCTOR OF PHILOSOPHY

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Title: AN ECONOMIC ANALYSIS OF SOME FACTORS ASSOCIATED WITH THE INTERNATIONAL TRADE FLOWS OF FROZEN GROUNDFISH BLOCKS

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Richard S. Johnston

This study is an economic analysis of some factors associated with the international market for frozen groundfish blocks. The objective of this study is to improve understanding of the interrelationships among production, consumption and trade flows, considering the emerging changes in harvesting activities resulting from extended jurisdiction of coastal states over fishery resources.

In pursuing this objective, a simultaneous equations model is built, in order quantitatively to evaluate the more relevant forces affecting the import-demand and export-supply for groundfish blocks in the international market. The period of analysis is 1964 to 1978, the data are quarterly, and the estimation procedure is Three Stage Least Squares.

The demand side of the market is modeled by specifying and estimating equations explaining the net imports of groundfish blocks in (1) the U.S.; and (2) the consuming countries in the rest of the world (ROW). The quantity demanded by importers is expressed as a function of the prices of groundfish blocks, prices of products using blocks as raw material, prices of alternative commodities in consumption, prices of other inputs, inventories of blocks held by the importers, income levels, exchange rates, and seasonal and cyclical factors.

The supply side of the market is modeled by specifying and estimating equations explaining the net exports of groundfish blocks in: (1) Canada; and (2) the producing countries in the ROW. In each relationship, the quantity supplied by exporters is specified as a function of prices of groundfish blocks, groundfish landings, inventories of blocks held by the exporters, exchange rates, and seasonal and cyclical factors.

The estimated coefficients of the structural equations are, in almost all cases, consistent with prior expectations and the predicted values of the endogenous, dependent variables are very close to the observed values. In the U.S., the price elasticity of demand for imported blocks is relatively high (-2.00) where price is measured in U.S. dollars. Increments in the wholesale price of sticks and portions, or in the import price of frozen groundfish fillets are associated with increases in imports. Increases in the inventories of blocks, or in the wages paid to labor in the U.S. seafood industry induce a reduction in these imports. Demand for blocks rises in the third quarter of the year and has been adversely affected, after 1972, by changes in fuel costs, among other factors. Income is negatively related to imports, suggesting that either groundfish is an "inferior" good or that specification errors may be present.

In the ROW importing countries, the price elasticity of demand for blocks is extremely high (-6.00), where price is measured in pounds sterling. A positive relationship appears to exist between imports and the U.K. Wholesale Price Index for food, but seasonal and post-1972 binary variables do not appear to explain changes in the ROW demand.

In Canada, the price elasticity of supply of blocks is relatively low, (0.30) where price is measured in Canadian dollars. Increments in groundfish landings and inventories increase the export volumes. Seasonal binary variables do not play a major role in this export supply relationship, but the increased fuel costs since 1972 appear to have reduced the supply.

In the ROW exporting countries, the price elasticity of supply of groundfish blocks is 0.60 and 1.58, where price is measured in Icelandic kronur and in Norwegian kroner, respectively. The larger the Atlantic Cod landings by the major suppliers, the greater the ROW volumes exported. Binary variables representing the second and third quarter of the year uncover an apparent increase in the ROW export-supply function not captured by the remaining supply-related variables and/or reflecting some seasonal pattern in domestic consumption of blocks in the ROW countries. After 1972, the ROW supply of blocks has registered a decrease.

An Economic Analysis of Some Factors Associated with the International Trade Flows of Frozen Groundfish Blocks

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Maria Lucia D'Apice Paez

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Typed by Nancy Kneisel for Maria Lucia D'Apice Paez

To Paulo,

the unusually perfect
combination of husband;
friend and colleague

To Paulina,

the remarkable daughter
of a working mother

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The following changes should be entered in the above Ph.D. dissertation:

Page Number	Should Read:	Instead of:
133-139-140-143-149-150	S1= 2.72	S1= 10
	S2= 2.72	S2= 10
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I. INTRODUCTION AND OBJECTIVES

Introduction

The worldwide proliferation of extended fishery jurisdiction over coastal waters is promoting radical shifts in the pattern of fish supply and demand. In the mid 1970's, the decrease in the anchovy catch in Peru, the collapse in herring stocks in the North Sea and the crisis in the Atlantic groundfishery provided the necessary conditions for the coastal nations to impose an effective control over the use of fishery resources. In many cases, this took the form of an extension of their respective territorial waters. Extended jurisdiction was adopted, at least in part, because of the prevailing view that the other most common management schemes (such as, quotas) have had limited success in preventing the fishery resources from being depleted. By transforming this "common property" or "open access" resource into one with "quasi-private property" characteristics, extended jurisdiction is justified as a more effective way to prevent a fishery from further over-fishing and from systematic dissipation of its economic rent among the resource users.[1]

In addition, the adoption of this scheme at that particular conjuncture occurred because the returns of this appropriation by coastal nations contiguous to the more productive fishing

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[1] In "open access", the equilibrium level of effort applied to the fishery occurs when the total revenue equals the total cost. The existence of profits induces new entrants to exploit the fishery, without any restriction, until the economic rent to the resource is totally dissipated. This "open access" equilibrium yield is greater than the "maximum economic yield", that corresponds to the optimal equilibrium position if private ownership of the resource were to prevail, i.e., when the marginal revenue intersects the marginal cost and the economic rent is maximized [see Anderson (1977) and Bell (1978) for further references].

grounds, was expected to be greater than the cost of enforcing such exclusive rights to management of the fish stocks.

Thus, the implementation of 200-mile jurisdictions, many of which spread after 1976, induced a great impact on the availability of fish resources to the major producing nations. Japan and many European countries heavily using distant waters are among the nations which suffered most from controlled access. On the other hand, Canada, Iceland, the U.S., the U.S.S.R. and some African and South American nations are likely to gain from international acceptance of their 200-mile zones. Governmental bilateral agreements and joint ventures between the "loser" and the "winner" nations have been increasing in number, as have the programs to promote better fishery resource management by the beneficiary countries.

There are indications that changes in trade patterns began to occur in the '70's and probably will become more evident in the '80's. Table 1 provides an overview of the shifts which have occurred by comparing the relative value of seven fishery commodity groups imported and exported by the leading traders between 1973 and 1977. It is evident, in this short period of time, that Japan lost its 1973-leadership as a fish exporting country, ranking fourth in 1977. Also, in this period, Japan replaced the U.S. as the major fish importing country in the world. In contrast, Norway, Canada and the Republic of Korea improved their relative positions during the period, becoming, respectively, the first, second, and third major fish exporting countries in 1977. At the same time, the United Kingdom (UK) dropped from the third to the fifth rank among the main fish importers, after France (third) and the Federal Republic of Germany (fourth).

With these changes in the trade patterns of fishery products in mind, it is of interest to develop an economic model in which the most important factors that affect the international trade of a specific fish product can be uncovered and empirically analyzed. The product chosen for such an investigation is frozen groundfish blocks. The results of the analysis should be of interest in estimating the impact of these emerging changes in the regional sources of supply on the demand patterns, on the price trends and on the trade flows of frozen groundfish blocks in the international market.

Table 1. World Export and Export of Seven Fishery Commodity Groups By Leading Countries of 1973 and 1977.

Country	1973 Value (Million US Dollars)	1973 Rank Position	1977 Value (Million US Dollars)	1977 Rank Position
Total World Exports	5,539.6	-	9,253.4	-
Norway	514.1	2	840.7	1
Canada	490.7	3	756.6	2
Republic of Korea	146.2	7	696.7	3
Japan	553.9	1	631.3	4
Denmark	381.9	4	627.2	5
United States (US)	285.2	5	508.1	6
Iceland	212.2	6	381.2	7
Other	2,955.5	-	4,811.6	-
Total World Imports	6,047.8		9,942.0	
Japan	1,019.4	2	2,295.5	1
United States (US)	1,392.3	1	2,085.8	2
France	368.8	5	674.9	3
F.R. of Germany (FRG)	430.1	4	666.2	4
United Kingdom (UK)	505.0	3	556.2	5
Italy	282.2	6	426.3	6
Netherlands	135.6	7	257.7	7
Other	1,914.4	-	2,977.5	-

Source: U.S. Department of Commerce. Fisheries of the United States (1978), based on Food and Agriculture Organization of the United Nations (FAO) data.

This investigation covers cod (gadus morhua), haddock (melanogrammus aeglefinus), pollock or saithe (pollachius virens and theragra chalcogramma), ocean perch (sebestes marinus and sebastodes alutus), hake (urophycis tenuis, merluccius merluccius, merluccius hubbsi), whiting (merlangius merlangus), cusk (Brosme brosme) and flatfish (sole and flounder).[2] Except for those latter species, the foregoing fish are commonly referred to, collectively, as "groundfish" because they are generally found and caught at, or near, the ocean bottom in temperate or cold waters. Groundfish species are the raw material used in the production of frozen blocks. Groundfish blocks consist of skinless and boneless fish meat compacted together and frozen to form blocks, weighing over 10 pounds. The blocks are the initial starting point in the production line of fish products available to the final consumption. These blocks are cut by band saw or guillotine into different shapes and, therefore, they need to have a strict specification, to yield a homogeneous product for industrial, large scale processing.

There are a number of aspects of the world market for groundfish blocks that make it an interesting subject for analysis. These include: (a) groundfish are likely to be the species most strongly affected by the extension of the 200-mile jurisdiction; (b) flows of trade of groundfish blocks represent a significant proportion of the total value of fish products imported by the leading seafood consuming countries such as the U.S.; (c) demand for "ready-to-eat" fish products, made from blocks, is on an upward trend as a worldwide phenomenon, as indicated by the rise in the number of "fast food" outlets and growth of sales of prepackaged convenience food. Each of these aspects is examined separately.

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[2]Although technically not classified as "groundfish", sole and flounder have physical and marketing characteristics similar to groundfish and they are equally utilized in the production of frozen blocks. The flatfish category also includes: turbot, plaice, halibut, dabs and fluke (that were not considered in this study, because they are not especially utilized in the production of blocks).

(a) Groundfish and extended jurisdiction - The main productive groundfish grounds are, predominantly, located in the North Atlantic Coast and Pacific coastal regions, including Alaskan waters. With the imposition of extended jurisdiction over fishery resources by Canada, the U.S. and Iceland, among the fishing states, in the second half of 1970's, those groundfish grounds were the most affected, solely because of their geographical location. This fact is likely to lead to substantial global changes in the production and trade patterns of groundfish products in the near future. With controlled access and improvements in the resource management, those coastal states are generating conditions to increase their own domestic catches of groundfish species by reducing the over-exploitation of these fishing grounds, once dominated by foreign fleets.

(b) International trade in groundfish blocks - The composition of U.S. imports of edible fishery products suggests that groundfish blocks can be considered one of the most important fish items traded in international markets.[3] As indicated in Table 2, blocks are the second most important product in the total value of imports of fishery products by the U.S., in both 1977 and 1978. Fresh and frozen shrimp is the leader. However, the imports of groundfish blocks, amounting to 291.7 (1977) and 325.4 (1978) million U.S. dollars, represented about 14% of those years' total imports by the U.S. These are indirect indications of the importance of groundfish blocks in world markets, since the U.S. is one of the major importing countries of fishery products.

(c) Demand characteristics - As living standards rise and as an increasing number of women in the labor force is observed in many countries, individuals adjust their consumption behavior to eat relatively more frozen prepared food at home and convenience food products

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[3] Other consuming countries' import data in seafood products, in which groundfish blocks are explicitly reported, are not available in international publications.

Table 2. U.S. Imports Value of Edible Fishery Products by Principal Items, 1977 and 1978.

Item	Value of Imports (Million US Dollars) 1977	1978
Fresh and Frozen:		
Fillets Groundfish	210.5	240.0
Other	160.9	178.3
Blocks and Slabs	291.7	325.4
Halibut	9.1	10.7
Salmon	10.8	13.6
Tuna Albacore	107.7	122.4
Other	142.7	198.1
Loins and Discs	4.9	6.5
Crabmeat	8.9	15.2
Scallops	53.0	72.8
Lobsters	250.3	256.3
Shrimp	488.3	418.3
Other	76.0	89.8
Canned:		
Herring	8.4	8.3
Salmon	1.2	0.7
Sardines	37.5	40.1
Tuna	44.6	63.8
Bonito and Yellowtail	1.0	0.4
Abalone	18.0	15.3
Clams	9.2	6.1
Crabmeat	8.0	9.5
Lobster	15.6	15.7
Oysters	17.9	24.5
Shrimp	3.2	3.4
Other	46.0	51.9
Cured:	48.9	61.6
Other Fish and Shellfish:	4.2	26.0
Total	2,078.5	2,274.7

Source: U.S. Department of Commerce, <u>Fisheries of the United States</u> (1978)

at "fast food" restaurants. These changes in consumer behavior are expected to spread to many countries (not only the western and more developed countries[4]) and they are reflecting new life styles where the value of homemakers' time is an important determinant of the consumption of food at home or away-from-home. As a consequence, fish products that require less time for home preparation or can be eaten in "fast food" outlets are in increasing demand as a worldwide phenomenon. Because of this upward trend in the consumption of those relatively new fish product forms, the demand for frozen blocks of groundfish has been increasing, since blocks constitute the basic raw material utilized in the production of these "ready-to-eat" fish products.

Objectives

In general, this study attempts to improve understanding of the interrelationships among production, consumption and trade flows of frozen groundfish blocks with particular attention to those changes emerging from extended jurisdiction over fish resources. In pursuing this objective, the basic purpose of this analysis is to construct and estimate an econometric model for groundfish blocks, in which the major factors affecting the import-demand and export-supply in this market can be determined and quantitatively evaluated. Hence, the specific objectives of this study are: (a) to establish a framework to analyze groundfish markets; (b) to identify the major importing and exporting countries of groundfish blocks; (c) to describe the more relevant market characteristics of frozen groundfish blocks in those selected trading countries; (d) to identify and to select the relevant theoretical variables associated with changes in the trade flows of groundfish blocks in the world market; (e) to obtain quantitative estimates of the appropriate relationships of international export/import demand and supply for groundfish blocks; (f) to evaluate these

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[4] Those expectations are taken into account by:Canada. Department of Fisheries and Oceans. Worldwide Fisheries Marketing Study (1979).

empirical results, in relation to previous studies and to the theoretical framework of reference.

Organization of the Study

Following this introductory chapter, Chapter II summarizes some of the important issues addressed in this present study. It includes an overview of international trade models and a discussion of supply and demand theory and its implications for applied work.

In Chapter III, an empirical framework is presented in which modeling alternatives for international trade issues are discussed; several previous studies in groundfish products are summarized; the major importing and exporting countries of groundfish blocks are identified and described in their relevant market characteristics; and, the seasonal and cyclical components of trade flows for groundfish blocks are considered.

In Chapter IV, the econometric model to be used in the study is specified and justified. In Chapter V, the empirical results are reported and analyzed. Implications, summary of findings, conclusions and suggestions for further studies are discussed in Chapter VI. Finally, the data and additional supporting material referred to in the text are presented in appendices.

II. THEORETICAL FRAMEWORK

An Overview of International Trade Models

Trade theory is concerned with economic relations among the nations. The first objective of the theory was to explain why certain goods are imported from abroad rather than being produced domestically. The initial simple answer to this question given by the classical theory is that imports take place when it is more expensive to produce a good within a country than abroad. That is,trade is explained by differences in the cost of producing a good among countries, as suggested by the concept of absolute advantage of Adam Smith.

David Ricardo reformulated the concept of absolute advantage, observing that, although a country has absolute advantage in producing two goods over another country, a country will export the good which has the greatest advantage [Snider, (1975)]. That is, according to Ricardo, a country exports those goods in which labor productivity is higher (relative to its productivity in other goods) than in other countries. Mutual gains from trade among countries are likely to emerge by the comparative advantage or disadvantage in production, based exclusively on labor productivity.

Subsequent to the classical approach, later theories of trade have extended Ricardo's analysis through a more general theory of opportunity costs[1], observing that labor is not the only input in production and cannot be viewed as strictly homogeneous in all countries. In competitive equilibrium, the ratio of prices of two goods is equal to their marginal opportunity cost and the quantities demanded of those goods are equal to the quantities produced. The necessary condition for trade between two countries is that the pretrade equilibrium in these countries be different. Countries' differences in opportunity costs among products are explained by differences in technical production relationships and/or factor supplies. In turn, the output prices are

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[1] The opportunity cost of producing one unit of an output x is the value foregone of producing another output y, the second best alternative use of the inputs bundle used to produce x.

also related to demand factors in each country's markets, i.e., consumer preferences, tastes, income, etc... In summary, international differences in factor supplies and production, coupled with demand patterns, account for the existence of trade among nations.

In the earlier twentieth century, Heckscher and Ohlin oriented their analysis towards the explanation of different costs of production by the differences in relative factor supplies among countries. Their conclusions are summarized in the "Heckscher-Ohlin theorem" as follows:

> "Comparative cost differences are based on relative differences in countries' factor endowments; each country tends to have a comparative advantage in, and to export, those goods requiring in their production the factor in relatively greatest supply in that country, and to have a comparative disadvantage in, and to import, those goods requiring in their production the factor in relative scarcest supply in that country" [Snider, (1975) pp. 45].

The Heckscher-Ohlin theorem[2] differs from earlier trade theories in that it assumes the existence of the same production function for a good among countries, in order to explain differences in relative pre-trade output prices, primarily, by differences in relative factor endowments. These authors tend to give less emphasis to the country's market demand under the hypothesis that consumption patterns do not outweigh the production conditions.

If free trade is allowed, the effects of these relative differences in factors among countries will be reduced, inducing an equalization in the returns to the factors and in factor prices, such as forecasted by the "Stolper-Samuelson theorem" in 1941 and the "Samuelson factor-price equalization theorem". The "Stopler-Samuelson theorem" states:

> "...moving from no trade to free trade unambiguously raises the returns to the factor used intensively in the rising price industry (land) and lowers the

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[2] The underlying conditions necessary for the Heckscher-Ohlin theorem to hold are mentioned by Snider (1975) as follows: (a) the existence of competitive markets; (b) identical production function with constant returns to scale; (c) the absence of factor reversals; (d) small differences in the pattern of demand; (e) the proper specification of factor categories; (f) the intra-country mobility of factors; and (g) immobility of factors among countries.

> returns to the factor used intensively in the falling-price industry (labor), regardless of which goods the sellers of the two factors prefer to consume" [Kindleberger and Lindert, (1978) pp. 85].

The "factor-price equalization theorem" states further:

> "...free trade will equalize not only commodity prices but also factor prices, so that laborers will earn the same wage rate and all units of land will earn the same rental return in both countries, regardless of the demand patterns in the two countries" [Kindleberger and Lindert, (1978) pp. 86].

However, price equalization among countries, as forecasted by Stopler and Samuelson, is difficult to observe with free trade because these theorems' underlying assumptions are seldom actually satisfied.[3] Also, empirical tests of the Heckscher-Ohlin theorem have not resulted in a definitive conclusion about its validity in explaining the basis of trade among nations by factor endowments. The well-known Leontief-Paradox[4] is an example of issues which have been raised in discussing the matter.

Although international trade theories are general in the level of abstraction and, consequently, difficult to be empirically tested, they can provide a framework of reference for applied problems. For example, from this simplified overview and abstracting from demand conditions, one can hypothesize that a country like the United States (U.S.)-- a net groundfish blocks importer-- has a marginal cost of producing additional units of this product greater than the marginal cost of

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[3] The "Stopler-Samuelson theorem's" assumptions are: (a) perfect competition; (b) factor supplies are given, factors are fully employed and mobile between sectors but not between countries; (c) one good is land intensive and other labor intensive with or without trade. The "Samuelson theorem" assumptions include (a), (b) and (c) mentioned above and also: (a) free trade with absence of transportation costs, information costs; tariffs and other trade barriers; (b) linearly homogeneous production functions; (c) absence of factors reversals [Kindleberger and Lindert (1978) pp. 85-86].

[4] Leontief empirically demonstrated that the U.S., assumed to be a capital abundant country, tends to export labor-intensive, rather than capital-intensive products, contrary to what would be expected by the "Heckscher-Ohlin theorem" [see Snider (1975) for further discussions].

producing other goods to export and trade for groundfish blocks, in a pre-trade position (and vice-versa for Canada, a net groundfish blocks exporter). As pointed out by Batie (1974), in the U.S. the marginal cost of producing additional units of fish is high because the input price is relatively high or the marginal product is relatively low, since in equilibrium marginal cost is equal to the ratio of input price to marginal product. The input prices may be high because of:

> "...(a) high cost of insurance, vessel and gear; (b) wages paid to labor that are higher than their marginal value; (c) domestic subsidies that are given for the production of exported goods (e.g., grain growers subsidies). The marginal product of the input(s) could be low because of resource exhaustion due to biologically adverse factors such as environmental destruction and overfishing " [Batie, (1974) pp. 33].

Other factors that may affect directly, or indirectly trade flows among countries include: (a) transportation costs and other transfer costs among spatially separated countries; (b) tariffs, quotas and other non-quantitative trade barriers imposed by a country on their imported products; (c) subsidies to increase a country's exports; (d) exchange rates. The rationale suggests that the higher the transportation costs and the tariffs, the lower the trade flows among countries. Also, import quotas and non-quantitative barriers to trade (such as institutional barriers, sanitary laws and strict product classification) negatively affect trade volumes.[5] The government-mandated devaluation of one particular currency in terms of the others tends to increase the exports of the country whose currency is devalued and to decrease its imports. That is, the devaluation of one country's currency means that its exported goods will be cheaper for the other countries' buyers and its imported goods will be more expensive domestically. As a consequence, there is a reduction of this country's willingness to import and an increase in its exports. Subsidies to a country's domestic producers indirectly favor its exports, allowing the subsidized-products to be offered in

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[5] The imposition of a strict product classification over imports (to determine tariffs) is a subtle way to prevent inconvenient foreign competition in domestic markets.

international markets at lower prices than those of competitor's products.

In summary, the theoretical framework of international economics suggests that, in order to analyze the factors affecting trade flows of any good marketed internationally, it is necessary to consider: (a) the underlying forces affecting demand and supply relationships; (b) the existing trade barriers, and production and trade subsidies; (c) the transportation costs and associated transfer costs among the trading countries; (d) the exchange rates among the countries' currencies; (e) non-tariff barriers. The next two sections examine (a) in more detail and from a more theoretical point of view.

Demand

In this section, an overview of modern demand theory will be presented with emphasis given to its implications for applied work, based especially on George and King (1971), Phlips (1974) and Hassan and Johnson (1976).

The consumer is considered to make a choice from a commodity space of n goods, each with a given price, such that his (her) satisfaction in consumption is maximized subject to a budget constraint. This maximization process can be stated as:

$$\text{Max } U(x_1, x_2, \ldots, x_n) \tag{2.1}$$

$$\text{subject to } \sum_{i=1}^{n} x_i p_i = I \tag{2.2}$$

or

$$F = U(x_1, x_2 \ldots x_n) + \lambda(I - \sum_{i=1}^{n} x_i p_i), \; i = 1,2\ldots n \tag{2.3}$$

where:

U = consumer's utility function assumed to be continuous, and twice differentiable with positive first derivatives;

x_i = quantity consumed of i^{th} commodity;

p_i = given price of i^{th} commodity;

I = consumer's income, assuming that total expenditures on all commodities equal consumer's total income;

F = Lagrangian equation;

λ = Lagrangian multiplier, interpreted as the marginal utility of income.

Differentiating equation 2.3 with respect to all x_i and λ, n+1 equations are obtained, corresponding to the first-order conditions for constrained maximization of the consumer's utility:

$$\frac{\partial U}{\partial x_i} - \lambda p_i = 0, \text{ for all } i \qquad i = 1,\ldots n \qquad (2.4)$$

$$\sum_{i=1}^{n} x_i p_i - I = 0 \qquad (2.5)$$

$$\text{provided that } \frac{\partial U}{\partial x_i} > 0 \quad \text{and } p_i > 0 \qquad i = 1,\ldots n \qquad (2.6)$$

The second-order condition for maximization states that the utility function needs to be quasi-concave. This implies that the Hessian matrix of U bordered by prices be negative-definite, i.e., be a matrix whose principal minor determinants alternate in sign, starting with negative:

$$(-1)^n \begin{vmatrix} U_{11} & U_{12} \cdots\cdots U_{1n} & -p_1 \\ \vdots & \vdots \qquad\quad \vdots & \vdots \\ U_{n1} & U_{n2} \cdots\cdots U_{nn} & -p_n \\ -p_1 & -p_2 \cdots\cdots -p_n & 0 \end{vmatrix} > 0 \qquad (2.7)$$

where:

$$U_{ij} = \frac{\partial^2 U}{\partial x_i \partial x_j} = \frac{\partial^2 U}{\partial x_j \partial x_i} \qquad i,j = 1,\ldots n \qquad (2.8)$$

By differentiating the n+1 first-order equations with respect to all prices and income, a system of n demand functions and one budget constraint equation is obtained:

$$x_1 = x_1 \; (p_1, p_2 \ldots\ldots\ldots\ldots p_n, I) \qquad (2.9)$$

$$\vdots$$

$$x_n = x_n \; (p_1, p_2 \ldots\ldots\ldots\ldots p_n, I) \qquad (2.10)$$

$$\lambda = \lambda \; (p_1, p_2 \ldots\ldots\ldots\ldots p_n, I) \qquad (2.11)$$

The demand functions relate the quantity consumed of each commodity to all commodity prices and income (Equations (2.9) to (2.10)). From this system, a set of elasticities may be estimated: n own-price elasticities; $n^2 - n$ cross-price elasticities; and n income elasticities.[6]

There are certain properties of the system of demand equations which may be viewed as "restrictions": (a) homogeneity; (b) Engel aggregation; (c) Cournot aggregation; and (d) the Slutsky equation. These "restrictions" or "properties" of the first-order conditions are particularly important in empirical work because they allow a reduction in the number of coefficients to be estimated in this system.

The homogeneity restriction postulates that every demand equation must be homogeneous of degree zero in income and prices. If all the prices and income were multiplied by a constant number, say α, the quantity demanded of each and every commodity remains unchanged. Mathematically, this restriction can be expressed in the demand function for a good x_i as:

$$x_i = x_i \; (\alpha p_1 \ldots, \alpha p_n, \alpha I) = x_i \; (P_1 \ldots p_n, I), \; i = 1 \ldots . n \qquad (2.12)$$

Applying Euler's theorem on homogeneous functions[7], it follows from the homogeneity property of each demand equation that:

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[6] The usual notation defines: $e_{ij} = \frac{\partial x_i}{\partial p_j} \frac{p_j}{x_i}$ as the own-price elasticity when i = j and i, j = i...n; and as the cross-price elasticity when i ≠ j and i, j = 1...n. $e_{iI} = \frac{\partial x_i}{\partial I} \frac{I}{x_i}$ i = 1, ...n is the income elasticity.

[7] Euler's theorem states that if a function $f(x_1 \ldots x_n)$ is homogeneous of degree h then: $f(\alpha x_1, \ldots \alpha x_n) = \alpha^h [f(x_1 \ldots x_n)]$ and

$$\sum_{i=1}^{n} \frac{\partial f}{\partial x_i} x_i = h[f(x_1 \ldots x_n)], \quad i = 1 \ldots n.$$

$$\sum_{j=1}^{n} \frac{\partial x_i}{\partial p_j} p_j + \frac{\partial x_i}{\partial I} I = 0 \qquad i, j = 1....n \tag{2.13}$$

In terms of elasticities this restriction can be expressed as: for any commodity i, the sum of the own (i=j) and cross-price (i≠j) elasticities equals the negative of the income elasticity, or:

$$\sum_{j=1}^{n} e_{ij} = -e_{iI} \qquad i = 1....n \tag{2.14}$$

where:

e_{ij} = own price elasticity (i=j) or cross-price elasticity (i≠j);

e_{iI} = income elasticity.

Only functional forms which are likely to be homogeneous of degree zero should be considered as an algebraic form for estimating demand equation. This is an important empirical consequence of the homogeneity condition. Following this reasoning, Phlips (1974) excluded linear equations as possible functional forms to be chosen in demand equation estimates, because they are not homogeneous functions of degree zero.[8]

The Engel aggregation restriction postulates that in any period of time the sum of the estimated expenditures on the n commodities is equal to total expenditures. A change in total expenditures must be entirely allocated to the n commodities in the consumer's utility function. This restriction is obtained by differentiating the budget constraint equation (equation 2.5) with respect to income:

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[8] Phlips (1974) pp. 38 mentioned that if there is a good reason to use linear equations, it would be necessary to divide all independent variables by the price of one of the goods or by the index of prices (say, CPI, or WPI) to make linear equations homogeneous of degree zero.

$$\sum_{i=1}^{n} \frac{\partial x_i}{\partial I} \quad p_i - 1 = 0 \tag{2.15}$$

In terms of elasticities, this restriction states that the weighted sum of the income elasticities is equal to one, or:

$$\sum_{i=1}^{n} w_i \quad e_{iI} = 1 \tag{2.16}$$

where:

$$w_i = \frac{p_i x_i}{I} \quad \text{or, the budget share of good } \underline{i};\ i = 1 \ldots n \tag{2.17}$$

The Cournot aggregation is obtained also by differentiating the budget constraint equation (equation 2.5) with respect to all commodities' prices:

$$\sum_{i=1}^{n} \frac{\partial x_i}{\partial p_j} \quad p_i = - x_j \qquad j = 1 \ldots n \tag{2.18}$$

In terms of elasticities, it follows that the weighted column sum of price elasticities (own and cross-price elasticities) in the $j^{\underline{th}}$ column is equal to the negative of the expenditure proportion on the $j^{\underline{th}}$ commodity, or:

$$\sum_{i=1}^{n} w_i \quad e_{ij} = -w_j \qquad j = 1 \ldots n \tag{2.19}$$

The Slutsky restriction relies on the idea that the derivatives of the demand equations in relation to prices can be decomposed into the substitution effect and the income effect by taking the total derivatives of the first-order conditions (equations 2.4 and 2.5):

$$U_{11}dx_1 + \ldots\ldots\ldots\ldots\ldots + U_{1n}\, dx_n - p_1 d\lambda = \lambda dp_1 \quad (2.20)$$

$$\vdots$$

$$U_{n1}dx_1 + \ldots\ldots\ldots\ldots\ldots + U_{nn}\, dx_n - p_n d\lambda = \lambda dp_n \quad (2.21)$$

$$-p_1 dx_1 + \ldots\ldots\ldots\ldots\ldots - p_n\, dx_n = -dI + x_1 dp_1 + \ldots + x_n dp_n \quad (2.22)$$

Expressing this n + 1 system of equations in matrix notation:

$$\begin{bmatrix} U_{11} & \ldots\ldots\ldots & U_{1n} & -p_1 \\ & & & \\ U_{n1} & \ldots\ldots\ldots & U_{nn} & -p_n \\ -p_1 & \ldots\ldots\ldots & -p_n & 0 \end{bmatrix} \begin{bmatrix} dx_1 \\ \\ dx_n \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda dp_1 \\ \\ \lambda dp_n \\ -dI + \sum_{i=1}^{n} x_i\, dp_i \end{bmatrix} \quad (2.23)$$

by Cramer's rule, the dx_j becomes equal to:

$$dx_j = \frac{\sum_{i=1}^{n} \lambda\, D_{ij} dp_i + D_{n+1,j}\left(\sum_{i=1}^{n} x_i\, dp_i - dI\right)}{D} \quad (2.24)$$

where: D_{ij} = co-factor of the element i,j of the bordered Hessian matrix;

$D_{n+1,j}$ = co-factor of the element n+1,j of the bordered Hessian matrix;

D = determinant of the Hessian matrix

The own-price slope is obtained by dividing dx_j in equation 2.24 by dp_j, treating the other prices and income changes as being equal to zero (or, $dp_i = dI = 0$):

$$\frac{dx_j}{dp_j} = \frac{D_{jj}\lambda}{D} + \frac{D_{n+1,i}x_j}{D} \quad (2.25)$$

The first term on the right hand side of this "Slutsky equation" (equation 2.25) is the substitution effect corresponding to the variation in the quantity of x_j demanded due to a change in p_j with a compensating change in income to keep the consumer at the same level of utility. The second term is the income effect that is a quantity change, which results from that portion of the price change which is like a change in income itself. Thus, the total effect of a price change can be decomposed into the two effects: the substitution and income effects.

The Slutsky's negativity condition states that this substitution effect is always negative. From the second-order condition, the bordered Hessian matrix must be $(-1)^n D > 0$. Because the principal minor of D_{jj} is of order n-1, then $(-1)^{n-1} D_{jj} < 0$. The D and D_{jj} must be opposite in sign and λ - the marginal utility of income - is always positive.[9] Therefore, the substitution effect is always negative, i.e., $\frac{D_{jj}\lambda}{D} < 0$ for all j, j = 1...n. However, for the income effect there is no *a priori* constraint in sign since the $D'_{n+1,j}$ term is not a principal minor. The income effect may be positive when $\frac{D_{n+1,j}}{D} > 0$, and the j^{th} commodity is classified as a normal good. The income effect may be negative when $\frac{D_{n+1,j}}{D} < 0$, and the j^{th} commodity is considered an inferior good. As a consequence, depending on the absolute value of the income effect in relation to the substitution effect, the sign of the total effect $\frac{dx_j}{dp_j}$ (that corresponds to the slope of the demand curve for j^{th} good) cannot be stated on *a priori* grounds.

The cross price slope, obtained by dividing dx_j in equation 2.24 by dp_i, treating the own price and income changes as being equal to zero (or, $dp_j = dI = 0$):

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[9] If $\lambda = \frac{\partial U}{\partial I} = \frac{\partial}{\partial I} [U(x_1 \ldots x_n)] = \sum_{i=1}^{n} U_i \frac{\partial x_i}{\partial I}$, i=1...n. $U_i = \lambda p_i$ from the first-order condition then:

$$\frac{\partial U}{\partial I} = \sum_{i=1}^{n} \lambda P_i \frac{\partial x_i}{\partial I} = \lambda \frac{\partial}{\partial I} \sum_{i=n}^{n} p_i x_i \text{ or, } \frac{\partial U}{\partial I} = \lambda \frac{\partial}{\partial I}(I) = \lambda$$

and $\lambda > 0$, since $U_i > 0$.

$$\frac{dx_j}{dp_i} = \frac{D_{ij}\lambda}{D} + \frac{D_{n+1,j}x_i}{D} \quad i \neq j \quad i,j = 1 \ldots n \qquad (2.26)$$

The first term on the right-hand side in equation 2.26 can be positive or negative since D_{ij} is not a principal minor of the bordered Hessian matrix. Thus, on equation 2.26, the sign of the total cross price $\frac{\partial x_j}{\partial p_i}$ is to be determined empirically. If it is greater, less or equal to zero the commodities i and j can be classified as substitutes complements or independents, respectively.

The Slutsky symmetry condition states that the first term of the right hand side of the Slutsky equation $\frac{D_{ij}}{D}\lambda$ is equal to $\frac{D_{ji}}{D}\lambda$. This holds true because $D_{ij} = D_{ji}$, since the bordered Hessian matrix is itself symmetric, i.e., $\frac{\partial^2 U}{\partial x_i \partial x_j} = \frac{\partial^2 U}{\partial x_j \partial x_i}$.

In terms of elasticities, the negativity and symmetry condition are represented respectively by:

$$e_{jj} = \bar{e}_{jj} - w_j e_{jI} \quad j=1 \ldots n \qquad (2.27)$$

and

$$e_{ij} = \frac{w_j}{w_i} e_{ji} - w_j (e_{iI} - e_{jI}) \quad i \neq j \quad i,j=1 \ldots n \qquad (2.28)$$

where:

$$\bar{e}_{jj} = \left(\frac{\partial x_j}{\partial p_j} \frac{p_j}{x_j}\right) U = \text{Constant}$$

Adding together these "restrictions", the number of independent parameters in the system of demand equations, equal to $1/2(n^2+n)-1$, remain to be estimated.[10]

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[10] Initially, given n commodities, there were n direct price elasticities, n^2-n cross-price elasticities and n income elasticities. The symmetry restriction reduced this number by $1/2(n^2-n)$ coefficients and the Cournot and Engel restriction reduced the coefficients by (n+1). Hence, $1/2(n^2+n)-1$ coefficients still remain to be estimated.

The concept of separability[11] reduces the number of parameters further and provides the necessary justification for defining goods related to a particular commodity of interest. This allows the omission of certain price variables, without necessarily incurring specification bias. Having this theoretical justification for the exclusion of some goods, the quantity consumed of a particular good is explained in terms of its own price, the price of other closely related goods in consumption, and the consumer's income. The maximization problem is solved by a two-stage budget allocation: firstly, the consumer allocates his income among various subsets of commodities and, secondly among commodities within each subset.

Being empirically impossible to determine separable groups of commodities by looking at their marginal utilities, some authors such as deJanvry (1966) used factor and cluster analysis to compose groups of commodities closely related in consumption. This deJanvry's grouping was adopted by George and King (1971) in their empirical work, resulting in 15 different groups of food commodities.[12]

Supply

Just as the demand equation derives from a set of maximization conditions under constraint, the supply relationship stems from the maximization of profits for a producing unit, subject to the production function contraint. That is, given a continuously differentiable production function:

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[11] According to Hassan and Johnson (1976), the concept of separability was introduced by Leontief (1947) and Sono (1961). Three types of separability were defined: strong, weak and Pearce separability [Goldman and Uzawa (1964)].

[12] For example, by using deJanvry's proportionality factor defined as: $\theta_{ij} = \frac{I}{e_{jI}} \frac{e_{iI}}{w_j e_{iI}} + 1$, fish products were considered within the food group of animal protein, including beef, veal, pork, lamb, chicken and turkey.

$$Y = y\ (z_1 \ldots\ldots z_n) \qquad (2.29)$$

where:

Y = level of output produced;

z_i = level of inputs employed in the production of Y, $i=1 \ldots n$.

It is assumed that the firm seeks to maximize its profits:

$$\text{Max } \pi = P_y Y - (p_1\ z_1 + \ldots + p_n z_n) \qquad (2.30)$$

subject to a production function:

$$Y = y(z_1 \ldots z_n) \qquad i=1 \ldots n \qquad (2.31)$$

where:

π = profit given by the difference between revenues and total cost;

P_y = given price of output y;

p_i = given price of input i.

When the production function is substituted for Y in equation 2.30, the problem becomes an unconstrained maximization of profits:

$$\text{Max } \pi = P_y[y(z_1 \ldots z_n)] - \sum_{i=1}^{n} p_i z_i \qquad (2.32)$$

and the necessary first-order conditions for maximization become equal to:

$$\frac{\partial \pi}{\partial z_i} = P_y \frac{\partial y}{\partial z_i} - p_i = 0 \quad \text{for all } i,\ i=1,\ldots n \qquad (2.33)$$

The equation 2.33 implies that the firm will employ resources in producing Y up to the point where the value of the marginal contribution of each input <u>i</u> is equal to the cost of acquiring additional units of that factor, p_i. For the multiple output-multiple input case, the first-order condition for maximization of profits can be stated, accordingly:

$$P_{yj} \frac{\partial y_j}{\partial z_{ij}} - P_i = 0 \qquad (2.34)$$

where z_{ij} is the amount of input _i_ used in the production of output _j_ and i=1...n, j=1...s.

From the first-order equations plus the given production function, one can derive the output supply and the input demand functions, provided that the second-order conditions are satisfied:[13]

$$Y^s = y^s(P_y p_1 \ldots p_n) \qquad (2.35)$$

$$Z_1 = Z_1(P_y p_1 \ldots p_n) \qquad (2.36)$$

$$\vdots$$

$$Z_n = Z_n(P_y p_1 \ldots p_n) \qquad (2.37)$$

The output supply function indicates the amount of the output Y that will be supplied as a function of its respective price and the prices of all inputs (equation 2.35). The input demand functions indicate the amount of each input _i_ that will be hired as a function of its own price, the other input prices and the output prices (equations 2.36 to 2.37).

By differentiating this system of equations, a set of restrictions is derived: (a) the sign conditions; (b) the symmetry conditions; and (c) the homogeneity condition.

The sign conditions states that: (a) the factor demand curves must be downward sloping in its correspondent factor price; i.e. the derivative $\frac{\partial zi}{\partial pi} < 0$. This is the case, since $\frac{\partial zi}{\partial pi} = - \frac{\partial^2 \pi}{\partial pi^2} < 0$ from the convexity of the profit function in P_i; (b) the output supply curve must be upward sloping in the output price, i.e. the derivative $\frac{\partial y}{\partial P_y} = \frac{\partial^2 \pi}{\partial P_y^2} > 0$ from the convexity of the profit function in P_y. However, there is no _a priori_ restriction on the sign for: (a) the response in the demand of an input _i_ due to changes in the output price and in the other inputs

[13]The second-order condition for profit maximization requires the principal minors of the relevant Hessian determinant alternate in sign, starting with the negative, i.e. the production function be strictly concave at the point at which the first-order condition is satisfied.

prices;[14] and (b) the response in the quantity supplied of an output Y due to changes in the input prices.[15]

The symmetry conditions follow from the mixed second order partial derivatives. That is: (a) the change in the quantity of an input i demanded associated with a change in the price of input j is equal to the change in the quantity of an input j demanded associated with a change in the price of input i:

$$\frac{\partial z_i}{\partial p_j} = \frac{\partial z_j}{\partial p_i} \qquad i \neq j \quad i,j = 1....n \tag{2.38}$$

since

$$\frac{\partial z_i}{\partial P_j} = - \frac{\partial^2 \pi}{\partial P_i \ \partial P_j} = - \frac{\partial^2 \pi}{\partial p_j \partial p_i} = \frac{\partial z_j}{\partial p_i} \tag{2.39}$$

(b) the change in the quantity demanded of input i due to changes in the output price is equal to the negative of the change in the quantity supplied of output y due to a change in the ith input price,or:

$$\frac{\partial z_i}{\partial P_y} = - \frac{\partial y}{\partial p_i} \tag{2.40}$$

since

$$\frac{\partial z_i}{\partial P_y} = - \frac{\partial^2 \pi}{\partial P_y \partial P_i} = - \frac{\partial^2 \pi}{\partial P_i \partial P_y} = - \frac{\partial y}{\partial p_i} \tag{2.41}$$

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[14] If $\frac{\partial z_i}{\partial P_y} < 0$, the input i is called inferior, provided that not all inputs are inferior simultaneously. If $\frac{\partial z_i}{\partial P_y} > 0$ the input i is non inferior.

If $\frac{\partial z_i}{\partial P_j} > 0$, $i \neq j$ and $i,j=1...n$, the inputs i and j are called substitutes and if $\frac{\partial z_i}{\partial p_j} < 0$ those inputs are called complements [Intriligator, 1978].

[15] From the homogeneity condition: $\frac{\partial z_i}{\partial P_y} = - \frac{\partial Y}{\partial P_i}$.

Finally, the homogeneity condition states that the output supply function and the input demand functions must be homogeneous of degree zero, i.e., the solution for profit maximization must be invariant to simultaneous and equi-proportional changes in output and input prices. Expressing this condition in terms of elasticities of the input demand and the output supply, respectively:

$$\sum_{j=1}^{n} \frac{\partial z_i}{\partial P_j} \frac{P_j}{z_i} + \frac{\partial z_i}{\partial P_y} \frac{P_y}{z_i} = 0 \qquad (2.42)$$

$$\sum_{j=1}^{n} \frac{\partial y}{\partial p_j} \frac{p_j}{y} + \frac{\partial y}{\partial P_y} \frac{P_y}{y} = 0 \qquad i=1...n \qquad (2.43)$$

III. EMPIRICAL FRAMEWORK

Considering the foregoing theoretical framework, previous empirical studies and the available information on the markets for frozen groundfish blocks (both at national and international levels), the intention in this section is to formulate a specific model to represent the main economic forces affecting international trade for this fishery product.

It is unlikely, however, that this study will be able to include, identify, quantify and analyze all factors which influence the trade flows and prices. In the empirical implementation of economic analysis some aspects often have to be excluded. Lack of data, time and funding constraints and other limitations of this order are among the main reasons for simplifying the real-world phenomena.

Thus, it is necessary to reduce the size of the economic analysis of international trade on frozen groundfish blocks. In order to do this, one must make simplifying assumptions, make judgments about the appropriate interval when demand and supply decisions are elaborated, choose a reasonable time period and geographical area for study, pick those points in the market channel on which to focus attention and select those variables that should be included in the model. Similarly, the choice of an analytical model and the proper algebraic form of estimating equations must be made as well as the choice of the statistical estimator.

These series of choices were made according to the steps which are discussed in the next two chapters.

Modelling Alternatives in International Trade Models

There are various economic approaches in the literature upon which one may model trade relations. Some of these include spatial equilibrium models, system dynamics models, econometric models, allocative imports among supplier models, and models that distinguish goods by place of production.[1]

[1]Applications of these approaches include: a) for the systems dynamics models best known applications are: Forrester (1971), Meadows et al (1972); b) for allocative imports among suppliers models: Truman and Resnick (1973) Truman (1974); c) for commodities by place of production: I.M.F. models by Armington (1969), Rhomberg (1970), Artus and Rhomberg (1973). For further discussion refer to Grennes et al (1977).

Two of these models were considered as applicable to the objectives of this study: the spatial equilibrium models and the econometric models. The spatial equilibrium models, first formulated by Enke (1951) and developed by Samuelson (1952), have been used extensively in international and interregional trade studies. The object of such a model is to select prices, quantities and trade flows, which maximize the "net social payoff" defined by Samuelson (1952) as a sum of consumer surplus, producer surplus, net of transportation costs [Grennes et al (1977)]. That framework illustrates how a problem of interspatial markets can be formulated mathematically as a maximization problem. Moreover, Samuelson's suggestion that the problem could be handled by using the mathematical developments, pioneered by Koopmans (1949) and Dantzig (1951) is relevant. This relevance is mainly due to developments in capturing the corresponding operational models, achieved by Takayama and Judge (1964), Takayama (1966), Takayama (1967) and Takayama and Judge (1971).[2]

Fox (1953) and Fox and Taeuber (1955) made one of the first empirical applications of spatial equilibrium models in the area of livestock-feed economies. Judge and Wallace (1958) provided a summary of this model and Bawden (1966) first discussed the application of such models for international trade problems, explaining how trade policies (such as import duties, import levies, export subsidies and quotas, etc.) may be incorporated into the model.

Other researchers have applied this model not only to international markets,[3] but also to interregional markets.[4]

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[2]See Tenthold and Bawden (1966) for a bibliography of spatial equilibrium studies as well as Judge and Takayama (1973).

[3]Mention can be made of the studies in international markets: Dean and Collins (1967) for fresh oranges; Bates and Schmitz (1969) for sugar; Zuszan et al, (1969) for winter oranges; Rojko et al (1971) for grains; Schmitz and Bawden (1973) for wheat and Takayama and Hashimoto (1976) for food.

[4]These include other studies, e.g., Henry and Bishop (1957) for broilers; Judge (1959) for livestock; King and Schader (1963), Guedry and Judge (1965) for cattle and feed grains; Hall et al, (1968) for U.S. agriculture; Judge et al, (1965) for livestock; Hsiao and Kottke (1968) for dairy industry; Leath and Blakely (1971) for grains; Brain and Jack (1973) for fresh apples; West and Brandow (1973) for dairy products.

The spatial equilibrium models have been used for normative purposes when the help to define the existence of a problem rather than the reason for its existence, i.e., "...show how the output at many locations 'should' flow to many consuming areas if competitive conditions are to be attained and costs minimized." [Lee and Seaver, (1971), pp. 63].

The authors referred to above avoid the normative use of spatial equilibrium and instead suggest the use of this model be applied to the broiler markets with a positive purpose that, "...should estimate the demand and supply functions simultaneously within the model in order to produce quantitative statements 'describing' the existing competitive markets and to predict the future course of economic variables." [Lee and Seaver, (1971), pp. 63].[5] Following this same approach, Charbonneau and Marasco (1975) examined the U.S. fresh and frozen oyster market.

According to Grennes et al (1977), there are some limitations on the use of this model for empirical work, derived from a set of very restrictive assumptions which are made in its formulation. Those limitations are: (a) the product under consideration must be homogeneous in the sense that the consumers are indifferent to the source of their purchases; (b) cross-hauling is excluded, since regions in deficit cannot export and vice-versa; (c) adjustments of the trade matrix due to changes in transportation cost are abrupt rather than smooth. Additional limitations include: (a) the impossibility of incorporating time lags and other non-quantitative institutional arrangements into the model; (b) the generated trade matrix tends to have many more zero elements than does the actual trade matrix.

Considering the above shortcomings of the spatial equilibrium models and the fact that such a model needs a great amount of detailed data in a large number of markets for an empirical implementation, a decision was made to utilize econometric techniques as an alternative for analyzing the economic forces affecting international trade in groundfish blocks.

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[5] Some would argue that although spatial equilibrium models have been used for normative purposes, they are not intrinsically normative.

Certain advantages can emerge from the use of traditional multivariate regression methods in the analysis of import and export data, thereby avoiding the very restrictive assumptions imposed by spatial equilibrium models. Endogeneous variables can be assumed dependent on certain exogeneous variables, recursively or simultaneously. Also, some non-quantitative and lagged variables can be easily incorporated in the model. Furthermore, grouping countries into broader categories can be performed freely, without necessarily compromising the validity of the study and its objectives.

Literature Review: The Groundfish Market

The number of empirical studies dealing with trade flows in groundfish or groundfish products in the literature is relatively small and is discussed in this section. Some demand studies for groundfish species of interest are also considered.

The study of Bell et al (1970) reported in Labys (1975), developed a large world model of living marine resources in which groundfish was included among 12 other fish species. The intention was to integrate all relevant biological and utilization factors into one complete model of world demand and supply for seafood products. The period of analysis was 1948-1968 and projections of consumption and prices to the year 2000 were derived for the U.S., taking into account all world markets.

A set of regional supply equations was derived from Schaefer's (1964) logistic growth model of a fishery biomass and estimated, assuming alternately linear and decreasing returns from fishing efforts.[6] Demand projections were made and regional supply projections were summed in order to estimate a world supply. By an iterative procedure, the world supply was equated to the projected world demand for each species, yielding projected equilibrium world prices. Of interest here is the ex-vessel demand estimates for groundfish species in Japan, Canada, Korea, Denmark,

[6] The derivation of the supply curve for fish is presented formally in Anderson (1977) and Bell (1978).

Table 3. Regression Results of Groundfish Demand Equations. by Selected Countries, in Bell *et al* in Labys (1975)

Country	Constant	Ex-Vessel Price Elasticity (1)	Income Elasticity (1)	R^2	Period
United States (US)	-2.01	0.10	0.85*	0.84	1948-68
Japan	-1.69	0.28	1.05*	0.83	1956-67
Canada	6.60	-3.63	1.20	0.30	1953-66
Korea	2.27	0.79	-1.06	0.26	1956-67
Oenmark	-3.90	-0.30	1.95*	0.83	1956-67
France	-10.31	-7.12*	6.60*	0.46	1956-67
Netherlands	6.97	-0.08	2.67*	0.88	1956-67
United Kingdom (UK)	-4.15	-1.40*	2.19*	0.55	1955-66

(1) "t" values for the coefficients significant at the five percent level are indicated by * symbol.

SOURCE: Bell *et al*. in Labys (1975)

France, the Netherlands and the U.S. The estimated price and income elasticities, generated from double-log equations are shown in Table 3. The authors found some inconsistencies with these coefficients and the derived direct and income elasticities were modified by them, in order to make long term projections by using the elasticity of the same product from a country with similar consuming habits (these adjustments are shown in Table 4).

Table 4. Groundfish Demand: Adjusted Direct Price and Income Elasticities Utilized for Making Projections in Bell *et al*. (Labys, 1975).

Country	Adjusted Price Elasticity	Adjusted Income Elasticity
United States	-1.00[a]	0.85
Japan	-1.00[a]	1.05
Canada	-1.00[b]	1.21
Korea	-1.00[a]	1.06
Denmark	-1.40[c]	1.95
France	-1.40[c]	2.19[c]
Netherlands	-1.40[c]	2.19[c]
United Kingdom	-1.40	2.19

(a) Price elasticity assumed to be -1 when "wrong" sign was found.

(b) Elasticity "too high" and low "t" value, correct elasticity assumed to be -1.

(c) Magnitude of elasticities unacceptable, substituted by U.K. price and income elasticity.

Source: Bell *et al*., in Labys (1975).

One study dealing directly with foreign groundfish blocks and fish sticks and portions is Newton's (1972) dissertation. Newton's main objective was to analyze the impact on the U.S. industry of a tariff reduction on imports of sticks and portions, effective after 1972. He looked at the ..."ability of foreign nations to compete for a share of the U.S. market as a result of this tariff reduction." The secondary objective was to describe the geographic and structural characteristics of the U.S. sticks and portions industry with information directly obtained by interviews with processing firms. In order to estimate U.S. supply and demand relations for fish sticks and portions, the author incorporated in his model the supply and demand of groundfish blocks, since the latter is the imported raw material used in the production of sticks and portions. Of interest is Newton's econometric model, which hypothesized simultaneous determination of prices and quantities in the market for sticks and portions and the market for frozen blocks. He constructed a model of four log-linear equations, including supply and demand relations for both products. Using annual data, the parameters were estimated by LIML (Limited Information Maximum Likelihood), TSLS (Two Stage Least Square) and OLS (Ordinary Least Square) procedures. The empirical results, shown in Table 5 were considered unsatisfactory by Newton because of the time interval used (monthly or quarterly information on the variables was not available) and the inadequate model specification. However, the Newton study offers a comprehensive historical overview of the U.S. sticks and portions processing industry and a unique description of the market structure of this sector. This includes locational, technological, and economic aspects. This overview is particularly relevant for the present study and will be of interest in discussions to follow.

Another analysis closely related to this present study is Bockstael's (1976) dissertation, which attempted, as part of a broader undertaking, to estimate the U.S. supply and demand for frozen groundfish blocks, at the import level. She considered, "...the interaction of consumer demand, imports and domestic landings in determining ex-vessel groundfish prices to domestic fishermen and retail prices of various groundfish products" (pp. 8). This part of her dissertation is an econometric analysis of the groundfish

Table 5. Empirical Results for Simultaneous Model of US Supply and Demand of Groundfish Frozen Blocks and Stick and Portions by Newton (1972), Yearly Data, 1964-1970.

Equation		LIML (1) Regression Coefficients	LIML (1) "t" values	TSLS (2) Regression Coefficients	TSLS (2) "t" values	Variable definition (3)
X45	Constant	-3.97	-3.63	-3.16	-3.04	X45 = log quantity of blocks
	X43	-2.86	-3.66	-2.07	-2.78	Log Price of Frozen Blocks
(Supply of Blocks to the U.S.)	X52	5.52	4.17	4.27	3.39	Log Price of Frozen Fillet
	X47	0.39	4.76	0.38	4.86	Log World Cod landings
X45	Constant	0.79	1.84	0.84	1.97	X45 = log quantity of blocks
	X43	-0.06	-0.21	-0.04	-0.16	Log Price of Frozen Blocks
(Demand of Blocks to the U.S.)	X41	0.39	3.95	0.34	3.50	Log Current level Block Inventory
	X04	-0.02	-2.09	-0.02	-2.02	Dummy Variable for Bishop Decree
	X16	0.01	2.61	0.01	2.69	Difference between log current and twelve month lagged inventory
	X17	-0.01	-4.45	-0.01	-4.37	Difference between log current and eleven month lagged inventory
X46	Constant	0.54	0.07	-0.07	-0.09	X46 = log quantity fish stick/portions
	X41	0.37	4.92	0.32	4.30	Log Current level Block Inventory
(Supply of Stick & Portions in the U.S.)	X42	0.66	1.38	0.39	0.83	Log quantity weighted price for Stick/Portions
	X40	0.09	2.92	0.11	3.87	Log time, 1964=1
X46	Constant	-6.73	-2.97	0.33	0.42	X46 = log quantity stick/portions
	X49	-0.93	-4.44	-1.04	-1.92	Log Price Fish Stick/Portions deflated by Wholesale Price Index
(Demand of Stick & Portions in the U.S.)	X04	0.02	1.09	-0.02	-2.43	Dummy Variable for Bishop Decree
	X40	0.07	0.90	0.18	6.92	Log time, 1964=1
	X51	10.43	4.02	1.14	1.26	Log Price Frozen Fillet deflated by Wholesale Price Index

(1) LIML stands for Limited Information Maximum Likelihood procedure;

(2) TSLS stands for Two Stages Least Square procedure

(3) Endogeneous variables are: X41, X42, X43, X45, X46, X49.

SOURCE: Newton (1972)

market including fresh and frozen fillets, frozen blocks and sticks and portions. She constructed a block recursive system of equations from retail to imports utilizing monthly data from 1964 to 1974. She employed both OLS and TSLS to estimate the parameters in each block. Of interest for the present study is her modelling of import markets in a system of four linear equations which included both supply and demand for frozen fillets and for frozen blocks of groundfish. The variables selected and the results obtained by TSLS procedure are summarized in Table 6 . It seems that she captured the main factors affecting supply and demand for frozen groundfish products imported by the U.S. For almost all of the coefficients the signs were according to a priori expectations and were statistically significant at the 95 percent level, especially for groundfish fillets. The U.S. import demand for fillets was shown to be affected by its own import price, the domestic wholesale fillets price, the level of fillets inventories, the expected rate of disappearance of fillets, a seasonality variable which distinguished March to May, from the rest of the year and a variable for anticipated ICNAF closings.[7] In contrast, the estimated U.S. import demand equation for blocks did not uncover a significant dependence of quantity demanded on its own import price, but the total inventories of blocks, sticks and portions, the expected rate of disappearance of sticks and portions and two seasonal variables were more important for explaining changes in U.S. imports of blocks in her model. On the supply side, the quantity of both blocks and fillets seemed to vary with import prices, world landings, West German domestic prices for these products and the variables accounting for the dollar devaluation and the quota system applied to frozen fillets. In this supply-demand model, Bockstael utilized a three month lag on prices as this lag fit the data better than any other. This was introduced in order to consider prior trade contracts among U.S. buyers and foreign suppliers. Also, the retail

[7]ICNAF stands for "International Commission for the Northwest Atlantic Fisheries".

Table 6. U.S. Supply and Demand of Frozen Groundfish Fillets and Blocks Estimated by Bockstael (1976) Using TSLS and Linear Equations, Monthly Data, 1964-1974.

Equation and Variables		Coefficient Value and Significance	Variable Definition (1)
	Constant	11.71*	IMPZ = monthly imports of frozen fillets
$IMPZ^D_t$	PIZ_{t-3}	-0.70*	Monthly weighted average import frozen fillet price
	PWZ_{t-3}	0.03*	Monthly weighted average wholesale frozen fillet price
(Demand of Frozen Fillet)	HZ_{t-3}	-0.20*	1st month cold storage holdings of frozen fillet
	DISZ	1.05*	Twelve month moving average of disappearance rate of frozen fillets
	S1	1.21	Dummy = 1, for Dec.-Jan.-Feb.; zero, otherwise
	S2	3.99*	Dummy = 1, for Mar.-Ap.-May; zero, otherwise
	S3	-0.13	Dummy = 1, for June-July-August; zero, otherwise
	ID	2.88*	Anticipatory variable for ICNAF closings
	Constant	-9.66	IMPB = monthly imports of blocks
$IMPB^D_t$	PIB_{t-3}	-0.06	Monthly weighted average import blocks price
	PSP_{t-3}	0.38	Monthly weighted average wholesale stick-portions price
(Demand of Blocks)	HS_{t-3}	-0.23*	1st month cold storage holdings of stick-portions and blocks
	DISP	1.03*	Twelve month moving average of disappearance rates of stick-portions
	S1	-0.25	Dummy = 1, for Dec.-Jan.-Feb.; zero, otherwise
	S2	2.62*	Dummy = 1, for Mar.-Ap.-May; zero, otherwise
	S3	3.17*	Dummy = 1, for June-July-August; zero, otherwise
	Constant	-3.05*	IMPZ = monthly imports of frozen fillet
$IMPZ^S_t$	PIZ_{t-3}	0.69*	Monthly weighted average import frozen fillet price
	PIB_{t-3}	-0.15	Monthly weighted average import blocks price
(Supply of Frozen Fillet)	WGZ_{t-3}	-3.93*	Monthly West German price of Cod frozen fillet
	WLO	0.16(E-05)	Three month moving average of groundfish catch in Iceland, United Kingdom, Canada, Norway, Denmark
	DD	-10.47*	Dummy for dollar devaluation DD = 1,01/1964 to 09/1973, zero otherwise
	SQ	2.38*	Dummy for quota SQ = 1, January, April, July, October, zero otherwise
	Constant	29.66*	IMPB = monthly imports of blocks
$IMPB^S_t$	PIB_{t-3}	0.60*	Monthly weighted average import blocks price
	PIZ_{t-3}	0.23	Monthly weighted average import frozen fillet price
	WGB_{t-3}	-5.26*	Monthly West German price of Cod blocks
(Supply of Blocks)	WLO	0.29(E-04)*	Three month moving average of groundfish catch in Iceland, United Kingdom, Canada, Norway, Denmark
	DD	-14.01*	Dummy for dollar devaluation DD = 1,01/1964 to 09/1973 zero otherwise

(*) Statistically significant at 95% level;

(1) Endogeneous variables: IMPZ, IMPB, PIZ, PIB and t = monthly observations.

SOURCE: Bockstael (1976)

demand market results indicated an extremely high direct price elasticity of demand for fresh and frozen fillets, equal to -6.21 and -3.71, respectively. However, she did not obtain a statistically significant direct price elasticity for the retail demand of sticks and portions and felt this resulted from the use of wholesale prices of sticks and portions as a proxy of their retail prices. She found also that the estimated income elasticity for these three groundfish product forms was statistically significant only for fresh fillets, where it was estimated at 2.26. Furthermore, the log-linear form of the retail demand equations gave a better fit than did the linear form according to the author.

In the literature, there are several other studies dealing with groundfish in U.S. markets. A few of them have considered the role of inventories and imports in the analysis and most of them have dealt with the harvesting sector. However, some interesting results of relevance to the present study have emerged, especially those pertaining to the magnitude of the estimated price and income elasticities of demand for groundfish species. Furthermore, the approaches used in these applied works may help in the general model formulation of the present analysis. Some of the most significant studies and their conclusions are mentioned next.

Nash, in Bell and Hazleton (1967), summarized some of the results of demand analyses for about 20 fish products, performed by the Division of Economics, Bureau of Commercial Fisheries. He reported that demand for all fish and shellfish, taken as a group, was estimated to be price inelastic (equal to -0.45), while for individual species the demand tended to be highly elastic. That is: (a) fresh flounder fillets showed a price elasticity of between -4.0 to -6.0 for the 1950-1963 period; (b) the price elasticity of demand for frozen flounder was about -3.5 for the 1954-1963 period; (c) fresh and frozen haddock price elasticity was estimated at -1.4 for the 1954-1964 period. These results are in accordance with _a priori_ expectations: less aggregated data representing goods with more substitutes generally led to higher estimated price elasticities and vice versa. The income elasticity for the fish and shellfish group was below unity (0.65 to 1.00), indicating that consumption of fish is a smaller proportion of the consumer's expenditures as income increases. However, for individual groundfish, the income elasticity ranged between 2.50 to 5.90, probably explained by the advent of sticks and portions, encouraging the increase of groundfish consumption. Estimated cross-price elasticities suggested that meat is an important substitute for fish as a group but not for individual fish products.

Bell (1968) attempted to evaluate the impact of the "Papal-Bishop decree" on the demand of fish in the Northeast U.S., where the Catholic population is concentrated.[8] Using monthly observations for the period January 1957 to August 1967, log-linear price dependent demand functions at the ex-vessel level were estimated by OLS for sea scallops, yellow-tail flounder, large and small haddock, cod, ocean perch and whiting. The independent variables selected were: (a) landings; (b) aggregated personal income; (c) beginning of the month cold storage holdings; (d) imports; (e) consumer price index for meat and poultry; (f) weighted ex-vessel prices for competing fish products; and (g) two variables accounting for the Lenten period and for the "Papal-Bishop decree." Direct price and income demand flexibilities were estimated and are shown in Table 7 in "elasticity" form. Quantity landed had negative, statistically significant coefficients in all cases but ocean perch. Aggregate income did not display significant coefficients with the exception of flounder and whiting. The cold storage variable had two different effects on ex-vessel prices: (a) a negative effect for large haddock, ocean perch and whiting; (b) a positive effect for flounder, small haddock and whiting. Bell explained this as..."negative or stock adjustment of inventory effect. The second is positive since buyers may purchase when

[8] The requirement that U.S. Catholics abstain from eating meat on Friday was abolished in December 1966 by a Bishop's decree. This followed a Papal Decree in February 1966 which relaxed rules on abstinence from meat during Lent. Those decrees are the "Papal-Bishop Decrees."

Table 7. Summary of Selected Empirical Demand Studies and their Estimated Price and Income Elasticities, for Groundfish Species.

Author and Source	Species	Geographic Area	Period and time interval	Market Level	Form of Equation	Econometric Approach (4)	Elasticity of Demand Price (1)	Elasticity of Demand Income (2)
Bell (1968)	Yellowtail Flounder	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-2.29*	1.97*
	Large Haddock	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-2.17*	0.46*
	Small Haddock	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-2.19*	-0.33
	Cod	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-3.15*	0.10
	Ocean Perch	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-250.0	0.75
	Whiting	New England	1957-67 monthly	Landings	log-linear inverse	OLS	-22.22*	32.04*
Waugh in Nash and Bell (1969)	Haddock	Boston Pier	- monthly	Landings	log-linear inverse	OLS	-3.22*	-
	Scrod	Boston Pier	- monthly	Landings	log-linear inverse	OLS	-4.33*	-
	Cod	New York Fulton Market	- monthly	Wholesale	log-linear inverse	OLS	-2.90*	-
	Flounder	New York Fulton Market	- monthly	Wholesale	log-linear inverse	OLS	-10.28*	-
Bell in Nash and Bell (1969)	Cod	Boston/New Bedford and Gloucester	- monthly	Landings	log-linear inverse	OLS	-3.30	-1.98*
	Yellowtail Flounder	New Bedford	- monthly	Landings	log-linear inverse	OLS	-2.28*	1.76*
	Whiting	Gloucester/ Portland/ Rockland	- monthly	Landings	log-linear inverse	OLS	-22.73*	27.79*
Lampe and Farrell in Nash and Bell (1969)	Haddock	New England	- monthly	Wholesale frozen fillet	log linear	LIML	1.40*	-1.11*
Storey and Lee in Nash and Bell (1969)	Haddock	Holyoke Springfield, Mass.	- weekly	Retail	linear	OLS	-	-

(continued)

(continued, Table 7)

Author and Source	Species	Geographic Area	Period and time Interval	Market Level	Form of Equation	Econometric Approach (4)	Elasticity of Demand Price (1)	Elasticity of Demand Income (2)
Farrell and Lampe (1967)	Haddock	New England	1954-62 monthly	Landings all year	log-linear inverse	LIML	-2.22*	
	Haddock	New England	1954-62 monthly	Retail all year	log-linear inverse	LIML	-32.25*	7.20*
	Haddock	New England	1954-62 monthly	Landings 1st semester	log-linear inverse	LIML	-2.22*	-
	Haddock	New England	1954-62 monthly	Landings 2nd semester	log-linear inverse	LIML	-1.77*	-
	Haddock	New England	1954-62 monthly	Retail 1st semester	log-linear inverse	LIML	-4.91*	1.49*
	Haddock	New England	1954-62 monthly	Retail 2nd semester	log-linear inverse	LIML	-4.41*	0.16*
Waugh and Norton (1969)	"Market Cod" (3)	New York Fulton Market	1962-68 monthly	Landings	linear inverse	OLS	-2.73*	2.87*
	"Market Cod"	New York Fulton Market	1962-68 monthly	Landings	log-linear inverse	OLS	-2.74*	3.08*
	"Market Cod"	Boston Pier	1962-68 monthly	Landings	linear inverse	OLS	-5.05*	3.39*
	"Market Cod"	Boston Pier	1962-68 monthly	Landings	log-linear inverse	OLS	-4.36*	2.98*
	"Steak Cod" (3)	New York Fulton Market	1962-68 monthly	Landings	linear inverse	OLS	-1.59*	1.89*
	"Steak Cod"	New York Fulton Market	1962-68 monthly	Landings	log-linear	OLS	-1.84*	2.33*
	Large Cod	Boston Pier	1962-68 monthly	Landings	linear inverse	OLS	-6.10*	3.15*
	Large Cod	Boston Pier	1962-68 monthly	Landings	log-linear inverse	OLS	-5.97*	3.27*
	Haddock	New York Fulton Market	1962-68 monthly	Landings	linear	OLS	-	-
	Haddock	New York Fulton Market	1962-68 monthly	Landings	log-linear inverse	OLS	-17.27	30.64

(continued, Table 7)

Author and Source	Species	Geographic Area	Period and time Interval	Market Level	Form of Equation	Econometric Approach	Elasticity of Demand Price (1)	Elasticity of Demand Income (2)
	Large Haddock	Boston Pier	1962-68 monthly	Landings	linear inverse	OLS	-4.24*	2.32*
	Large Haddock	Boston Pier	1962-68 monthly	Landings	log-linear inverse	OLS	-3.39*	1.47*
	Scrod Haddock	Boston Pier	1962-68 monthly	Landings	linear inverse	OLS	-3.58*	2.49*
	Scrod Haddock	Boston Pier	1962-68 monthly	Landings	log-linear inverse	OLS	-4.18*	2.82*
	Whiting	New York Fulton Market	1962-68 monthly	Landings	linear inverse	OLS	-1.41*	2.04*
	Whiting	New York Fulton Market	1962-68 monthly	Landings	log-linear inverse	OLS	-176*	3.37*
Lee and Storey (1970)	Haddock	Massachusetts	1967	Retail	linear	OLS	-3.00	—
O'Rourke and DeLoach (1971)	Lingcod	California	- annual	Ex-vessel	log-linear inverse	OLS	-8.27*	3.27*
	Lingcod	Pacific Coast	- annual	Ex-vessel	log-linear inverse	OLS	-	31.22*
	Lingcod	Pacific Coast	- annual	Processed	log-linear inverse	OLS	-13.84	-5.79
	Flounder	Pacific Coast	- annual	Ex-vessel	log-linear inverse	OLS	-5.18*	-1.66
	Flounder	Pacific Coast	- annual	Processed	semi-log inverse	OLS	-	2.87*
	Flounder	California	- annual	Ex-vessel	log-linear inverse	OLS	-2.58*	0.78*

(1) The reciprocal of the direct price flexibility (obtained in inverse demand equation) is the lower absolute limit of the direct price elasticity if it is assumed, for simplicity, that the cross-price effects were close to zero. See Houck (1965) for further discussion;

(2) The income elasticity was calculated by dividing the estimated income flexibility by the estimated price. flexibility;

(3) Designation used by the authors probably referred to a market classification of the species;

(4) OLS (Ordinary Least Square); LIML (Limited Information Maximum Likelihood).

(*) Coefficient significant at five percent level. When the coefficient of price flexibility was not statistically significant, the transformation of flexibilities into elasticities includes an additional source of error, by virtue of the residuals being measured vertically in the former case and horizontally in the latter.

prices are falling (i.e. in the summer months), and sell (i.e. in the winter months) when prices are rising" [ibid, pp. 1349]. Imports affected the ex-vessel prices for flounder, large haddock and whiting negatively, and the prices of the other species, positively. Meat and poultry prices had a positive impact on the dependent variable. Ex-vessel prices for groundfish apparently rise during Lent in response to ex-vessel prices of competing fish products landed in New England. Bell's results indicated the demand for groundfish shifted downward, after 1966 when Roman Catholics were permitted to consume meat on Fridays during Lent. The major difficulty encountered by Bell in this study was a positive autocorrelation in the residuals, casting doubts about the impact of the church decrees in the long run.

In November 1968, the Bureau of Commercial Fisheries held a conference on the demand for fishery products (Nash and Bell, 1969). One of the main goals was to draw together all the demand relationships for fish species estimated by various researchers. For groundfish species, the major contributions were due to Waugh, Bell, Lampe and Farrell, and Storey and Lee, whose estimates of price and income elasticities are summarized in Table 7. A study of Farrell and Lampe (1967) refers to an analysis of demand and supply of haddock products in New England at various market levels: landings, wholesale, cold storage, imports and retail. This study was one of the first attempts to consider the mutual dependence of these market levels. As a consequence, the authors estimated the parameters of the system of ten log-linear equations using LIML procedures. The data were monthly, covering the period of 1954 to 1962. The authors obtained two sets of estimates, using whole-year and half-year data in different equations. The latter accounted for an increase on market activity in the first half of the year. However, this model generated statistically significant coefficients in the demand and supply equations at only the landings and retail market levels and not at the intermediate market levels (wholesale, imports and cold storage). Thus, only inverses of the estimated price and income flexibilities of demand, in the landings and retail markets, are reported in Table 7. Of further interest to the present study is the empirical evidence of an increase in consumption of haddock during the first half of the year, explained by the authors by the observance of Lent.

Waugh and Norton (1969) relying on an earlier work (Waugh in Nash and Bell (1969)) developed an investigation on the variations in fish prices including groundfish, for the New England fishing industry. The monthly, undeflated, ex-vessel prices were specified to be a function of current landings, total income and trigonometric (sine and cosine) variables, for the 1962-1968 period. The latter variables were designed to account for seasonal patterns. These demand equations in both linear and log-linear form were estimated by OLS. The inverses of the estimated price and income flexibilities of demand for groundfish are reported in Table 7. In general, the results yielded statistically significant coefficients with expected signs with only a few exceptions (red snapper, scup, oyster, clams and sea scallops). However, the presence of positive autocorrelation in the residuals was detected in most of the equations. The authors also compared the results using trigonometric variables and those using monthly "dummy" variables. They concluded that the results were basically the same under both procedures. Of further interest is the formulation in this study of a model to examine the effects of imports on annual average ex-vessel prices of flounder and other groundfish (cod, haddock, pollock, cusk and hake), for the period 1954-1967. Considering the interdependency of domestic prices and quantities imported, Waugh and Norton used simultaneous equations to analyze this relationship. It was assumed that: (a) the ex-vessel prices depend on total supply (domestic landings and imports) and personal income; (b) the quantities imported depend on domestic landings and tariffs. The system of structural equations in linear form and the estimated coefficients, obtained by TSLS, were the following:

For flounder:

$$P = 1.0644 - 0.044\ Qd - 0.0430\ Qm + 0.0250\ T \quad (3.1)$$

$$Qm = 213.9010 - 0.0307\ Qd - 25.9783\ t \quad (3.2)$$

For groundfish:

$$P = -5.0377 + 0.0140\ Qd - 0.0012\ Qm + 0.064\ Y \quad (3.3)$$

$$Qm = 1564.20 - 0.51\ Qd - 176.76\ t \quad (3.4)$$

where:

P = annual average ex-vessel price;

Qd - annual domestic landings;

Qm = annual imports;

Y = index of total personal income;

t = percent *ad valorem* tax on all fish

In equations 3.1, 3.2 and 3.4, the regression coefficients have the expected signs while, in the demand for groundfish, represented by equation 3.3, this is not the case for the domestic landings variable. The authors explained this result by the decline in the share of domestic landings on total U.S. supply of groundfish. Furthermore, competitive relationships among fish, poultry and meat were investigated in this study for the period 1935-1967. *Per capita* consumption of each product was specified to be a function of its deflated retail price index and income. OLS was used to estimate parameters, both in linear and log-linear forms. While the estimated direct price elasticities were negative, some inconsistent signs in the cross-price elasticities were found and attributed to poultry *per capita* production and prices.[9] When the poultry price and consumption variables were dropped from the demand equations, the results indicated a substitutional relationship between fish and meat, although the income coefficient in the demand for fish lost its statistical significance in this new approach.

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[9] In this period, it was observed that "...a sharp upward trend in poultry production and a corresponding decline in the deflated price of poultry " [Waugh and Norton, (1969), pp. 34] had occurred.

At the retail level, Lee and Storey (1970) estimated, by OLS, two demand functions for fresh haddock fillets, using weekly data for 1964 to 1968 from a sample of five stores in Massachusetts. The quantity demanded was defined as the dependent variable and the independent variables selected were: (a) retail haddock prices; (b) retail prices of other competitive species (swordfish, halibut, flounder and cod); (c) total store sales. Four "dummy" variables were also included, accounting for: (a) special sale price periods; and (b) quantity of shellfish and other finned fish. However, the results were not satisfactory due to problems of multicolinearity and autocorrelation but the authors did show a high own-price elasticity of haddock demand from the estimated equations (Table 7).

O'Rourke and Deloach (1971) studied the California fresh and frozen fish and shellfish industry, from fishing through retailing operations. The study included a section which analyzed ex-vessel prices for 12 finfish and shellfish species, including lingcod and flounder for both the Pacific and the California Coast. They assumed that annual ex-prices of each species could be explained by landings, the price of a substitute and California per capita income, using the log-linear form and OLS procedures. For lingcod and flounder, the estimated price elasticities were greater than unity in absolute terms. The income elasticities were positive in most of the cases, with the exception of processed lingcod and fresh flounder whose coefficients were not significantly different from zero (Table 7). The authors inferred from these empirical results that California fishermen could increase their returns by increasing the landings of some species, provided not all were increased at the same time.

On the basis of past research it appears, that, on statistical grounds, the log-linear form of the demand equation is most satisfactory. Estimated direct price elasticities of demand at various levels of the market appear to be relatively high. Estimated income elasticities are relatively high, although results are mixed in signs and have a wide range of magnitude.. This summary in Table 7 will be used as a reference for further analysis.

Area of Study

This section is devoted to a discussion of market conditions in the major groundfish block trading countries.

The United States (U.S.) Market

Looking at the historical patterns of trade in groundfish blocks and at market characteristics, it is evident that the U.S. has for some time been the major consuming country for this product form.[10] The U.S. block market depends heavily on other countries' supply and there has been a steady increase in U.S. apparent domestic consumption during the last two decades. As evidence, U.S. imports of groundfish blocks increased from 166.1 million pounds, in 1964, to 386.9 million pounds in 1978, or by 133 percent. The apparent disappearance jumped from 173.9, in 1964, to 390.3 million pounds, in 1978, or a 124 percent increase (Table 8).[11] During this period, imports always represented more than 94 percent of the apparent block disappearance, since the amounts produced in the U.S. were insignificant, when compared to import volumes.

This increase in groundfish blocks imports and domestic apparent disappearance was a direct result of the rapid growth in fish sticks and portions consumption, since blocks are the raw material in sticks and portions production in the U.S. As shown in Table 9, the domestic production of sticks and portions increased from 179.9 million pounds, in 1964, to 448.6 million pounds, in 1976. This increase was due in large part to the growth of portions production which in that period registered an increase of 234 percent, while sticks production increased by only 26 percent. Per capita annual apparent consumption of sticks and portions jumped from 0.969 pounds in 1964 to 2.035 pounds in 1978 (Table 9).

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[10] Actually, the U.S. (together with Japan) is the world's largest fish importing country for seven major fishery commodity groups [U.S. Dept. of Commerce, Fisheries of the U.S., (1978)].

[11] Apparent disappearance is defined as the sum of domestic U.S. production and total imports, net of inventory changes (i.e., adding beginning inventories and subtracting ending inventories).

Table 8. Frozen Groundfish Blocks (1). U.S. Total Supply, Utilization and Ratio of Imports and Disappearance, 1964-1978.

Year	Supply (in million pounds)				Utilization (million pounds)		Ratio of Imports to Disappearance (%)
	Beginning Inventories	U.S. Freezings	Imports	Total	Endings Stocks	Apparent Disappearance	
1964	25.8	2.0	166.1	193.9	20.0	173.9	95.51
1965	20.0	2.9	214.8	237.7	37.4	200.3	107.24
1966	37.4	6.0	206.6	250.0	35.2	214.8	96.18
1967	35.2	6.2	189.5	230.9	32.3	198.6	95.42
1968	32.3	3.6	261.1	297.0	44.4	252.6	103.36
1969	44.4	2.0	266.8	313.2	43.0	270.2	98.74
1070	43.0	4.4	272.6	320.0	30.6	289.4	94.19
1971	30.6	6.5	311.3	348.4	62.7	285.7	108.96
1972	62.7	3.1	355.5	421.3	75.8	345.5	102.89
1973	75.8	6.1	358.7	440.6	80.6	360.0	99.64
1974	80.6	2.4	265.9	348.9	75.7	273.2	97.33
1975	75.7	2.2	302.8	380.7	79.0	301.7	100.36
1976	79.0	2.7	364.9	446.6	61.1	385.5	94.66
1977	61.1	4.6	366.5	432.2	73.2	359.0	102.09
1978	73.2	2.1	386.9	462.2	71.9	390.3	99.13

(1) Includes: Cod, Flatfish, Haddock, Pollock, Other fish frozen into blocks

SOURCES: US Department of Commerce. Fishery Statistics of the US (1964-1978)
US Department of Commerce. US Imports for Consumption (1964-1978)

Table 9. Groundfish Sticks and Portions. U.S. Total Supply and Total and *Per Capita* Utilization, 1964-1978.

Year	Supply (million pounds)						Utilization (million pounds)		
	Beginning Stocks	Production			Imports	Total	Ending Stocks	Apparent Consumption	
		Sticks (1)	Portions (2)	Total				Total	Per Capita
1964	13.6	73.6	106.3	179.9	0.2	193.7	8.1	185.6	0.969
1965	8.1	82.5	140.4	222.9	0.3	231.3	20.2	211.1	1.091
1966	20.2	81.4	147.6	229.0	0.4	249.6	19.5	230.1	1.176
1967	19.5	73.9	161.3	235.2	0.4	255.1	14.0	241.1	1.222
1968	14.0	91.7	182.8	274.5	0.9	289.4	24.0	265.4	1.328
1969	24.0	113.4	217.0	330.4	1.6	356.0	25.4	330.0	1.637
1970	25.4	115.9	234.3	350.2	1.2	376.8	22.0	354.8	1.746
1971	22.0	97.8	239.7	337.5	1.2	360.7	23.2	337.5	1.637
1972	23.2	114.5	269.2	383.7	1.4	408.3	34.4	373.9	1.784
1973	34.4	127.2	298.4	425.6	1.7	461.7	41.5	420.2	2.002
1974	41.5	103.1	276.2	379.3	1.5	422.3	33.3	389.0	1.840
1975	33.3	91.1	295.6	386.7	0.4	420.4	35.3	385.1	1.808
1976	35.3	93.4	340.1	433.5	0.6	469.4	31.0	438.4	2.042
1977	31.0	87.0	350.8	437.8	0.6	469.4	30.5	438.9	2.029
1978	30.5	93.2	355.4	448.6	1.4	480.5	37.1	443.4	2.035

(1) Production of Sticks includes: cooked (breaded and battered) and raw, breaded sticks.

(2) Production of Portions includes: cooked (breaded and battered), breaded raw, and unbreaded portions.

SOURCE: U.S. Department of Commerce. Fishery Statistics of the U.S. (1964-1978)
U.S. Department of Commerce. U.S. Imports for Consumption (1964-1978)
U.S. Department of Commerce. Fish Sticks, Fish Portions and Breaded Shrimp (1964-1978)

This rapid increase in the production and consumption of sticks and portions is attributable to their introduction in the 60's in frozen dinner production, fast-food restaurants and in other institutional outlets in ever-growing quantities,[12] and also by the fact that more Americans are eating away-from-home.[13]

Furthermore, increasing U.S. imports of frozen groundfish blocks were supported by a liberal U.S. tariff schedule applied to imports of this product and by the inability of U.S. block producers to supply the growing needs of the sticks and portions processors. That is, the duty on blocks imports was 1.00 cents per pound, from July, 1964 through December, 1968, and duty-free thereafter. Also, U.S. groundfish block production, based primarily in New England industries, did not grow at the same rate as did block disappearance. As a matter of fact, it is estimated that, in 1978, U.S. block production capacity was around 45 million pounds, while the U.S. consumed 390.3 million pounds in this year.[14]

On the other hand, sticks and portions for domestic consumption are processed almost entirely in the U.S. due to the magnitude of import

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[12] Bockstael (1976) indicated that 90 percent of the portions and 20 percent of the sticks produced go to institutional channels (i.e., schools, hospitals, business cafeterias, restaurants, quick service drive-ins, etc.).

[13] The demand for food away-from-home was estimated by Johnston (1976) for 15 cities in the U.S. The calculated price elasticities ranged from -0.59 to -3.79 and the income elasticities were between 0.48 and 1.83. Also, Prochaska and Schrimper (1973) considering the rise in the trend of eating out in the U.S., included the effects of the opportunity costs of homemaker's time in explaining the away-from-home food consumption. The inclusion of this variable resulted in lower estimates of income elasticities for food consumed away-from-home, than what would have been obtained in its absence, varying from 0.26 in rural areas to 1.16 in urban areas.

[14] This data was disclosed by the report of the <u>International Trade Commission</u> (1980).

duties, greater transportation costs and perishability of this product relative to frozen blocks. That is, until 1972, the tariff imposed on raw sticks imports was 20 percent ad valorem and on cooked portions, 30 percent. After 1972, those tariffs were reduced by half, i.e., to 10 and 15 percent, respectively.[15]

Therefore, U.S. policy was designed to permit the processing industry to obtain the input-- blocks-- at lower cost, while the output-- sticks and portions-- is protected by a high import duty. Even when the duty level for sticks and portions was reduced, the U.S. sticks and portions industry continued to be protected, thereby excluding foreign processors from entry into the U.S. market.[16]

The conjunction of all the above mentioned phenomena (i.e., duty-free treatment for blocks imports, insufficient domestic industrial block production capacity, high import duties on sticks and portions, successful adoption of sticks and portions by fast-food restaurants and by other institutional buyers and a concomitant increase in consumption of food away-from-home) could explain the rapid growth of U.S. sticks and portions consumption in the last two decades. As a consequence of this expansion, the sticks and portions basic raw material-- blocks-- was heavily imported by the U.S.

The growth of U.S. block imports was followed by the increase in imports of other forms of groundfish products, such as frozen fillets. As shown in Table 10, in the 1964-1978 period, the imports of frozen fillets oscillated from 78.5 to 273.5 million pounds, registered an increase of 223 percent and averaged 177.4 million pounds a year.

As opposed to the situation for frozen blocks, U.S. imports of frozen fillets shares its importance with the domestic production.

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[15]The GATT (General Agreement on Tariffs and Trade), Kennedy Round meeting, in 1967 decided that this tariff reduction would be effective by 1972.

[16]This discussion is drawn from Newton (1972) and his conclusions on the matter.

Table 10. Frozen Groundfish Fillets. U.S. Production, Total Imports, and Imports by Species. 1964-1978

Year	U.S. Production (million pounds)	Imports by Species (million pounds)			
		Total	Cod	Cusk, Haddock Hake Pollock	Flatfish
1964	75.2	79.0	33.4	24.0	21.6
1965	77.2	78.5	33.7	20.7	24.1
1966	75.4	101.7	40.9	26.1	34.7
1967	71.0	91.1	32.1	25.7	33.3
1968	55.3	118.2	46.6	32.1	39.5
1969	47.3	143.9	61.9	33.9	48.1
1970	42.9	190.8	95.8	36.1	58.9
1971	43.8	171.0	80.7	34.0	56.3
1972	39.3	229.7	99.0	42.5	88.2
1973	47.0	237.6	83.0	48.7	105.9
1974	45.3	186.5	74.3	34.7	77.5
1975	36.8	231.8	92.7	40.8	98.3
1976	40.6	272.5	121.1	50.6	100.8
1977	59.9	273.5	126.1	51.5	95.9
1978	62.4	255.4	121.2	45.1	89.1
Annual Average	54.6	177.4	76.2	36.4	64.8
Annual Percentage Average		100.0	42.95	20.52	36.53

SOURCE: U.S. Department of Commerce. Fishery Statistics of the U.S. (1964-1978)
U.S. Department of Commerce. U.S. Imports for Consumption. (1964-1978)

On the average, during the period 1964-78, U.S. domestic production represented 31 percent of total imports. However, this production registered a reduction over the years, falling from 75.2 million pounds in 1965 to 36.8 million pounds in 1975, and increased again thereafter (Table 10).

Another difference between blocks and fillets is that a more restrictive tariff schedule applies to U.S. fillet imports. For fillets, there is a combination of a quota and an ad valorem duty. A duty of 1.875 cents a pound is imposed for volumes imported under the quota amounts and 2.50 cents a pound for imports over the quota amounts. The quota is set equal to 15 million pounds, or 15 percent of the last three years' U.S. annual consumption, which ever is larger. Additional duty is paid on imports over one-fourth the quota entering within each three-month period of the year.

Table 10 illustrates cod as the most important single species in U.S. frozen fillet imports accounting, on the average, for 43 percent of the total import volumes for the period 1964-1978. However, the percentage increase in cod fillet imports from 1964 to 1978, 262 percent, was less than that registered for other imported fillet species, such as flatfish (sole-flounder).

Cod also has been the most important single species in U.S. blocks imports since, on the average, it represents 57 percent of the total imports for the period 1964-78 (Table 11). However, the percentage of the total accounted for by the cod species has decreased over the period, from 65 percent, in 1964, to 53 percent, in 1978. In contrast, imports of pollock species have registered a significant percentage increase, their contribution being 7 and 21 percent, in 1964 and 1978, respectively (Table 11). Among the other groundfish species included in total U.S. block imports, haddock's average share was only 9 percent over the period and it declined over time from 13 to 7 percent. The percentage of flatfish blocks has remained stable, around 6 percent, and the group of other species' percent contribution has been 12 percent on the average. (Table 11). Even though most processors probably would prefer cod blocks, these switches in species mix are likely to be related to the scarcity of cod supply and high price of cod blocks, especially in comparison with pollock (U.S. Department of Commerce, Food Fish Market Review, 1971).

Table 11. U.S. Imports of Groundfish Blocks. Percentage of Imports by Species, 1964-1978.

	Percentage of Imports (%)				
Year	Cod	Haddock	Pollock	Flatfish	Other Species
1964	65.21	13.42	6.68	5.54	9.15
1965	61.55	10.75	6.80	8.33	12.57
1966	64.07	11.52	4.31	6.78	13.32
1967	61.69	11.29	4.92	6.96	15.14
1968	67.56	9.00	3.22	5.40	14.82
1969	72.19	7.38	2.89	5.62	11.92
1970	71.53	7.45	7.59	4.44	8.99
1971	62.04	9.28	9.28	7.26	12.14
1972	58.41	7.28	15.44	4.95	13.92
1973	43.19	7.56	28.96	6.97	13.32
1974	42.54	7.90	30.09	7.93	11.54
1975	52.96	12.09	24.64	4.23	6.08
1976	49.49	7.84	26.31	5.95	10.41
1977	55.91	8.40	22.62	4.12	8.95
1978	52.91	6.98	21.01	4.34	14.76
Annual Average	57.66	8.85	15.91	5.77	11.78

SOURCE: U.S. Department of Commerce. U.S. Imports for Consumption (1964-1978).

It is of interest to consider the geographical source of imported blocks to the U.S. Here, the data reveal that Canada has been the single most important block exporting country, as shown in Tables 12 and 13. During the period under discussion, an average of 80.9 million pounds a year has been imported from Canada to the U.S. (Table 12). This figure represents about 28 percent of annual average block imports (Table 13). Iceland, the second major supplying country, shared about 19 percent of the total blocks imports, or, 55.5 million pounds, a year average during the 1964-78 period. The third and fourth major suppliers were Norway and Denmark, respectively.

Historically, however, the Canadian share of U.S. blocks imports has decreased gradually. In 1964, imports from Canada were 59 percent of the total imports; in 1974, when the figure was the lowest, Canada's share was 13 percent; at the end of the period it was around 23 percent (Table 13). This reallocation of the U.S. supply sources of block imports can be attributed in part, to the Canadian Fisheries Price Support Board's Program which has been in effect since May 1969, and to a more aggressive Icelandic fishery export policy. To support cod block prices, at or above 24 cents a pound (FOB - U.S.), the Canadian Board made 11 purchases after May 1969, amounting to over 17.5 million pounds [U.S. Department of Commerce, Food Fish Market Review, (1969)]. As a consequence, the strengthening of Canadian block prices encouraged a diversification of the supply sources to the U.S. market. Meanwhile, the Icelandic Government developed an assistance program for its fishing industry in 1964, and a price equalization fund for the freezing industry was introduced. Also, devaluations of the Icelandic krona in relation to the U.S. dollar, (1967-68), had a favorable effect on Iceland's competitive export position in foreign markets. In addition, Iceland had promoted vertical integration by establishing a subsidiary company in the U.S. that was an extension

Table 12. U.S. Imports of Groundfish Blocks by Country of Origin, 1964-1978.

Year	Canada	Norway	Iceland	Denmark	Other Countries (1)
	Volume of Imports (million pounds)				
		Other Countries			
1964	98.6	9.2	39.3	4.7	14.3
1965	119.8	11.4	47.1	10.7	25.8
1966	98.0	11.9	37.9	16.1	42.7
1967	96.0	15.4	28.7	11.9	37.5
1968	106.2	34.6	58.2	21.9	40.2
1969	88.7	73.0	53.9	17.8	33.4
1970	83.8	71.8	73.3	15.7	28.0
1971	96.5	60.9	74.2	35.7	44.0
1972	73.4	61.8	61.6	56.9	101.8
1973	65.2	45.7	66.5	49.3	132.0
1974	34.2	22.8	45.0	39.0	124.9
1975	39.1	65.3	57.1	37.8	103.5
1976	49.1	50.8	65.1	51.6	148.3
1977	74.3	45.7	60.8	64.7	121.0
1978	90.8	44.9	63.6	59.9	127.7
Annual Average	80.9	41.7	55.5	32.9	75.0

(1) Especially Japan, Republic of Korea and Argentina.

SOURCE: U.S. Department of Commerce. U.S. Imports for Consumption (1964-1978)

Table 13. Percentage of Total U.S. Imports of Groundfish Blocks by Country of Origin, 1964-1978.

Year	Canada	Norway	Iceland	Denmark	Other Countries
	Percentage of Imports (%)				
		Other Countries			
1964	59.36	5.54	23.66	2.83	8.61
1965	55.77	5.31	21.93	4.98	12.01
1966	47.44	5.76	18.34	7.79	20.67
1967	50.66	8.13	15.14	6.28	19.79
1968	40.67	13.25	22.29	8.39	15.40
1969	33.25	27.36	20.20	6.67	12.52
1970	30.74	26.34	26.89	5.76	10.27
1971	31.00	19.56	23.84	11.47	14.13
1972	20.65	17.38	17.33	16.00	28.64
1973	18.18	12.74	18.54	13.74	36.80
1974	12.86	8.57	16.93	14.67	46.97
1975	12.91	21.56	18.86	12.48	34.19
1976	13.46	13.92	17.84	14.14	40.64
1977	20.27	12.47	16.59	17.65	33.02
1978	23.47	11.60	16.44	15.49	33.00
Annual Average	28.20	14.53	19.34	11.47	26.14

SOURCE: U.S. Department of Commerce. U.S. Imports for Consumption (1964-1978).

of its block producing firm abroad.[17]

However, Canadian suppliers remained the major source of U.S. block imports, followed by Iceland, Norway and Denmark. The other block supplier countries had no regular flow of trade with the U.S., and their share never exceeded 47 percent during the 1964-1978 period. Japan, the Republic of Korea and Argentina are the most important countries representing this group (Table 12).

Canada's importance in the U.S. groundfish market can also be observed in frozen fillet imports: no less than 31 percent over the period 1964-1978. However, this percentage of Canadian fillets in total U.S. blocks imports has declined from 73 percent (1964) to 40 percent (1978),as shown in Table 14.

Table 14. Imports of U.S. Frozen Groundfish Fillets from Canada. Quantity and Percentage of Total Imports, 1964-1978.

Year	Imports from Canada	
	Quantity (million pounds)	Percent of Total (%)
1964	57.8	73.14
1965	59.1	75.30
1966	78.5	77.19
1967	72.4	79.53
1968	84.6	71.56
1969	98.8	68.64
1970	97.7	51.17
1971	85.0	49.72
1972	87.5	38.07
1973	78.0	32.82
1974	63.0	33.76
1975	73.8	31.83
1976	83.5	30.62
1977	91.7	33.53
1978	101.9	39.89
Annual Average	80.9	45.60

Source: U.S. Department of Commerce, U.S. Imports for Consumption (1964-1978).

[17]With this kind of market arrangement, the "Icelandic Freezing Plants Association" and the "Federation of Icelandic Cooperative Societies" established subsidiary companies in the U.S. to guarantee a stable flow of Icelandic products to the U.S. markets and probably to allow higher integrated profits for the Icelandic fishing industry. The sticks and portions produced in the U.S. by an Icelandic company are not subject to any import duty.

As the U.S. is the main importer and consumer country of groundfish blocks, it follows that the most important U.S. trade partners (Canada, Iceland, Norway and Denmark), are likely to be the world's major exporters of this product form. As mentioned earlier, other countries that may be also considered as major exporters of groundfish blocks are Japan and the Republic of Korea, supported by Alaska pollock catches. However, the participation of these countries in U.S. markets only started in 1971, and over the 1971-78 period a wide variation in their trading volumes was observed.[18] Thus, considering the past trends for the purposes of this study, neither Japan nor Korea can be rigorously classified as traditional block exporters. This fact does not dismiss the roles of Japanese or Korean suppliers in U.S. block markets, and their participation is included in the composition of block import volumes and prices analyzed in this study. However, if the intention is to study international markets for groundfish blocks, countries such as Canada, Iceland, Norway and Denmark can be treated as representing the supply side of the market.

Except for Canada, a complete series of blocks production and exports in each country is not available. However, their importance on trade can be indirectly inferred by looking at their relative participation in world groundfish landings. That is, Canada, Iceland, Norway and Denmark, as a group, have been responsible for a significant portion of annual world landings of cod, varying between 31 to 50 percent in the 1964-1977 period (Table 15). The remaining major producing countries of this species are Portugal, Spain, USSR and the U.K. but they do not strongly participate in international trade as exporting countries. In addition, Canada, Iceland, Norway and Denmark landed 18 to 39 percent of the annual world haddock catches in the same 1964-1977 period (Table 16). Also,

[18]During 1971-78, U.S. imports from Japan of Alaska pollock varied from 6.5 million pounds (1978) to 60.7 million pounds (1974). For the same period, U.S. imports from Korea ranged from 0.02 million pounds (1972) to 58.6 million pounds (1976) [U.S. Department of Commerce, U.S. Imports for Consumption (1964-78)].

Table 15. Cod (1). World Landings and Percentage of Oistribution by Leading Countries, 1964-1977.

	Cod World Landings					
	Percentage (%)					
Year	Canada	Iceland	Norway	Denmark	Sub-total (2)	Total (thousand metric ton)
1964	11.78	10.48	8.37	2.55	33.18	267.8
1965	11.33	8.82	9.91	2.87	32.93	276.6
1966	10.66	9.15	10.01	3.12	32.94	287.4
1967	9.08	6.54	9.78	2.99	28.39	312.3
1968	10.34	7.51	11.48	3.44	32.77	386.7
1969	8.22	8.01	12.01	2.64	30.88	357.7
1970	8.36	9.81	14.53	3.08	35.78	314.2
1971	8.58	8.94	17.17	4.68	39.37	285.1
1972	8.00	8.35	17.16	5.60	39.11	273.8
1973	6.97	9.33	13.17	5.38	34.85	253.6
1974	5.55	8.58	12.09	4.94	31.16	281.2
1975	6.02	10.97	13.97	5.73	36.69	242.3
1976	8.11	11.89	16.67	6.87	43.54	238.8
1977	10.32	14.35	18.56	6.68	49.91	229.9

(1) Gadus Morhua

(2) The remaining leading countries are: Portugal, Spain, USSR, and U.K.

SOURCE: F.A.O., Yearbook of Fisheries Statistics (1970-77).

Table 16. Haddock (1) World Landings and Percentage of Distribution by Leading Countries, 1964-1977.

Year	Haddock World Landings					
	Percentage (%)					Total (thousand metric ton)
	Canada	Iceland	Norway	Oenmark	Sub-total (2)	
1964	9.76	9.62	7.48	12.38	39.24	588.0
1965	6.74	7.15	8.77	8.81	31.47	748.0
1966	8.44	0.41	11.14	6.69	26.68	729.0
1967	11.57	7.99	10.74	5.25	35.55	484.0
1968	10.18	6.98	12.79	8.11	38.06	487.0
1969	4.60	3.64	6.78	3.30	18.32	962.0
1970	2.94	3.48	4.21	17.40	28.03	914.3
1971	5.77	6.40	9.40	6.54	28.11	506.3
1972	3.14	5.36	8.77	6.89	24.16	547.3
1973	2.93	5.56	14.06	2.58	25.13	620.9
1974	2.51	5.88	13.12	8.39	29.90	581.5
1975	3.67	6.93	11.79	7.16	29.55	529.2
1976	3.75	6.78	10.08	10.57	31.18	514.7
1977	6.64	8.78	10.49	6.69	32.60	403.3

(1) Melanogrammus Aeglefinus

(2) The remaining leading countries are: the U.K. and USSR.

SOURCE: F.A.O, Yearbook of Fisheries Statistics (1970-77).

Table 17. Pollock (1) and Alaska Pollock (2) World Landings and Percentage of Distribution by Leading Cnuntries, 1964-77.

	Pollock World Landings						Alaska Pollock World Landings		
	Percentage (%)						Percentage (%)		
Year	Canada	Iceland	Norway	Denmark	Sub-total (3)	Total (thousand metric ton)	Japan	Republic Knrea	Total (4) (thousand metric ton)
1964	7.64	5.38	48.21	0.94	62.17	403.0	74.50	2.25	918.0
1965	6.76	6.10	43.41	1.22	57.49	408.0	66.30	2.56	1042.0
1966	4.10	4.62	42.40	0.95	52.07	454.0	63.45	1.72	1221.0
1967	4.19	6.90	41.07	1.31	53.47	420.0	71.87	1.01	1735.0
1968	5.10	10.64	29.49	2.18	47.41	357.0	72.97	1.30	2201.0
1969	3.70	12.41	28.44	1.29	45.84	435.0	76.19	0.39	2552.0
1970	1.70	9.97	25.68	2.75	40.10	640.6	76.75	0.43	3057.3
1971	1.76	8.84	21.35	2.10	34.05	681.3	73.99	1.99	3588.9
1972	2.79	9.15	25.56	2.94	40.44	655.3	72.04	3.51	4213.3
1973	4.13	8.59	24.78	1.55	39.05	658.2	65.43	5.57	4617.1
1974	3.33	8.62	21.33	6.23	39.51	756.7	58.19	6.05	4907.0
1975	3.78	8.72	19.26	5.38	37.14	704.0	53.29	7.72	5023.9
1976	3.09	7.57	20.22	9.17	40.05	750.5	48.23	8.93	5070.3
1977	4.60	8.32	26.82	3.76	43.50	563.4	44.87	7.73	4296.0

(1) Pollachius Virens (or saithe);

(2) Theragra chalcogramma;

(3) The remaining leading countries are : USSR, France, West Germany and Polland;

(4) USSR is the remaining leadinn country.

SOURCE: F.A.O. Yearbook of Fisheries Statistics (1970-77) of relevance, was the contribution of the USSR and the U.K. in haddock landings, but most of their catches were consumed locally. Even for pollock those four countries have contributed a substantial percentage to annual world landings. This proportion was not less than 34 percent for the 1964-1977 period (Table 17). Japan is the world's main producer of Alaska pollock and together with the Republic of Korea has been exporting blocks of this species to the U.S. markets since 1972, as discussed earlier. The remaining landings of Alaska pollock originate predominantly from USSR catches.

The Canadian Market

Canada, together with Norway, Japan and the Republic of Korea, has been, and still is one of the world's major exporters of fishery products and the traditional U.S. trade partner for these items [U.S. Department of Commerce, Fisheries of the U.S., (1978)].

Canadian fishing grounds in the Northwest Atlantic and Northeast Pacific are among the most productive in the world. The Northwest Atlantic (including waters around Newfoundland, Nova Scotia and New Brunswick provinces) is more important than the northeast Pacific grounds, not only in terms of value but also in volume caught.

The major species harvested by Canada are: (a) groundfish species (cod, flatfish and ocean perch); (b) pelagic species (herring, mackerel and salmon); (c) molluscs (scallops and oysters) and; (d) crustaceans (lobsters and crabs). In 1978, in terms of ex-vessel value, cod, lobsters, scallops and herring were the most significant species in Canada's Atlantic sea landings (Table 18).

Between 1964 and 1978, cod catches in Canada dropped gradually until 1975, averaging 454.6 million pounds yearly, or about 44 percent of the total groundfish landings in this country (Table 19). Evidently, cod was the leading species, with flounder-sole being the second most important among the groundfish species. The latter had an average share of 23 percent with volumes increasing over the period. Ocean perch, the third most important species, also registered an increase in its landings, while haddock catches dropped in the same period and, on the average, contributed about 7 percent to total groundfish landings (Table 19).

In general, changes in the species composition were due to greater exploitation of the less valuable species, such as ocean perch and pollock. This happened when the more valuable species, cod and haddock, became overfished and subject to ICNAF quotas. However, since 1976, both groundfish and cod landings in Canada have been increasing, probably due to the implementation of the 200 mile economic zone.[19] As a matter of

Table 18. Canada, Ex-vessel Value of Landings on the Atlantic Coast by Species, 1978.

Sea Fish Species		Ex-Vessel Value (million Canadian dollars)
Groundfish	Cod	82.9
	Cusk	1.4
	Flounder/sole	23.8
	Haddock	17.9
	Hake	2.0
	Pollock	5.0
	Ocean-Perch	12.5
	Other	11.0
	Sub-Total	156.5
Pelagic		
	Herring	35.3
	Salmon	4.2
	Mackerel	3.7
	Other	13.0
	Sub-Total	56.2
Molluscs and Crustaceans		
	Scallops	62.2
	Oysters	1.0
	Lobsters	65.3
	Crab	11.5
	Other	17.1
	Sub-Total	157.1
Viscera, Tongues, Scalls		0.7
Total Sea Fish		370.5

SOURCE: Canada, Statistics Canada, Monthly Review of Canadian Fisheries (1978).

[19] With the 200 mile zone imposed by Canada in 1976, the excessive catches of foreign ships was avoided. This implied that Canadians have been giving stocks a chance to recover while steadily increasing their own catches.

Table 19. Canada.Groundfish (1) Landings by Major Species, 1964-1978.

Year	Landings (millions pounds, common landed form) (2)							
	Cod	Cusk	Flounder Sole	Haddock	Hake	Pollock	Perch Rose (3)	Total
1964	576.2	7.9	161.9	106.4	18.6	56.9	80.2	1008.1
1965	543.1	8.8	197.2	92.3	12.5	51.7	117.1	1022.7
1966	562.0	11.2	232.8	112.9	16.8	47.3	183.1	1166.1
1967	521.4	11.4	228.5	102.8	14.0	32.7	172.6	1083.4
1968	587.2	7.8	227.8	90.8	11.3	33.8	202.5	1161.3
1969	728.6	6.3	272.8	81.3	13.1	29.5	213.2	1344.8
1970	482.8	7.3	298.9	139.5	17.0	25.6	239.2	1210.3
1971	447.7	10.4	281.5	53.3	27.5	22.0	248.2	1090.6
1972	402.6	11.3	210.9	31.6	28.5	33.6	242.3	960.8
1973	321.8	11.2	265.3	33.4	28.5	49.8	355.4	1065.4
1974	277.5	10.2	208.7	26.7	24.6	45.7	186.6	780.0
1975	260.9	9.7	192.4	34.0	22.4	55.3	221.3	796.0
1976	336.7	5.7	229.7	33.9	18.9	50.8	186.6	862.3
1977	368.0	6.1	244.4	48.4	21.0	57.1	146.5	891.5
1978	402.0	9.2	224.0	71.0	17.3	52.9	148.6	925.0
Annual Average	454.6	9.0	231.8	70.6	19.5	43.0	196.2	1024.6
Percent Annual Average	44.37	0.90	22.62	6.89	1.90	4.20	19.15	100.00

(1) Includes Groundfish used mainly in block production;

(2) Common landed form is the form in which the fish was landed, including fish dressed head on and undressed;

(3) Also known as Ocean Perch.

SOURCE: Canada. Statistics Canada. Monthly Review of Canadian Fisheries Statistics (1964-1978) fact, the expected effects of the 200-mile limit will be even more intensively felt in a longer prospective, if one considers that larger and more fish are likely to predominate with controlled catches in Canadian waters. According to Fishing News International (1980), Canadian groundfish landings are projected to be 1,062 thousand tons in 1983, in which cod represents about 600 thousand tons. Indeed, an excess supply may be now emerging in the market for Canadian groundfish block production (as opposed to the shortage observed in the 70's), not only because of the increase in catch, but also because of the recession in the U.S. economy.

In recent years, approximately two thirds of the value of Canadian fish products have been derived from exports, since there is an excess supply in Canada's domestic markets. This is also true for the various processed groundfish products. Of special interest here are frozen fillets, frozen blocks and salted groundfish products. Comparing the series on total supply of those products to exports in the 1964-78 period, it can be seen that Canadian exports were, on average, about 91 percent of total blocks supply, 83 percent of total fillets supply and 64 percent of salted groundfish supply (Tables 20, 21 and 22).[20] These percentages indicate a strong dependence of Canadian groundfish products on foreign markets. Also, the average annual exports of frozen fillets -- around 118.4 million pounds -- are larger than exports of the other two product forms, i.e., they are 45 and 106 percent higher than the exports of frozen blocks and salted groundfish, respectively (Tables 20, 21 and 22).

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[20] Total supply is defined here as the total production in Canada adjusted for inventories (adding beginning inventories and subtracting ending inventories).

Table 20. Canada. Supply and Exports of Frozen Groundfish Blocks (1), 1964-1978.

Year	Supply (million pounds)				Exports	Ratio of Exports to Total Supply
	Beginning Stocks	Freezing	Ending Stocks	Total Supply	(Million pounds)	(%)
1964	12.9	99.0	5.7	106.2	106.9	100.66
1965	5.7	131.6	8.6	128.7	123.2	95.73
1966	8.6	109.6	25.9	92.3	96.7	104.77
1967	25.9	95.0	12.0	108.9	102.7	94.31
1968	12.0	109.4	8.9	112.5	110.3	98.04
1969	8.9	100.8	10.3	99.4	85.2	85.71
1970	10.3	82.1	2.9	89.5	82.7	92.40
1971	2.9	101.3	5.0	99.2	89.1	89.82
1972	5.0	75.8	5.8	75.0	63.4	84.53
1973	5.8	78.2	10.4	73.6	65.3	88.72
1974	10.4	48.7	13.0	46.1	35.5	77.01
1975	13.0	44.2	9.2	48.0	38.4	80.00
1976	9.2	61.9	7.0	64.1	51.8	80.81
1977	7.0	98.0	10.9	94.1	83.2	88.42
1978	10.9	106.2	11.8	105.3	88.1	83.66
Annual Average	-	89.4	-	89.5	81.5	91.06

(1) Includes Cod, Flounder/Sole, Haddock, Pollock, Ocean Perch and other Groundfish.

SOURCE: Canada. Statistics Canada. Fish Freezing and Stocks (1964-1978)
Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-78).

Table 21. Canada. Supply and Exports of Frozen Groundfish Fillets (1), 1964-1978.

Year	Supply (million pounds)				Exports	Ratio of Exports to Total Supply (%)
	Beginning Stocks	Freezings	Ending Stocks	Total Supply	(Million pounds)	
1964	12.2	101.2	14.0	99.4	71.8	72.23
1965	14.0	92.5	10.0	96.5	82.2	85.18
1966	10.0	143.6	20.8	132.8	108.4	81.63
1967	20.8	135.1	19.1	136.8	104.4	76.32
1968	19.1	155.6	15.5	159.2	130.8	82.16
1969	15.5	165.8	11.4	169.9	143.0	84.17
1970	11.4	161.2	16.6	156.0	148.6	95.25
1971	16.6	148.7	16.2	149.1	131.4	88.13
1972	16.2	157.7	15.8	158.1	140.6	88.93
1973	15.8	170.2	22.0	164.0	142.1	86.65
1974	22.0	121.4	19.9	123.5	104.8	84.86
1975	19.9	132.4	15.6	136.7	113.5	83.03
1976	15.6	137.5	17.3	135.8	115.6	85.12
1977	17.3	142.9	12.3	147.9	117.3	79.31
1978	12.3	167.3	12.6	167.0	122.0	73.05
Annual Average	-	142.2	-	142.2	118.4	83.26

(1) Includes Cod, Haddock, Sole-Flounder, Pollock, Ocean Perch and other Groundfish

SOURCE: Canada. Statistics Canada. Fish Freezing and Stocks (1964-1978)
Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-78).

Table 22. Canada. Supply and Exports of Salted Groundfish, 1964-1978.

Year	Supply (million pounds)				Exports (million pounds) (2)	Ratio of Exports to Total Supply (%)
	Beginning Stocks	Production (1)	Ending Stocks	Total Supply		
1964	40.0	137.5	42.6	134.9	93.4	69.24
1965	42.6	105.5	39.7	108.4	74.6	68.82
1966	39.7	110.5	36.3	113.4	70.6	62.26
1967	36.3	131.9	54.6	113.6	80.2	70.60
1968	54.6	112.2	40.7	126.1	74.6	59.16
1969	40.7	76.2	26.2	90.7	72.4	79.82
1970	26.2	91.5	17.5	100.2	57.7	57.58
1971	17.5	83.9	17.8	83.6	47.4	56.70
1972	17.8	51.4	20.9	48.3	36.7	75.98
1973	20.9	57.4	16.8	61.5	36.0	58.54
1974	16.8	62.6	19.5	59.9	37.4	62.44
1975	19.5	66.5	25.5	60.5	34.9	57.68
1976	25.5	71.6	29.1	68.0	47.7	70.15
1977	29.1	75.5	21.1	83.5	46.7	55.93
1978	21.1	90.6	26.3	85.4	53.6	62.76
Annual Average	-	88.3	-	89.2	57.6	64.57

(1) Includes Cod, Hake, Pollock and other Groundfish wet salted, dried salted and boneless salted;

(2) Includes Cod, Haddock, Cusk, Hake, Pollock, other Groundfish

SOURCE: Canada. Statistics Canada. Monthly Review of Canadian Statistics (1964-1978)
Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-78).

Canadian exports of frozen blocks averaged 81.5 million pounds a year in the period 1964-78 (Table 20). In the same period, exports of salted groundfish, averaging 57.6 million pounds, indicate that the domestic market consumes proportionally more salted groundfish than frozen fillets and blocks (Table 22). Nevertheless, the importance of Canadian consumption of frozen blocks and fillets has grown over time, since the respective ratio of exports to total supply declined gradually from 1964 to 1978 (Tables 20 and 21).

Thus, it is evident that a high percentage of Canada's groundfish products is exported. It can also be demonstrated that Canadian exports are almost exclusively oriented towards U.S. markets. This is especially true for frozen products but is not the case for salted groundfish. Of Canadian frozen block exports, about 95 percent was exported to the U.S. over the period 1964-1978, or, 77.7 million pounds a year (Table 23). The remaining volume --3.8 million pounds-- was exported mainly to Western European countries (U.K., West Germany and France) and to Australia. These Canadian exports were allocated almost exclusively to the U.K., which imported an annual average of 2.9 million pounds over this period (Table 23). Similarly, Canadian frozen fillet exports have also been marketed in the U.S., representing no less than 91 percent of the total exports and averaging, during the 1964-78 period, 115.2 million pounds a year (Table 24). In contrast, during the same period, salted groundfish exports were not consumed by U.S. markets with such predominance. Exports to the U.S. averaged 15.8 million pounds a year (27 percent of the total exports of this product form) as shown in Table 24. The bulk of the salted groundfish production was exported to Central America (Puerto Rico, the Dominican Republic, and Jamaica), to Europe (Portugal, Spain and Italy) and to South America (Brazil).[21] As a consequence, there are clear

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[21]Salting is a very old method of preservation, but salted fish does not appeal to the modern tastes of consumers in most developed countries, like the U.S. Therefore, the markets for salted groundfish are different than those for frozen groundfish products. Thus, Canada tends to export salted groundfish to countries where this product form is a traditional food commodity and/or where factors such as lack of refrigeration, hot climates and/or low income are present.

Table 23. Canada. Frozen Groundfish Blocks. Export Volumes and Distribution by Country of Destination, 1964-1978.

	Exports to the US.		Exports to Other Countries							
			Quantity (thousand pounds)					Total		
Year	Quantity (thousand pounds)	Percent of total Export (%)	United Kingdom	West Germany	France	Australia	Other Countries	Quantity (thousand pounds)	Percent of total exports (%)	Total Exports (thousand pounds)
1964	96579.7	90.38	9743.4	38.4	104.5	-	395.4	10281.7	9.62	106861.4
1965	118341.7	96.05	4001.2	350.0	2.0	425.8	79.6	4858.6	3.95	123200.3
1966	89476.2	92.53	6998.8	2.3	-	152.5	70.6	7224.2	7.47	96700.4
1967	95378.0	92.83	7226.6	14.1	13.8	-	114.8	7369.3	7.17	102747.3
1968	98775.2	89.52	11354.9	192.1	10.6	-	6.7	11564.3	10.48	110339.5
1969	83460.0	97.98	1716.8	-	-	-	-	1716.8	2.02	85176.8
1970	80216.8	96.97	2023.4	136.4	-	-	343.0	2502.8	3.03	82719.6
1971	88190.2	98.94	365.1	364.3	-	-	214.6	944.0	1.06	89134.2
1972	62536.6	98.69	619.8	210.0	-	-	2.8	832.6	1.31	63369.2
1973	65158.1	99.75	11.7	68.8	3.7	-	81.3	165.5	0.25	65323.9
1974	35140.8	99.06	90.7	63.6	-	115.8	62.4	332.5	0.94	35473.3
1975	36749.3	95.75	-	253.0	226.2	273.6	877.9	1630.7	4.25	38380.0
1976	49684.4	95.82	59.6	1655.2	2.4	376.8	71.6	2165.6	4.18	51850.0
1977	80110.5	96.33	3.2	2064.8	424.0	348.3	214.5	3054.8	3.67	83165.3
1978	85509.7	97.04	263.3	31.0	767.6	455.4	1086.4	2603.7	2.96	88113.4
Annual Average	77687.2	95.32	2965.2	362.9	103.6	143.2	241.4	3816.3	4.68	81503.6

SOURCE: Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-1978)

Table 24. Canada. Frozen Fillet and Salted Groundfish. Exports To the US. Volume and Percentage, 1964-1978.

	Exports to the US			
	Frozen Fillets		Salted Groundfish	
Year	Quantity (million pounds)	Percent of total exports (%)	Quantity (million pounds)	Percent of total exports (%)
1964	69.8	97.21	13.6	14.60
1965	77.9	94.77	13.1	17.60
1966	105.9	97.69	13.7	19.40
1967	102.2	97.89	12.9	16.08
1968	128.4	98.16	15.2	20.38
1969	141.4	98.88	14.3	19.75
1970	145.8	98.11	14.9	25.82
1971	120.8	91.93	15.3	32.28
1972	131.8	93.74	14.3	38.96
1973	141.3	99.44	18.6	51.67
1974	102:4	97.70	19.8	52.94
1975	112.6	99.21	16.1	46.13
1976	114.2	98.79	18.0	37.74
1977	113.5	96.76	17.4	37.26
1978	119.4	97.87	20.3	37.87
Annual Average	115.2	97.30	15.8	27.43

SOURCE: Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-1978).

cultural and economic factors explaining the difference between frozen and salted groundfish export markets for Canadian production. However, salting does remain an alternative to freezing when the market for frozen fish is depressed relative to that for salted fish.

Looking at the composition of Canadian exports by groundfish species it is obvious that cod predominates in the frozen blocks and salted groundfish exports, but not for fillet exports. That is, cod contributed (on an average yearly basis) 67 percent of the total frozen blocks exports and 80 percent of the total salted groundfish exports (Tables 25 and 26). In contrast, ocean perch and sole have been the species most widely utilized for frozen fillet exports and together they made up 68 percent of the yearly average of total exports of this product over the 1964-78 period (Table 27).[22]

In summary, the Canadian frozen groundfish block industry is dependent basically on cod landings, has frozen fillets and salted groundfish as alternative product forms, and faces almost exclusively a foreign demand, especially the U.S. market, followed by the U.K. market.

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[22] As discussed earlier, sole, although technically not classified as groundfish, has physical as well as marketing characteristics similar to groundfish species.

Table 25. Canada. Total Exports of Groundfish Blocks, by Species, 1964-1978.

	Frozen Block Exports (thousand pounds)					
Year	Cod	Haddock	Pollock	Ocean Perch (1)	Sole/Flounder (1)	Other Species
1964	76478.8	6705.7	10095.6	-	-	13581.3
1965	71527.6	5812.8	14165.4	-	-	31694.5
1966	60242.1	4926.6	6593.0	-	-	24938.7
1967	59986.4	5547.3	6136.3	8724.0	11526.7	10826.6
1968	70334.2	4621.9	5448.3	10857.4	11878.1	7199.6
1969	56436.4	1559.0	3041.0	7836.7	11719.9	4583.8
1970	60142.3	606.4	1550.2	8383.0	9873.1	2164.3
1971	57876.3	893.3	1828.0	9358.1	16861.1	2317.4
1972	42566.2	386.9	1604.5	5267.7	11345.4	2198.5
1973	38459.2	425.7	2891.1	7896.5	11806.3	3845.1
1974	23160.9	229.1	1083.4	1838.8	6923.2	2237.9
1975	21999.0	516.2	3089.4	1884.2	7617.5	3273.7
1976	36672.9	304.8	1764.1	1789.2	7569.2	3749.8
1977	69202.0	906.1	1180.0	1070.7	8053.8	2752.7
1978	69877.4	2336.9	2022.3	1258.0	9410.5	3208.3
Annual Average	54330.8	2385.2	4166.2	4410.9	8305.6	7904.8
Percent Annual Average	66.66	2.93	5.11	5.41	10.19	9.70

SOURCE: Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-1978)

(1) The symbol - stands for data not available under this category.

Table 26. Canada. Total Exports of Salted Groundfish by Species, 1964-1978.

	Salted Groundfish Exports (million pounds)				
Year	Cod (1)	Haddock Cusk (2)	Hake (2)	Pollock (2)	Other Species (2)
1964	78.1	1.2	3.1	9.9	1.1
1965	63.9	1.6	3.2	5.5	0.4
1966	60.0	2.0	2.9	5.2	0.5
1967	71.0	1.8	2.3	4.3	0.8
1968	64.2	2.2	2.3	5.0	0.9
1969	65.3	1.2	1.8	4.0	0.2
1970	48.5	0.8	2.3	3.9	2.2
1971	38.5	1.2	3.8	2.4	1.5
1972	25.3	2.0	6.2	2.7	0.5
1973	25.1	1.6	4.8	3.9	0.6
1974	23.9	1.8	5.4	5.0	1.3
1975	20.4	1.8	5.5	4.7	2.5
1976	32.6	1.3	4.3	4.9	4.6
1977	33.9	1.2	4.8	5.3	1.5
1978	33.8	1.9	5.1	5.0	7.8
Annual Average	45.6	1.6	3.8	4.8	1.8
Percent Annual Average	79.17	2.78	6.60	8.33	3.12

(1) Includes the items: Cod Boneless Salted, Cod Wet Salted and Cod Salted (43%, 43% or less, 46-50%, 44-45%, less than 45% of salinity).

(2) Includes only dried/salted products.

SOURCE: Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-1978)

Table 27. Canada. Total Exports of Groundfish Frozen Fillets by Species, 1964-1978.

Year	Frozen Fillet Exports (million pounds)						
	Cod	Haddock	Hake, Cusk Pollock	Ocean Perch	Sole	Flatfish	Other Species
1964	17.8	12.1	1.8	15.6	21.1	2.3	1.1
1965	17.6	9.0	2.3	22.3	26.0	4.1	0.9
1966	18.5	12.5	2.6	35.6	33.7	4.5	1.0
1967	15.6	12.4	1.5	33.6	34.7	5.2	1.4
1968	20.6	13.3	2.1	45.1	42.1	6.9	0.7
1969	27.8	11.0	2.2	50.5	44.6	6.3	0.6
1970	30.8	5.3	2.0	56.0	51.3	1.1	2.1
1971	22.0	4.5	1.2	49.0	43.3	1.2	10.2
1972	26.7	2.0	2.1	58.2	41.5	0.4	9.6
1973	19.1	1.7	3.3	74.0	41.6	0.3	2.1
1974	13.7	1.8	2.3	51.4	33.3	0.3	2.0
1975	17.7	3.3	2.7	53.2	33.4	0.3	2.9
1976	20.2	2.9	3.5	44.9	40.4	0.2	3.5
1977	25.0	5.0	20.5	29.8	33.6	0.3	3.1
1978	32.0	10.9	5.2	34.9	34.9	0.7	3.4
Annual Average	21.7	7.2	3.7	43.6	37.0	2.3	3.0
Percent Annual Average	18.33	6.08	3.12	36.82	31.25	1.94	2.53

SOURCE: Canada. Statistics Canada. Trade of Canada: Export by Commodities (1964-1978)

The Icelandic Market

The fishing industry in Iceland is that country's most important activity, playing a dominant and unique role in the Icelandic economy. Most of Iceland's catches are taken from surrounding fishing grounds with the exception of herring which is mainly caught in the North Sea. For human consumption, groundfish represent the mainstay of the Icelandic fish catches, as shown in Table 28. Capelin (which is processed predominantly into non-human consumption products, oil and meal) has demonstrated a steady increase in their volumes during the period 1964-78. Since 1973, the volume of capelin landed (441.5 thousand metric tons) has exceeded total groundfish catches (398.1 thousand metric tons). Herring, which until 1968 represented the most significant portion of Icelandic landings, experienced noteworthy decreases due to a ban on its exploitation imposed for conservation reasons (Table 28).

As for Canada, cod is an important component of the Icelandic groundfish harvest. For example, during the 1978 fishing season, the cod species accounted for 62 percent of groundfish landings and 20 percent of all fish and shellfish landed (Table 29). Other groundfish landings -- haddock, pollock, pout, ocean perch and other groundfish -- were at considerably lower levels than were the cod catches (each group's landings were about one tenth of the cod catch). Capelin alone constituted 62 percent of total Icelandic catches, but was used primarily for reduction into fish meal and oil, as mentioned earlier (Table 29).

It is pertinent to the present study to consider the disposition of Iceland's catches by mode of utilization. The main modes have been freezing and salting. Considering the total groundfish landings in 1978 -- 513.6 thousand metric tons -- it is evident that a significant portion of the catch went to freezing and salting (434.5 thousand tons) as shown in Table 30. Fresh-chilled groundfish, fish meal, and oil were the utilization modes of secondary importance in Iceland (1978 catch). Canning and drying were even less relevant when compared to the aforementioned modes. Also, the disposition of catch exclusively for

Table 28. Iceland. Total Landings Distributed by Species, 1964-1978.

Year	Quantity (thousand metric tons)				
	Ground Fish	Herring	Capelin	Other Species	Total Landings
1964	415.3	544.4	8.6	3.1	971.4
1965	381.8	763.0	49.7	4.6	1199.1
1966	339.4	770.3	124.9	8.0	1242.6
1967	333.5	461.5	97.2	5.5	897.7
1968	337.0	142.8	78.2	7.4	565.4
1969	450.2	56.6	171.0	10.8	688.6
1970	474.2	51.4	191.8	16.3	733.7
1971	421.7	61.3	182.9	18.4	684.3
1972	385.7	41.5	277.0	21.7	725.9
1973	398.1	43.4	441.5	24.3	907.4
1974	422.2	40.5	462.2	19.5	944.4
1975	443.7	33.4	501.1	16.1	994.3
1976	475.8	30.0	458.8	21.1	985.7
1977	502.9	28.9	812.7	29.4	1373.9
1978	513.6	37.3	966.7	48.6	1566.2

SOURCE: Aegir (1979)

Table 29. Iceland. Total Fish and Shellfish Landings Distributed by Species and Percentage, 1978.

Species	Landings in 1978	
	Quantity (thousand metric ton)	Percentage of Total (%)
Cod	319.7	20.41
Haddock	40.6	2.59
Pollock	44.3	2.83
Pout	34.6	2.21
Ocean Perch	33.5	2.14
Other	40.9	2.61
Sub-total	513.6	32.79
Herring	37.3	2.38
Capelin	966.7	61.72
Sub-total	1004.0	64.10
Lobster	2.0	0.13
Shrimp	7.3	0.47
Sub-total	9.3	0.60
Lumpfish	4.1	0.26
Blue Whitting	26.4	1.69
Other	0.0	0.00
Sub-total	30.5	1.95
Scallop	8.8	0.56
Total	1566.2	100.00

SOURCE: *Aegir* (1979)

internal consumption was low, around 5.2 thousand metric tons in 1978, indicating that Icelandic markets for fishery products are irrelevant, despite a very high rate of fish consumption per capita, around 100 kg a year.

Looking at Icelandic export values for all marine products from 1970 to 1978, it is also evident that frozen and salted fish constituted a greater part of these exports (Table 31). Only in 1977 and 1978 did exports of fish meal and oil exceed exports of salted fish,on a value basis. For the same period, fresh-chilled, dried and canned fish products contributed even less to the value of Icelandic exports, remaining always below 11 percent of the total exports (Table 31).

The allocation of the value of Icelandic exports of fishery products by country of destination can be observed in Table 32. The main markets were America (especially the U.S.) with percentages varying from 30 to 44 percent. The EEC countries were the next group of important markets during the 1970-78 period.

It is interesting to note that Icelandic exports are centralized in the hands of national processing units such as "The Icelandic Freezing Plants Association" and "The Federation of Icelandic Cooperative Societies." The former association opened a sales office in New York in 1944, and by 1947 established a subsidiary company, "The Coldwater Seafood Corporation", that is now producing fish sticks and portions in the U.S. The "Federation of Icelandic Cooperative Societies" also opened a subsidiary in the U.S., "The Iceland Products Incorporated," which serves a similar role, running a fish processing plant.[23]

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[23]The "Coldwater Seafood Corporation" runs a large processing plant in Maryland and "The Iceland Products Incorporated" has its own processing plant in Pennsylvania for blocks and fillets imported from Iceland.

Table 30. Iceland. Disposition of Groundfish Catches by Product Form, 1978.

	Disposition of Catch (thousand metric ton)							
Specie	Fresh/ Chilled	Frozen	Dried	Canned	Salted	Internal Consumption	Fish Meal	Total Catch
Cod	14.3	194.4	5.6	0.0	104.3	1.0	0.1	319.7
Haddock	3.5	32.6	0.5	0.1	0.2	3.7	0.0	40.6
Pollock	5.3	29.4	0.5	-	9.1	0.0	0.0	44.3
Pout	-	-	-	-	-	-	34.6	34.6
Redfish	2.8	30.6	-	-	0.0	0.0	0.1	33.5
Sub-total	25.9	287.0	6.6	0.1	113.6	4.7	34.8	472.7
Other	2.2	32.2	1.0	0.0	1.7	0.5	3.2	40.9
Total	28.1	319.2	7.6	0.1	115.3	5.2	38.0	513.6

SOURCE: Aegir (1979)

(1) The symbol - stands for none.

Table 31. Iceland. Total Fishery Export Value Distributed by Product Form, 1970-1978

	Percentage of Export Value (%)							Total Value (million Kronur)
Year	Frozen (1)	Salted	Fresh/ Chilled	Dried	Fish Meal and Oil	Canned	Other mode	
1970	52.25	18.75	11.24	2.38	13.90	1.42	0.06	10081.4
1971	56.42	18.20	9.20	2.23	11.32	1.60	1.03	11056.4
1972	56.73	19.49	7.61	2.37	11.53	1.86	0.41	12319.6
1973	48.03	17.36	8.33	1.79	22.68	1.53	0.28	19189.6
1974	44.23	26.54	7.34	1.72	17.77	2.00	0.40	24588.2
1975	48.93	28.67	3.90	2.40	14.70	1.25	0.15	37339.1
1976	49.40	28.86	3.68	2.84	13.88	1.12	0.22	53367.6
1977	50.79	18.77	1.75	3.16	23.70	1.64	0.19	76335.1
1978	49.47	17.25	4.11	5.42	22.05	1.46	0.24	136657.6

(1) Frozen fillets, frozen blocks, whole frozen fish, frozen capelin, shrimp, lobster, scallops and roe (Frozen export data are not available on a species basis)

SOURCE: Aegir (1979)

Table 32. Iceland. Total Fishery Export Value Distributed by Country of Destination, 1970-1978.

Year	Percentage of Export Value (%)								Total Value (million Kronur)
	EFTA (1)	EEC (2)	Comecon (3)	Other European Countries	America	Africa	Asia and Australia	Other Countries	
1970	31.10	12.60	11.80	4.50	38.40	0.70	0.70	0.20	10081.4
1971	28.50	10.00	11.30	5.00	44.10	0.20	0.60	0.30	11056.4
1972	25.60	10.90	13.40	5.80	41.40	1.30	1.50	0.10	12319.9
1973	10.90	34.30	9.00	5.20	36.40	0.20	3.90	0.10	19189.6
1974	19.00	22.20	14.40	8.10	30.20	0.40	5.60	0.10	24588.2
1975	18.80	20.10	13.70	7.00	37.40	1.80	1.10	0.10	37339.1
1976	19.80	20.90	9.90	5.20	40.00	1.90	2.20	0.10	53367.6
1977	12.80	24.40	12.40	5.20	39.40	3.20	2.50	0.10	76335.1
1978	9.90	28.90	7.90	6.80	37.90	3.30	5.30	0.00	136657.6

(1) European Free Trade Association;

(2) European Common Market;

(3) Trade organization of the Soviet Bloc. (Council for Mutual Economic Assistance).

SOURCE: Aegir (1979)

Also, all Icelandic salted fish is exported through "The Union of Icelandic Fish Producers" and a similar export organization exists for herring, "The Herring Board." In short, all organizations of this kind are a way to promote fishery products exports on which the Icelandic economy essentially depends.

Since 1976, with the implementation of the 200-mile economic zone, Iceland substantially increased its catch. According to Fishing News International (1980), larger four year old cod is beginning to dominate Iceland's catches. These catches have improved to 360 thousand tons in 1979 and may well reach 400 thousand tons in 1980.[24] However, difficulties of selling Icelandic fish products in the U.S. are also forecasted at the present for the same order of reasons discussed earlier for Canadian exports.

The Norwegian Market

Norway is one of the largest producers of fish among OECD (Organization of European Economic Development) member-countries.[25] The most important fish species in Norwegian landings is once again, cod, followed by other groundfish species and herring and sprat (Table 33). Cod species are caught mainly in Northern Norway's waters and herring species in the Western and Northern part. Also illustrated in Table 33, is that a considerable part of the catch was utilized for non-human consumption, i.e., meal and oil, during the 1970-77 period. Mackerel, molluscs, crustaceans and other species were of secondary importance in Norwegian landing in terms of volume (Table 33).

[24] In 1978, cod landings were around 319.7 thousand tons (Table 29).

[25] OECD was founded in 1960 and the member countries are: Australia, Belgium, Canada, Denmark, France, West Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, Norway, Finland, Portugal, Spain, Sweden, Turkey, the U.K., the U.S., and New Zealand.

Table 33. Norway. Total Landings by Species, 1970-1977

Year	Quantity Landed (thousand tons)							
	Cod	Other Groundfish	Herring and Sprat	Mackerel	Other Species	Reduction to Fish Meal Oil (1)	Molluscs and Crustaceans	Total Landings
1970	308.0	180.3	75.7	26.2	52.0	2042.9	10.5	2695.6
1971	324.2	175.3	48.3	22.6	47.3	2177.8	10.3	2805.8
1972	312.2	193.4	48.5	29.0	49.6	2206.5	12.6	2851.8
1973	219.6	262.1	51.7	26.2	32.8	2100.7	15.4	2708.5
1974	232.7	229.5	43.8	28.3	37.7	1800.3	17.9	2390.2
1975	233.3	184.0	46.1	20.6	29.3	1770.6	21.3	2305.2
1976	279.0	187.6	42.8	29.7	49.2	2567.2	27.6	3183.1
1977	287.2	172.8	33.1	33.2	44.4	2561.2	28.1	3160.0

(1) Includes Capelin, Herring, Sprat, Mackerel and other fish.

SOURCE: OECD. Review of Fisheries (1970-1977)

The disposition of these catches by product form indicates that a large portion of the products for human consumption go to freezing and curing (salting, drying and smoking), as shown in Table 34. As discussed earlier, this is the case for the same reason as for Iceland: long distances between fishing grounds and main consuming markets. As a matter of fact, on a yearly average over the span between 1970-77, about 277.5 thousand tons of Norwegian catch was frozen and 240.0 thousand tons was cured (Table 34). The volume allocated for fresh-chilled consumption only represented one-fourth of that frozen. An even smaller portion was utilized for canning, while the volume of fish processed into meal and oil represented a substantial portion of the catch in those years (Table 34).

Noting the distribution of Norwegian exports by product form, it can be observed that frozen fish products are not always first in monetary value. When compared to other product forms in the period 1970-77, frozen fish shared its importance with cured products and fish meal and oil (Table 35). Only in the years 1970, 1971 and 1973 did frozen fish make a greater contribution to the value of total exports than did cured fish. In 1973 and 1977, exports of fish meal and oil exceeded the exports of frozen and cured fish. The remaining export items -- shellfish and fresh-chilled products -- represent a small amount of the total export value of Norwegian fishery products in this period (Table 35).

There are no data available referring to frozen groundfish block participation in Norwegian exports and to the specific trade flows among Norway and its consuming countries. However, according to OECD, Market for Frozen Fish (1966), frozen pollock fillets were usually exported to the east European countries and to the USSR, and frozen cod and haddock fillets to the E.E.C. countries (especially the U.K.) and the U.S. According to the same source, exports of cured fish went

Table 34. Norway. Disposition of Catches by Product Form, 1970-1977.

Year	Disposition of Catches (thousand tons)						
	Fresh Chilled	Frozen	Cured (1)	Canned	Reduction to Fish Meal & Oil	Other Uses	Total Catches
1970	94.2	300.0	229.3	29.2	2032.0	10.9	2695.6
1971	69.1	273.5	264.3	21.0	2170.5	7.4	2805.8
1972	80.8	264.6	271.8	28.1	2200.8	5.7	2851.8
1973	64.6	283.7	235.0	24.4	2095.8	5.0	2708.5
1974	51.3	279.5	235.2	24.0	1795.3	4.9	2390.2
1975	57.4	267.2	192.8	17.3	1765.7	4.8	2305.2
1976	73.5	277.3	247.4	17.8	2561.4	5.7	3183.1
1977	59.4	274.2	244.1	21.1	2555.8	5.4	3160.0
Average	68.9	277.5	240.0	22.9	2147.2	6.2	2762.5

(1) Includes Salted, Dried and Smoked Fish.

SOURCE: OECD. Review of Fisheries (1970-1977)

Table 35. Norway. Total Fishery Export Value by Product Form, 1970-1977.

Year	Percentage of Export Value (%)							Total Value (million Norway Kroner)
	Fresh Chilled	Frozen	Cured	Canned	Reduction to Fish Meal	Other	Shellfish	
1970	4.47	29.22	23.84	14.32	22.17	4.74	1.24	1858.0
1971	3.24	27.80	27.61	13.03	23.52	3.67	1.13	2126.0
1972	3.65	27.26	29.13	12.53	22.90	2.95	1.58	2410.0
1973	2.76	25.18	23.70	8.73	33.50	3.17	2.96	2967.0
1974	2.78	25.11	30.98	8.20	25.08	4.65	3.20	2879.0
1975	3.39	24.77	32.11	8.30	22.62	6.38	2.43	2710.0
1976	2.86	22.75	29.93	6.31	28.73	5.86	3.56	3599.0
1977	2.76	22.34	25.92	5.54	33.14	6.03	4.27	4310.0

(1) Includes Salted, Dried and Smoked Fish

SOURCE: OECD. Review of Fisheries (1970-1977)

mainly to Angola, Brazil and Portugal and exports of fish meal and oil went to the U.K., West Germany, Sweden, France and Yugoslavia.

Norway's fishery products industry is organized into national associations similar to Iceland , which centralizes the exports through special sales organizations or export committees. However, unlike Iceland, the fishery industry and its export products in Norway do not play as important a role in the Norwegian economy.

The Danish Market

The main fishing-grounds for Danish fishermen are the waters around the Denmark coasts and the North Sea. Fishing in distant waters plays an insignificant role for the national fishing industry. For human consumption, the major species caught by the Danish fleet are cod and herring, followed by plaice. Of proportionately less importance, are mackerel and shellfish, if one considers the landings of Denmark during the 1970-77 period (Table 36). For non-human consumption, the catch utilized for reduction purposes accounts for a significant proportion of the total volume caught in Denmark,for the same period under consideration (Table 36).

Data on the disposition of Danish catches are not available through OECD fisheries publications. However, it is possible to examine the disposition of exports by product form, on a value basis, for the period 1970-77. From these figures (Table 37) it can be seen that there is a predominance of fresh-chilled fish in Danish exports with percentages varying from 27 to 35 percent of the total export value over the period. Frozen fish exports represent the second major category of importance on Danish fish products exports, contributing not less than 21 percent of the total export value in the span 1970-77. The proportion of meal and oil exported may be compared to frozen fish as equivalent in value, varying between 19 and 34 percent of total exports over this period (Table 37).

Table 36. Denmark. Total Landings By Species, 1970-1977.

	Quantity Landed (thousand Metric Tons)							
Year	Cod	Plaice	Herring	Mackerel	Reduction (fish meal Oil)	Molluscus and Crustaceans	Other Species	Total
1970	96.8	49.7	122.3	7.8	1059.7	26.9	58.1	1421.3
1971	133.4	43.7	274.1	7.7	1128.6	37.6	68.7	1693.8
1972	153.2	46.0	133.3	11.1	1123.2	36.1	75.1	1578.0
1973	139.8	38.1	132.9	8.8	1212.1	33.2	77.4	1642.3
1974	137.3	36.6	113.5	18.3	1584.2	34.8	50.1	1974.8
1975	140.3	39.1	103.4	18.7	1481.3	33.0	57.2	1873.0
1976	162.6	45.9	96.4	26.3	1607.0	45.2	62.9	2046.3
1977	145.8	44.8	75.3	42.9	1480.9	50.2	64.1	1904.0

SOURCE: OECD. Review of Fisheries (1970-1977)

Table 37. Denmark. Total Fishery Export Value by Product Form, 1970-77.

	Percentage of Export Value (%)							
Year	Fresh Chilled	Frozen	Cured (1)	Canned	Reduction to fish meal and oil	Shellfish	Other	Total Value (thousand U.S. dollar)
1970	35.03	25.66	3.30	8.38	23.42	1.97	2.24	169.1
1971	35.31	28.74	3.40	8.91	20.23	1.81	1.60	208.3
1972	33.24	28.47	3.61	12.07	19.02	2.37	1.22	265.7
1973	28.25	24.81	3.33	10.22	30.08	1.82	1.49	349.4
1974	27.45	21.72	3.30	10.04	34.42	1.65	1.42	485.0
1975	32.76	20.92	4.81	11.90	24.57	4.04	1.00	399.0
1976	29.16	22.71	4.39	12.66	26.03	4.17	0.88	498.3
1977	28.63	22.95	4.30	12.55	26.16	4.74	0.67	713.0

(1) Includes Salted, Dried and Smoked Fish

SOURCE: OECD. Review of Fisheries (1970-1977)

The predominance of fresh-chilled products in Danish exports can be explained by the short distances from Denmark's ports both to the fishing grounds and to the markets in Europe. This geographic characteristic differentiates Denmark's fish exports from those of the other exporting countries, considered earlier in this chapter. Also, Denmark differs from those countries in the amount of cured fish exported. Danish cured fish exports never exceeded 5 percent of the respective total export value in 1970-77, while for Norway and Iceland, this proportion was at higher levels.

In Denmark, there also exists a central export organization that takes care of fish exports on behalf of individual fishery cooperatives. The main foreign markets for the Danish fishing industry have been: (a) the U.K. for flatfish, (b) West Germany for herring, (c) Italy, Sweden and Switzerland for fresh fish, and (d) the U.S. and the U.K. for frozen fish [OECD. Fisheries Policies in Western Europe and North America, (1966)].

Furthermore, it should be noted that the Faroe Islands and Greenland are Danish territories. Both are dependent on fishing activities for their economic livelihood. However, their production is traded directly on international trade, without Danish government interference. Therefore, these territories were not considered in the analysis since the proportion traded in international markets is small in comparison to the above mentioned supplying countries (Table 38).

The United Kingdom (U.K.) Market

The United Kingdom (U.K.) can be characterized as the second most important frozen blocks importing country, competing directly with the U.S. for sources of supply. Despite its large volume of landings, the U.K. has been defined as an important net fish importer, after Japan and the U.S., among the OECD member countries.

Table 38. Faroe Islands and Greenland. Value of Exports and Percentage of Total Exports of Fish and Fish Products of OECD member countries, 1970-77.

Year	Exports (1)			
	Faroe Islands		Greenland	
	Value (U.S. million dollars)	Percent of Total OECO Countries Exports (%)	Value (U.S. million dollars)	Percent of Total OECO Countries Exports (%)
1970	32.9	1.94	11.0	0.65
1971	43.2	0.02	--	--
1972	50.9	1.82	8.2	0.29
1973	69.5	0.02	22.3	0.53
1974	--	--	34.5	0.88
1975	--	--	31.0	0.88
1976	--	--	34.5	0.76
1977	--	--	40.3	0.74

(1) This symbol -- stands for none.

SOURCE: OECO, Review of Fisheries (1970-1977).

This is true because of the size of the U.K. population compared with other large fishery supplying countries,[26] coupled with the importance of fish in the British diet. An important factor in the U.K. is the "fish and chips" outlet -- specialized retail shops which deal, wholly or mainly, with fish. These retail shops constitute one of the major buyers of frozen groundfish blocks and are responsible for a significant portion of the whitefish distributed in Britain at retail.

Considering the yearly average of total British landings from 1970-1977, 950.8 thousand metric tons, it can be seen that these catches originated mainly from groundfish species, predominantly cod. Herring and sprat, among the pelagic species, are next in importance, on a volume basis (Table 39).

Like Denmark, the disposition of British catches is oriented mainly towards fresh and chilled production due to the geographical proximity of Britain's fishing grounds to the consumer markets (Table 40). However, the fish industry has been increasing the proportion of frozen production at the expense of the fresh-chilled form. As shown in Table 40, frozen fish production increased from a level of 281.3 thousand metric tons in 1970, to 336.6 thousand metric tons in 1977, a 54 percent increase. The fresh-chilled form registered a drop in its production of about 47 percent in the same period. This shift in the British production can be attributed to rising interest in less expensive frozen fish at the retail level, and by the promotion activities of the "Whitefish Authority,"[27] to increase fish consumption in the U.K. Of less importance is the British production of cured and canned fish

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[26] In 1977, Iceland's population was estimated to be 0.22 million inhabitants; Denmark's 5.09 million; Norway's 4.04 million, while the U.K. registered about 55.85 million inhabitants.

[27] The "Whitefish Authority" founded in 1951, is a semi-public body responsible for the organization, development and regulation of the whitefish industry in the United Kingdom.

Table 39. United Kingdom. Total Landings by Species, 1970-1977

Year	Cod	Haddock	Pollock	Other Groundfish (1)	Herring and Sprat	Shellfish (2)	Other	Total Catches
	Quantity (thousand metric tons)							
1970	345.2	176.3	44.2	165.3	181.9	56.4	5.7	975.0
1971	305.9	181.3	53.3	174.6	197.9	54.5	8.1	975.6
1972	301.8	156.6	47.5	166.7	211.5	59.3	11.4	954.8
1973	273.7	149.5	56.4	183.2	254.3	70.9	25.3	1013.3
1974	267.6	126.2	44.3	202.4	232.0	63.7	33.5	969.7
1975	242.4	112.5	34.8	189.4	171.5	67.2	51.1	868.9
1976	211.6	125.8	39.9	148.5	178.3	82.0	146.6	932.7
1977	147.5	122.6	35.4	154.6	139.8	77.6	238.8	916.3
Average	261.0	143.8	44.5	173.1	195.9	66.4	65.1	950.8

(1) Dogfish, Sole , Plaice, Ocean Perch, Skate, Whiting and other demersal fish

(2) Molluscus and Crustaceans.

SOURCE: OECD. Review of Fisheries (1970-77)

Table 40. United Kingdom. Disposition of the Catches by Product Form. 1970-1977.

Year	Fresh/ Chilled	Frozen	Cured (1)	Canned	Reduction (2)	Other Purposes	Total (3)
	Disposition of Catch (thousand metric tons)						
1970	690.5	281.3	32.2	14.5	48.7	16.8	1084.0
1971	683.1	258.3	39.8	16.4	76.5	16.2	1090.3
1972	617.5	283.6	36.9	12.0	112.8	10.6	1073.4
1973	622.3	316.5	78.1	7.2	140.2	5.4	1169.7
1974	412.2	297.0	113.7	5.0	138.8	9.9	976.6
1975	387.2	264.6	83.9	8.7	113.8	13.2	871.4
1976	421.4	291.6	51.8	8.0	152.6	8.9	934.3
1977	364.7	336.6	29.8	6.1	170.5	10.3	918.0

(1) Includes salted, dried and smoked fish

(2) Includes fish meal and oil

(3) These figures include allowances for Salmon and Trout landings.

SOURCE: OECO. Review of Fisheries (1970-77) for human consumption and fish meal and oil for non-human consumption (Table 40).

Considering the allocation of Britain's import values by product form, during the 1970-77 period, the most significant contribution to this total value was made by the prepared-preserved fish and frozen fish both destined for human consumption (Table 41). Other appreciable portions of the U.K. imports were captured by fish meal and oil for non-human consumption. Their percentage varied from 33 to 42 percent in this period, which was higher than that achieved by preserved or frozen fish products (Table 41). Of reduced importance are the imports of fresh fish since the bulk of the domestic catch is already allocated in this form, as demonstrated before in Table 40.

Information is not available (data series) about the exact composition of the U.K.'s frozen fish imports by product form. However, it is known that cod and haddock blocks and fillets are usually the major components of frozen fish imports, according to OECD, Market for Frozen Fish (1966). Data on U.K. import values of fishery products for human consumption, in 1979, also indicate that the cod species is the most important single component of fresh, chilled and frozen products (Table 42). Data also indicates that the U.K. is seriously competing with the U.S. for the same sources of supply. That is, in terms of value, U.K. imports of frozen products originated especially from Norway, Iceland, Denmark and Canada, as shown in Table 43, for the year 1979.

Table 41. United Kingdom. Total Fishery Import Value Distributed by Product Form, 1970-1977.

Year	Percentage of Import Value (%)						Total Value (million pounds Sterling)
	Fresh	Frozen	Semi-Preserved	Prepared and Preserved	Shellfish Preparation	Reduction into fish meal and oil	
1970	5.20	15.54	0.79	25.09	11.46	41.92	126.7
1971	5.52	15.33	0.57	30.30	11.30	36.98	126.8
1972	6.20	15.95	0.47	31.46	12.64	33.28	139.7
1973	5.37	17.42	0.31	26.44	11.99	38.47	187.9
1974	6.62	18.95	0.48	24.03	13.50	36.42	188.9
1975	6.13	21.05	0.35	28.43	14.36	29.68	200.5
1976	4.56	22.67	0.42	25.99	12.66	33.70	282.8
1977	6.55	23.34	0.66	22.36	12.35	34.74	317.5

SOURCE: OECD. Review of Fisheries (1970-77)

Table 42. United Kingdom. Imports of Fresh, Chilled and Frozen Fishery Products by Species, 1979.

Product Form	Imports	
	Value (thousand pounds Sterling)	Percent (%)
Fresh, Chilled or Frozen except Fillets:		
Cod	32939	37.21
Plaice	10993	12.42
Other species	44585	50.37
Sub-total	88517	100.00
Fresh, Chilled or Frozen Fillets:		
Cod	67079	74.18
Haddock	12624	13.96
Other Species	10725	11.86
Sub-total	90428	100.00
Total Imports	321212	

SOURCE: White Fish Authority. European Supplies Bulletin (March 1980)

Table 43. United Kingdom. Imports of Fresh, Chilled and Frozen Fishery Products by Country of Origin, 1979.

Product Form by Country of Origin	Imports	
	Value (thousand pounds Sterling)	Percent (%)
Fresh or Chilled:		
Netherlands	17 840	33.84
Iceland	11 499	21.81
Denmark	9 910	18.79
Other Countries	13 476	25.56
Sub-total	52 725	100.00
Frozen:		
Norway	45 364	28.72
Iceland	20 788	13.16
Denmark	9 519	6.03
Canada	5 754	3.64
Other countries	76 508	48.44
Sub-total	157 933	100.00

SOURCE: White Fish Authority. European Supplies Bulletin (March,1980).

Seasonal Components

Previous studies suggest that a seasonal pattern exists in the consumption of fish products. Therefore, it is expected that a seasonal component may be present in the apparent disappearance and production of frozen blocks. This needs to be considered in the present study. Having this hypothesis in mind, an index accounting for the seasonal variation in the main variables was constructed for the period 1964-1978, in order to evaluate the magnitude of their shifts and to help in defining, empirically, the appropriate time interval to be used in this analysis.

Demand Side

As shown in Figure 1, the existence of a well-defined seasonal pattern is observed in the monthly averages of import volumes and prices of blocks, first-of-the month cold storage holdings of blocks, and apparent disappearance for the 1964-78 period in the U.S. markets[28].

In a "typical" year, U.S. imports of blocks increase from February to August, dropping thereafter until February of the next year. The blocks inventory build-up for the year begins in May and ends in October. The apparent disappearance of blocks reaches its highest level in March, decreases until July, when it is at the lowest level, and increases again thereafter (Figure 1).

From this observed seasonal pattern, one can infer the important role played by blocks inventories in adjusting imports to disappearance. As a matter of fact, the seasonal indices of the U.S. domestic disappearance of blocks and of imports move in opposite directions, except for the first quarter of the year. When imports sharply increase in the second quarter, the disappearance indices decline. In the third period, the former reaches its maximum, while the latter reaches its

[28]As discussed earlier, the term "apparent disappearance" is defined by the sum of total supply (domestic production plus imports), net of cold storage holdings (beginning inventories minus ending inventories). The index is constructed here by computing the monthly percentages of each year's average value and averaging these percentages for each month of the year.

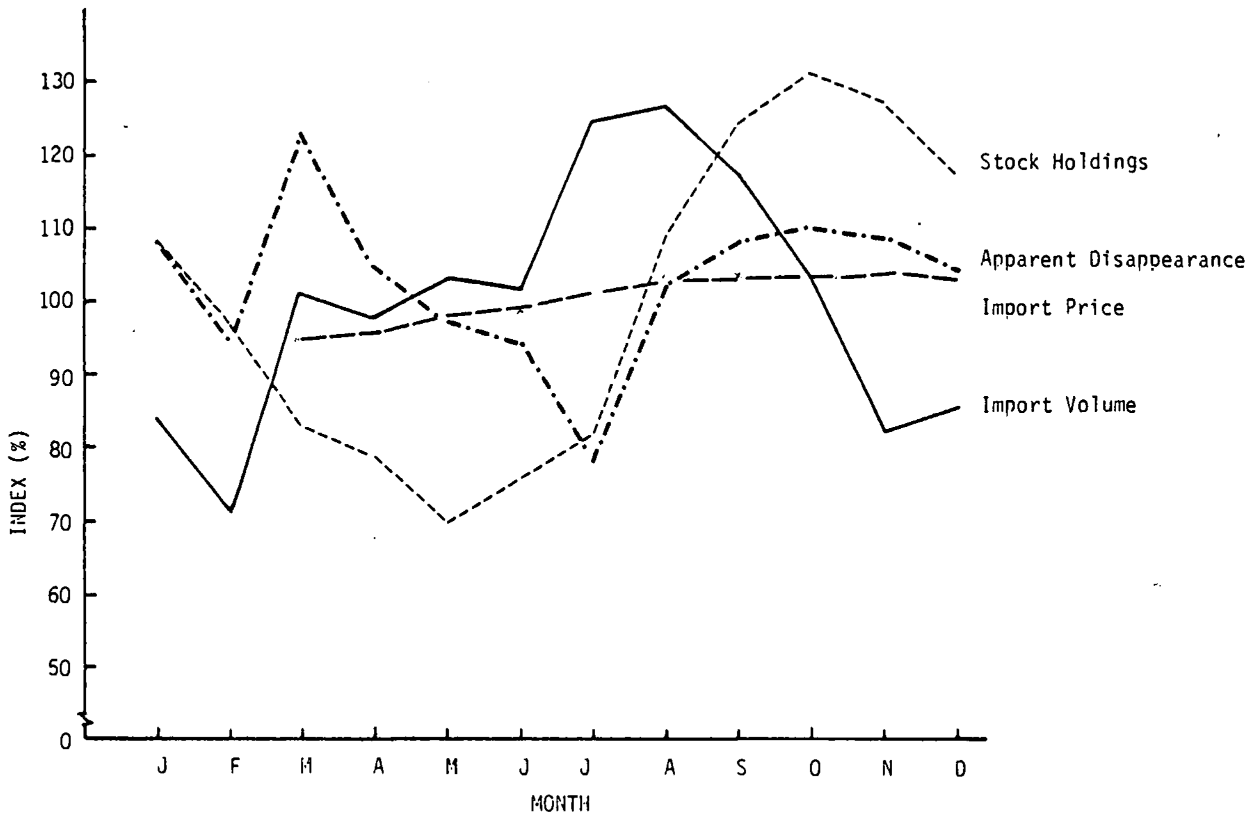

Figure 1. U.S. Groundfish Frozen Blocks - Seasonal Variation in Import Volume, Apparent Disappearance, First-of-the-month Cold Storage Holdings, Weighted Import Price, Monthly Average, 1964-1978.

Source: U.S. Department of Commerce. U.S. Imports (1964-78).
U.S. Department of Commerce. Fisheries Statistics of the U.S. (1964-77)
U.S. Department of Commerce. Frozen Fishery Products (1977-78).
U.S. Department of Commerce. Food Fish Market Review (1964-78).

minimum level, as shown in Figure 1. As a consequence, the cold storage holdings of blocks begin to increase in May, when disappearance levels are lower than import levels.[29] There is an inventory build-up in May, shortly after the intersection of the indices of disappearance and imports, when the former is decreasing and the latter is increasing. The inventory depletion starts in October, when the apparent disappearance index again intersects the import index, and begins to decrease at a slower rate than imports.

Therefore, cold storage adjustments result in the existence of an inverse relationship between inventories and imports of blocks, during the calendar year. The import quantity tends to increase when inventories are at low levels and vice-versa. Also, as a consequence of the inventory adjustments, prices of imported blocks are relatively stable during the seasons of the year. Prices are almost constant and,therefore,close to the year's average price for the 1964-78 period. The only price movement is an increase from the beginning to the end of the year. In the first two quarters, the prices of imported blocks are lower than the average and during the second half it is higher. This increase can probably be explained by the pressures of inventories replenishment in the second half of the year and/or for upward shifts in the seasonal demand, coupled with an inflationary increase in prices over time.

The seasonal behavior of apparent disappearance of blocks---the input---is ultimately related to the seasonal changes in the production and demand of sticks and portions---the output---, given some lag. If one compares Figures 1 and 2, this association can be demonstrated. When the index of blocks disappearance is falling from March to July, the index of sticks and portions production is also decreasing. Both indices reach their maximum levels in October and their minimum levels in July. In turn, the seasonal pattern in the production of sticks and portions is determined by the seasonal behavior in the consumption of

[29]This relation hold true since, by definition, the disappearance is equal to the sum of imports and domestic production, net of inventories changes, as mentioned earlier.

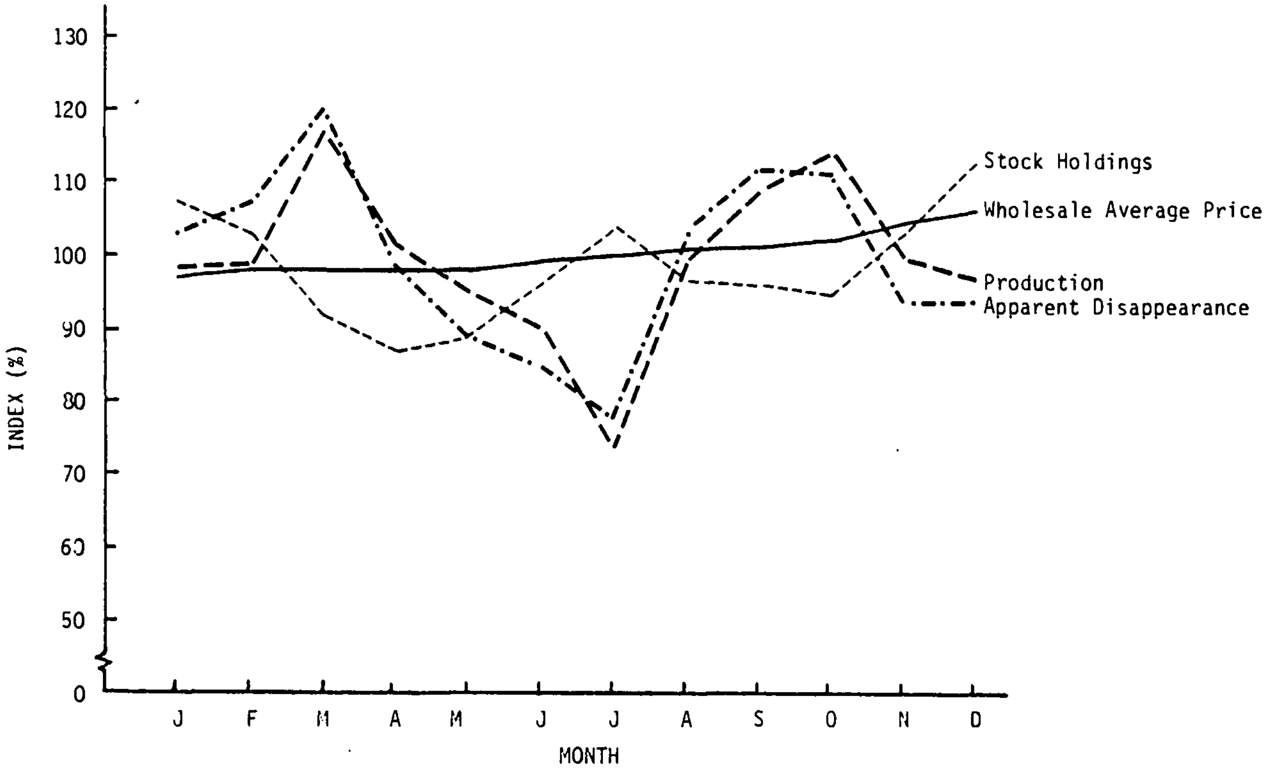

Figure 2. U.S. Groundfish Sticks and Portions - Seasonal Variation in Production, Apparent Disappearance, First-of-the-month Cold Storage Holdings, Weighted Wholesale Prices, Monthly Average 1964-78.

Source: U.S. Department of Commerce. <u>Food Fish Market Review</u> (1964-78)
U.S. Department of Commerce. <u>Fisheries Statistics of the U.S.</u> (1964-77).
U.S. Department of Commerce. <u>Frozen Fishery Products</u> (1977-78).

sticks and portions with a short lag, obtainable by holding inventories (Figure 2).

The index of production of sticks and portions (not necessarily the actual levels) is higher than the index of apparent consumption of sticks and portions, when both indices are decreasing from March to July. The inventory index begins to increase in April. When this inventory index reaches its highest level in July, the indices of apparent consumption and production of sticks and portions are at their lowest level. From July to October, the inventories begin to be depleted, when the index of consumption of sticks and portions is now exceeding the index of production of these products (Figure 2). This pattern is likely to be related to the shorter period of time that sticks and portions can be stored, compared to blocks. For blocks, the imports and disappearance indices move in opposite directions and inventory of blocks are of fundamental importance in adjusting supplies to quantities demanded. For sticks and portions, the index of production follows closely the index of the apparent consumption and inventory of these final products can be looked on as residual. The inverse relationship between inventories and production holds for the sticks and portions market; i.e., low inventory levels correspond to high production levels and vice-versa.

In summary, due to the direct and close association of the seasonal production and consumption of sticks and portions, the seasonal disappearance of blocks is, ultimately, a consequence of the seasonal consumption of sticks and portions in the U.S. markets. In contrast, the seasonality in U.S. imports of blocks may be correlated with production of blocks and groundfish landings in the supplying countries. This aspect will be discussed later in this chapter.

As discussed earlier, there are studies that identified seasonal shifts in fish consumption and explained those shifts as originating from religious reasons, such as the Lenten period, which corresponds usually to the months of February to April for any given year. Other studies verified a downward shift in prices in the late Spring, and early summer for groundfish species. A similar seasonal pattern was also here observed in the consumption of sticks and portions. However, an upward shift in the consumption of these fish products in the third quarter as portrayed for sticks and portions has apparently not been uncovered before in the literature, except by Newton (1972) and Bockstael (1976).[30] Actually, sticks and portions, as opposed to U.S. domestic fresh groundfish fillets and frozen fillets (the product form on which most earlier studies were based), are a highly processed fish product and they have apparent diverse market characteristics. Besides being a product that utilizes almost exclusively imported raw materials--the blocks--, the sticks and portions are sold in the institutional markets, especially the school-lunch program, more than any other fish product. Newton (1972), based on data obtained from interviews with processors, indicated:"...the purchases of fish portions for the school-lunch program are estimated to be at least 50 percent of total annual production" (pp. 9). Also Bockstael (1976) mentioned that 90 percent of the production of portions and 20 percent of the stick production is distributed to institutional buyers (school-lunch, cafeterias, hospitals, quick-service restaurants, etc...i.e. buyers other than retail stores), while 50 percent of fillets production is allocated to this market (pp. 77).

As a corollary effect, large-scale production of sticks and portions becomes another characteristic that might differentiate the utilization patterns of blocks from those of other seafoods destined to be used in smaller-scale production processes. Newton (1972) also mentions that production of sticks and portions is concentrated in the hands of a small number of processing firms,[31] facing relatively large-scale institutional buyers. In addition, market operations are carried out on a contract basis between the institutional buyer and the processor.

Supported by these characteristics, it could be hypothesized that one of the reasons that the apparent consumption of sticks and portions and the disappearance of blocks decreases in the spring and summer months, (reaching its minimum level in July) is the drop in the purchases

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[30]Newton (1972) discussed and showed graphically this upward shift and Bockstael (1976) included in her model seasonal "dummy" variables accounting for the quarters of the year.

[31]In 1969, Newton (1972) indicated that 23 firms owned by 7 organizations were responsible for 97 percent of the total production of sticks and portions (pp. 20).

by the school lunch program in the summer vacation months. For the same reasons, the upward shift in the quantities of sticks and portions demanded during the third quarter, just before the school year begins, can be justified. Also, some problems of perishability may be present in the storage of these products at summer temperatures as opposed to temperatures during the fall season.

The increase in apparent consumption of sticks and portions in the first quarter may be explained as a Lenten period phenomenon. However, it is difficult to be sure of this effect on the sticks and portions markets at a national level. The previous studies referred only to the New England area, where Roman Catholics are more concentrated than in any other part of the U.S.. Sticks and portions, despite their production being concentrated in New England plants, are distributed nationwide. Therefore, it is not clear that the increase in the consumption of sticks and portions in the first quarter is a direct effect of Lent.

Supply Side

While the seasonal patterns of the disappearance of blocks might be related to seasonal patterns in the consumption of sticks and portions in the U.S. markets, it is possible to associate increases in U.S. imports of blocks during the second and third quarters with landing patterns of groundfish in the block supplying countries.

Considering the quarterly variation in Canadian groundfish landings (averaged data for the 1964-1978 period), one can observe that it is in the third quarter that the seasonal index of this variable reaches its maximum level, dropping until the end of the first quarter of the following year (Figure 3). This seasonal behavior of Canadian landings coincides with the variation in U.S. imports of blocks, graphically represented in Figure 1. This is reasonable to expect, since Canada is a large supplier of blocks to the U.S. and Canadian production of blocks has the same seasonal variation as do their landings. As shown in Figure 3, the Canadian block industry builds its own inventories during periods of increased groundfish landings and production of blocks. A positive seasonal relationship emerges between exports and inventories, supported by the seasonal variation in groundfish landings in Canada.

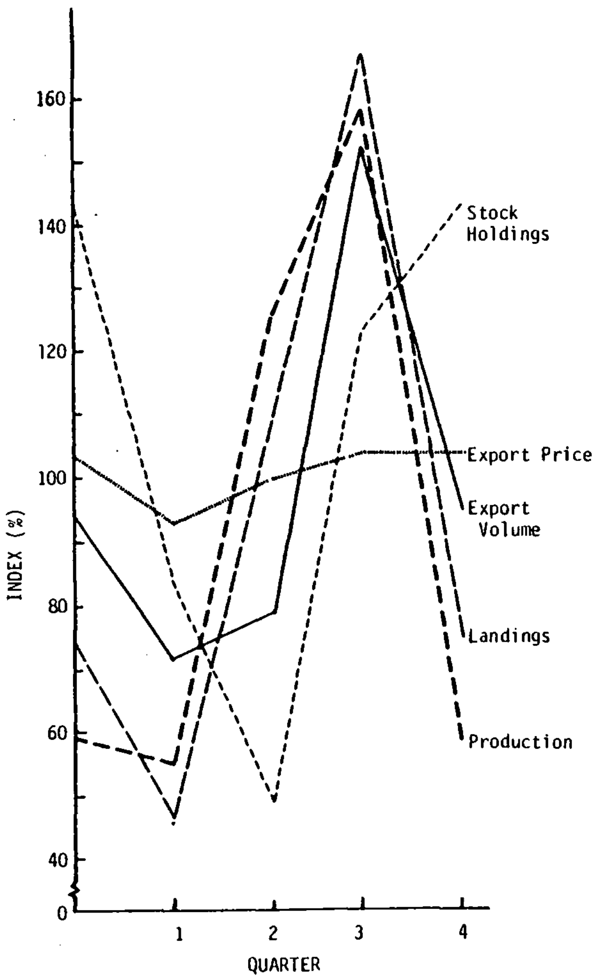

Figure 3. Canadian Frozen Groundfish Blocks. Seasonal Variation of Production, Total Groundfish Landings, First-of-the-Month Storage Holdings, Export Volumes, Weighted Export Prices, Quarterly Average, 1964-1978.

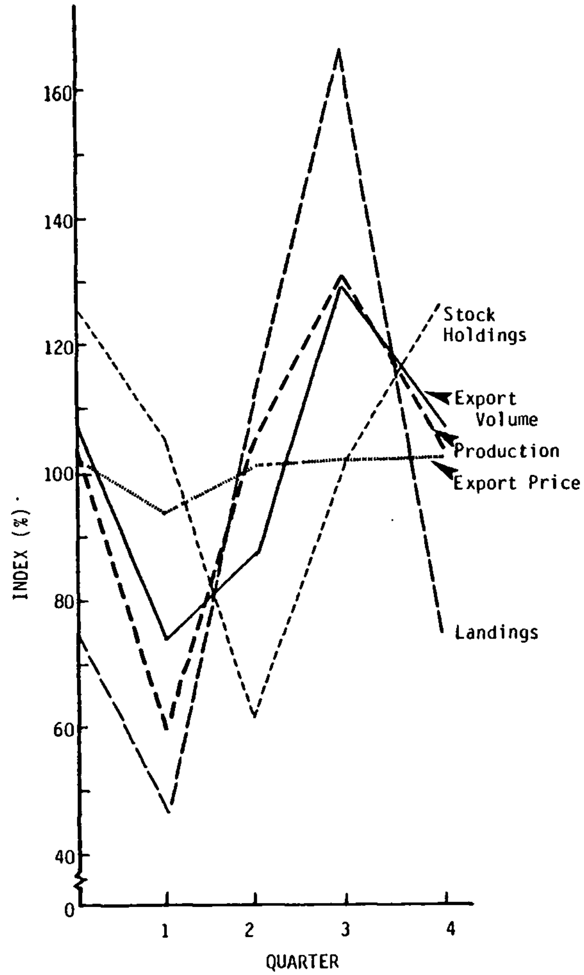

Figure 4. Canadian Frozen Groundfish Fillets. Seasonal Variation of Production, Total Groundfish Landings, First-of-the-month Cold Storage Holdings, Export Volumes, Weighted Export Prices, Quarterly Average, 1964-1978.

Source for Figures 3 and 4:

Canada. Statistics Canada. Trade of Canada (1964-78).
Canada. Statistics Canada. Monthly Review of Canadian Fisheries Statistics (1964-78).
Canada. Statistics Canada. Fish Freezings and Stocks (1964-78).

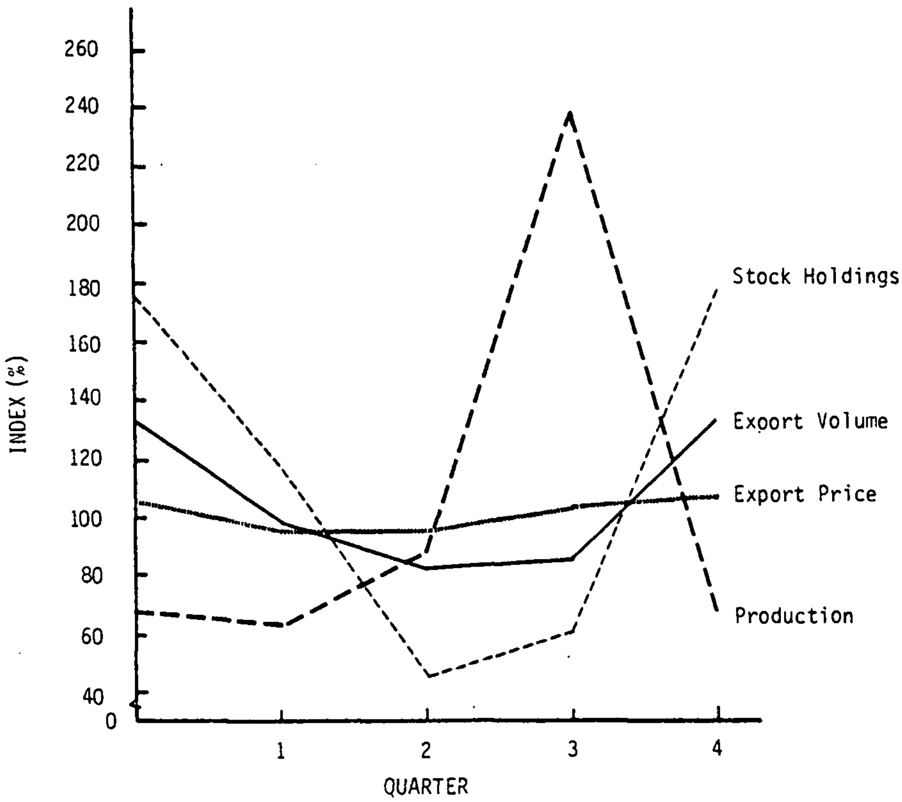

Figure 5. Canadian Salted Groundfish. Seasonal Variation of Production, First-of-the-month Cold Storage Holdings, Export Volumes, Weighted Export Prices, Quarterly, Average, 1964-1978.

Source: Canada. Statistics Canada. Trade of Canada (1964-78). Canada. Statistics Canada. Monthly Review of Canadian Fisheries Statistics (1964-78).

Frozen groundfish fillets---an alternative use for Canada's groundfish---show seasonal patterns in production, inventory and export levels similar to those for blocks (Figure 4). The average indices for the period 1964-1978 for exports and production of frozen fillets rise from the end of the first to the end of the third quarter, when the indices reach their peak, coinciding with the maximum landings levels of groundfish in Canada. Also, the index of first-of-the-month inventory levels is at a minimum at the end of the second quarter, rising until the end of the fourth quarter. The same positive relationship between Canada's frozen fillet exports and inventories is shown here.

Export prices for both frozen fillets and blocks register little seasonal variation around the yearly average, represented by the index number 100 (Figures 3 and 4). These export price indices in Canada are below the year's average during the first two quarters and higher in the subsequent quarters of the year. This pattern is similar to that observed earlier for U.S. import prices of blocks.

The indices for salted groundfish production, exports and inventories, averaged for the 1964-1978 period, differ from those for frozen groundfish products (Figure 5). As for blocks and fillets, salted production is at its maximum at the end of the third quarter, when there is a peak in groundfish landings. However, unlike blocks and fillets, the salted groundfish export volume index reaches its highest level in the fourth quarter, as do inventories. The variation indicates that there is a larger lag period between production and exports for salted products in Canada than is the case for frozen products. Probably, this can be explained by the relative ease with which salted fish can be stored (i.e., freezer facilities are not required),their smaller cost of storage when compared to frozen products and/or different seasonal demand patterns in the major importing countries (i.e. Spain, Portugal, and Central and South America countries as mentioned earlier).

Data are not available to examine in such detail seasonal patterns in the Norwegian, Icelandic, Danish and the U.K. groundfish markets.

However, scattered data on cod landings, the major species utilized in the production of blocks, have been located for Iceland, Norway and Denmark for several years. As shown in Figure 6, the Iceland, Norwegian and Danish Atlantic cod landings are concentrated basically

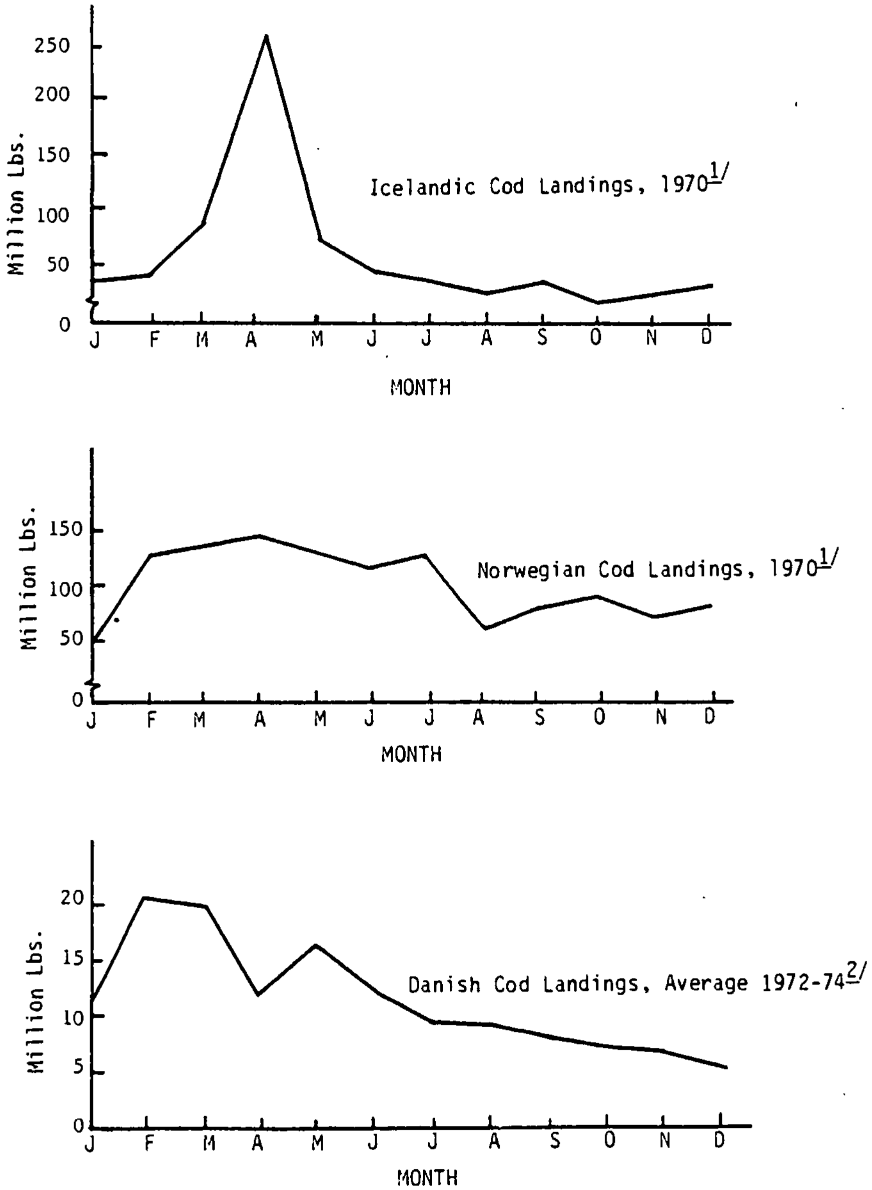

Figure 6. Cod Landings by Month in Iceland, Norway, and Denmark, 1970, 1972 and 1974.

Source: [1]U.S. Department of Commerce. Food Fish Market Review (1971).
[2]Denmark. Fiskeriministeriet. Fiskeriberetning Aret (1972-74).

in the first two quarters of the year. Iceland's landings take place in the second quarter of the year, especially in April. Denmark's landings peak in the first quarter, especially in February. Both Iceland and Denmark have a well-defined concentration of their catches in this first half of the year. In contrast, Norway's landings of cod are more evenly distributed over the year but, as with Iceland and Denmark, they are concentrated in the first two quarters of the year.

A possible reason why Canadian landings have different seasonal patterns than do other exporting countries is that the Canadian fleet tends to concentrate its fishing activity in a different area in the North Atlantic than do Iceland, Norway or Denmark. According to F.A.O. fishery statistics, the Canadian cod catch originates mainly from region 21 near the Canadian coast, while the other countries catches came from the fishing area 27.[32]

Further relevant information on inventories, trade flows, consumption and export-import prices for groundfish blocks on a seasonal basis was not available.

Based on previous studies and on the seasonal patterns uncovered by the available data, a quarter (three month period) was deemed the time interval most satisfactory for grouping the data in the present study. Not only is the quarter expected to be a time interval sufficiently long to avoid possible econometric problems, such as serial correlation, but it is also short enough to capture the main seasonal patterns uncovered by the foregoing discussion.

Cyclical Components

Besides the seasonal components, it was judged of interest to investigate the longer-term cyclical nature of export-import prices for groundfish blocks and related fish products, since such a slight seasonal variation was shown for these prices. It is hypothesized that some

[32] For statistical purposes, the area 21 includes the waters between the North America coast and the longitude 42°W, above the latitude 35°N. The area 27 is adjacent to area 21 and includes the waters between European countries and the longitude 42°W, above the latitude 36°N.

significant shift may be occurring over time that needs to be taken into consideration.

The U.S. and Canada are the only countries for which it has been possible to obtain specific import and export prices for frozen groundfish blocks for the 1964-1978 period. It is assumed that the general patterns of Canadian export prices and U.S. import prices can be extrapolated to other countries' price trends, considering the importance of those two countries in international trade of groundfish blocks.

The quarterly weighted average F.O.B.-prices of groundfish frozen blocks and fillets imported by the U.S.[33] and the U.S. weighted average wholesale prices for sticks and portions[34] are plotted in Figure 7. By this graph, one can define two distinct periods between the years 1964 and 1978: the first period falls before 1973 and the second period afterwards. From 1964 to the end of 1972, prices were relatively stable although in 1969 a relative mild upward pressure on prices began to manifest itself. However, during the year of 1973, the prices began to vary more erratically; i.e., following a short downward turn from 1974 to 1976, these prices increased even more rapidly than before.

Another observed phenomenon is that wholesale prices of sticks and portions were higher than the blocks and fillets import prices over this period, except for a short interval in the first two quarters of 1976. In turn, U.S. import prices for blocks were at lower levels than the prices of the other products. In general, all of these prices of groundfish products followed a parallel trend in the U.S. markets (Figure 7).

Obeying a similar cyclical pattern are the quarterly weighted average F.O.B.-prices of frozen groundfish blocks and fillets exported

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[33]This price is defined as the quarterly value of all groundfish species imported divided by the volume of all groundfish species imported, irrespective of the port of origin. The value considered was the custom value defined by the U.S. imports statistics as "...market value in foreign country and therefore excludes U.S. imports duties, freight charges from foreign country to the U.S. and insurance." [U.S. Department of Commerce, U.S. Imports for Consumption]. Custom value was considered here, since it is the only value reported throughout the period of study.

[34]This U.S. weighted wholesale price is defined as the sum of the quoted quarterly average wholesale prices of sticks and portions multiplied by their respective quarterly production and divided by the total quarterly production of both products.

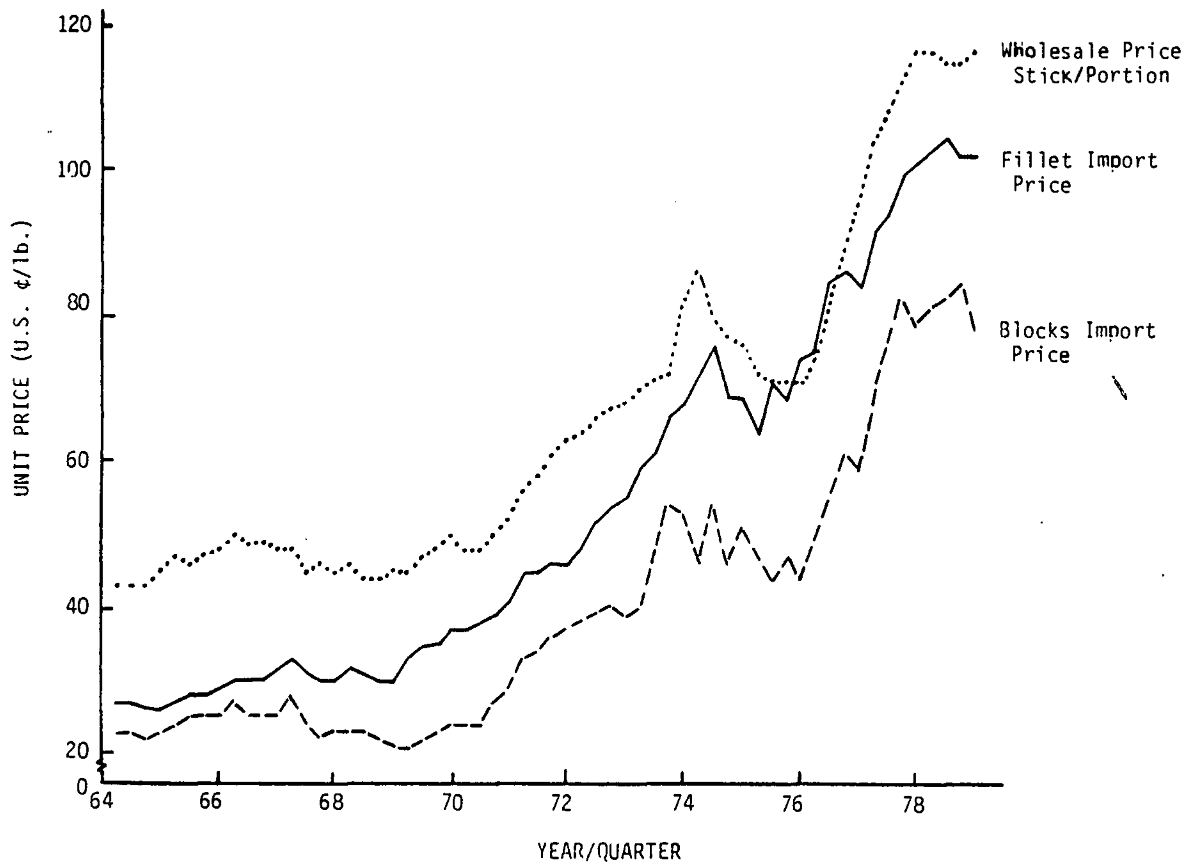

Figure 7. U.S. Frozen Groundfish Products. Weighted Import Prices of Frozen Blocks and Fillets, and Weighted Wholesale Prices of Sticks and Portions by Quarter, 1964-1978.

Source: U.S. Department of Commerce. Food Fish Market Review (1964-78).
U.S. Department of Commerce. U.S. Imports (1964-78).

by Canada.[35] They also suggest two distinct sub-periods: before and after 1973 (Figure 8). Before 1973, a more stable and more smooth behavior in prices is observed. After 1973, the prices began to increase in an somewhat erratic manner. Similar to U.S. prices, the export prices of blocks and frozen fillets in Canada presented a short downward shift between 1974 and 1976, increasing more sharply thereafter. Frozen fillet export prices in Canada were higher than those for blocks over the 1964-1978 period, except in the second quarter of 1977.

This parallelism between U.S. and Canadian prices of frozen groundfish products is easily explained, if one considers the interconnection between Canadian exports and U.S. imports of blocks. The price that U.S. buyers pay to Canadian exporters is equal to the price the latter received, adjusted by the exchange rate plus some "random error". These "errors" may result from differences in reporting periods in each country's statistics on trade and possible time lag discrepancies between them, differences between "official" and "actual" exchange rates, etc...

Furthermore, quarterly weighted average F.O.B.-prices of salted groundfish exported by Canada[36], plotted in Figure 9, also show a behavior similar to that for prices of exported frozen products. However, the observed downward shift between 1974 and 1976 was not seen in the salted groundfish prices, although, as with blocks and fillets, they sharply increased after 1973. Probably the diversity in consuming markets between frozen and salted groundfish, as pointed out earlier, could explain those small differences in price behavior.

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[35]This variable is defined as the quarterly value of all groundfish species exported divided by the volume of all groundfish species exported by Canada, irrespective of the port of destination. The value considered is defined by Statistics Canada as "...F.O.B.-place of lading, exclusive of inland freight, insurance, handling, etc..." [Canada, Statistics Canada, Trade of Canada].

[36]This price is defined as the quarterly value of all groundfish species exported salted divided by the corresponding volume exported, irrespective of the port of destination. The value considered here is the same as that defined earlier in discussing the Canadian export statistics.

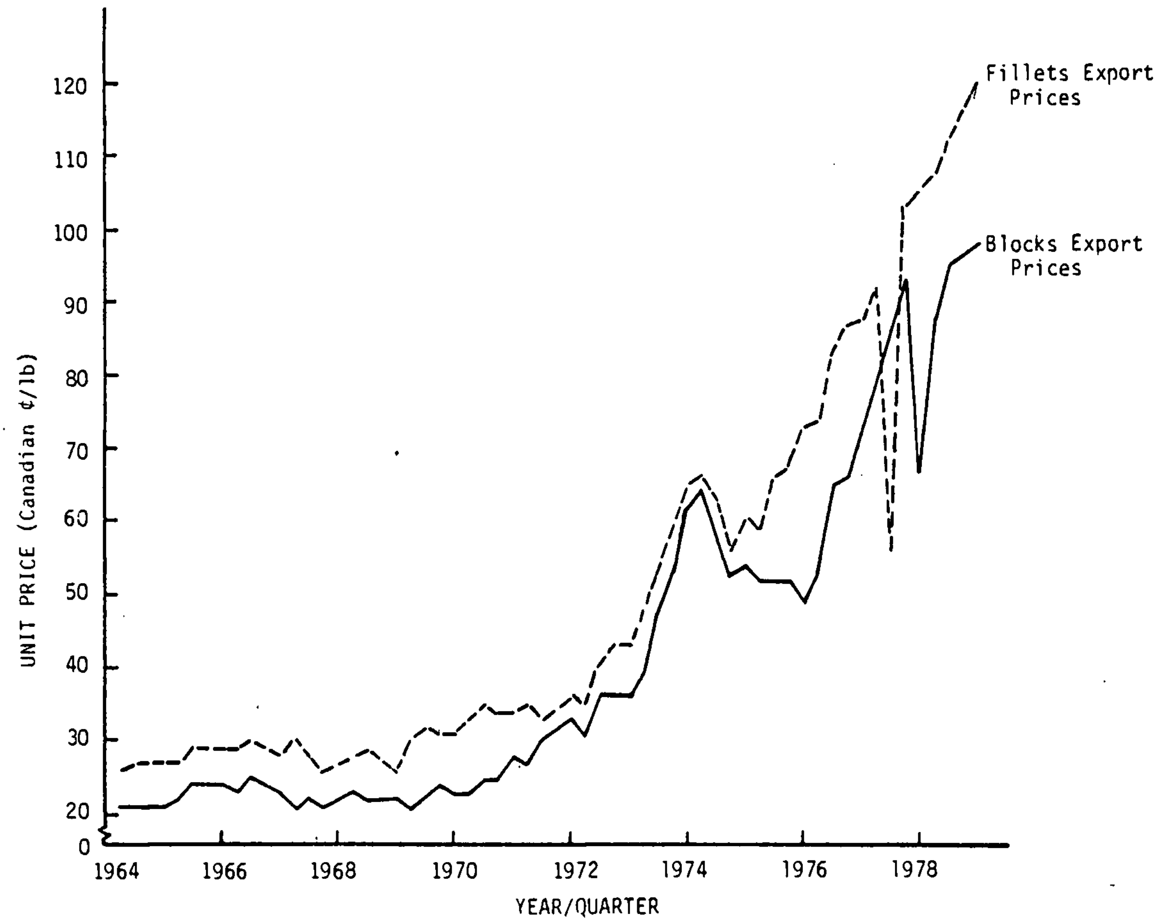

Figure 8. Canadian Frozen Groundfish Products. Weighted Export Prices of Frozen Blocks and Fillets by Quarter, 1964-1978.

Source: Canada. Statistics Canada. <u>Trade of Canada</u> (1964-78).

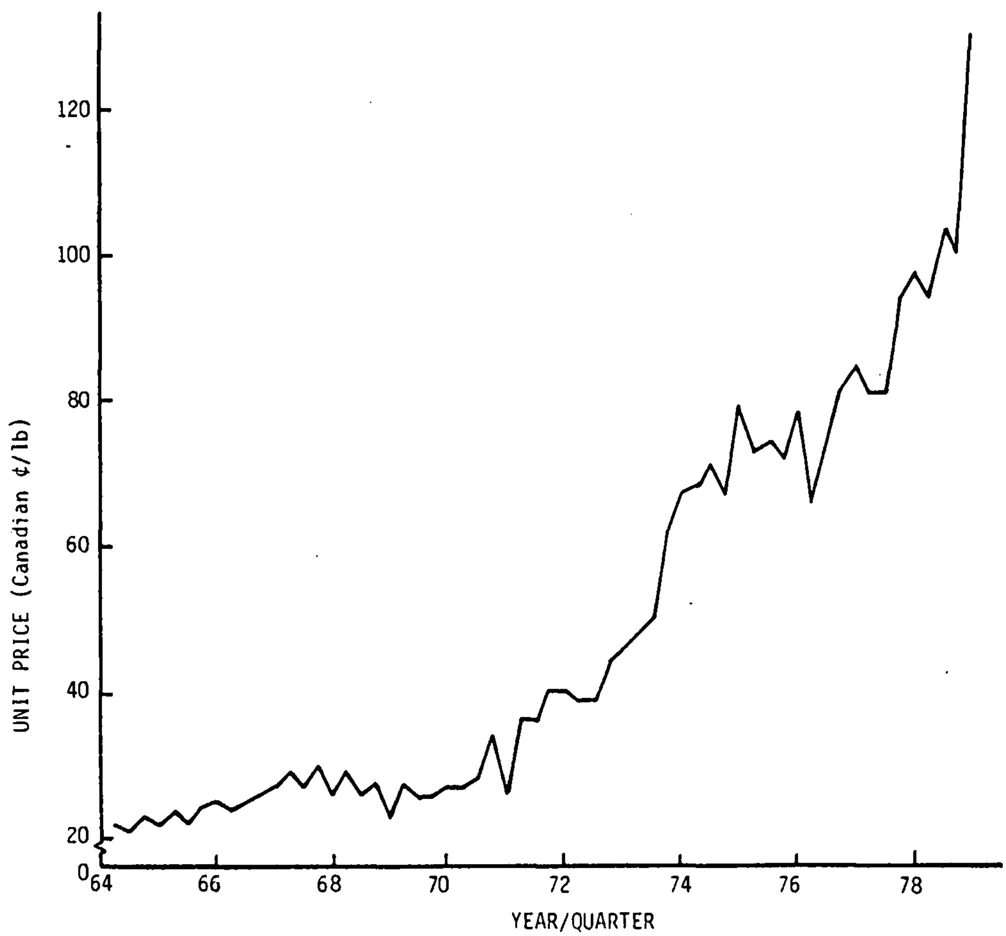

Figure 9. Canadian Salted Groundfish. Weighted Export Prices by Quarter, 1964-1978.

Source: Canada. Statistics Canada. <u>Trade of Canada</u> (1964-78).

The trend patterns that allow the division of this 1964-1978 period into two sub-periods---1964-1972 and 1973-1976---may be associated with: (a) the change in foreign policy adopted by the U.S. when a major devaluation of the U.S. dollar was carried out in 1973, resulting in more expensive imports and more competitive export prices abroad; this may have indirectly affected the groundfish markets; (b) the impact of the energy crises on international trade flows, generated by the oil embargo of OPEC countries in 1973 which induced further increases in fuel cost and freight rates; (c) the increased world competition for supplies of groundfish blocks, especially by the European markets, considering the admission of Denmark and the U.K. into the E.E.C.[37] Additional factors, such as dock strikes at U.S. ports and the dramatic decline in the anchovy seen in Peru, may also be associated with this upward pressure in prices of groundfish products.

The eventual downward price trend observed from 1974 to 1976 was too short to be considered as a separate sub-period. The depressed prices might well be related to a widespread abundance of cod and haddock landings during 1974 in the major harvesting and exporting countries.[38]

In addition, it can be shown that U.S. import prices of blocks by major supplying countries---Canada, Iceland, Norway, Denmark and other countries---varied almost together over the 1964-1978 period (Figure 10). A test of the hypothesis that these differences in U.S. import prices by country of origin were not statistically significant was not rejected, at the five percent level of confidence (Appendix 1). Thus, there

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[37] This admission implied the gradual elimination of trade barriers for these newcomer countries, encouraging, for example, the Danish exports of fish products to E.E.C. member countries. This may have increased the competition among the U.S. and other E.E.C. consuming countries such as the U.K., West Germany, France, etc.

[38] To relieve this downturn in prices, export subsidies on fillets and blocks of cod and pollock were provided by the E.E.C. producing countries [U.S. Department of Commerce, Food Fish Market Review and Outlook (November, 1975)].

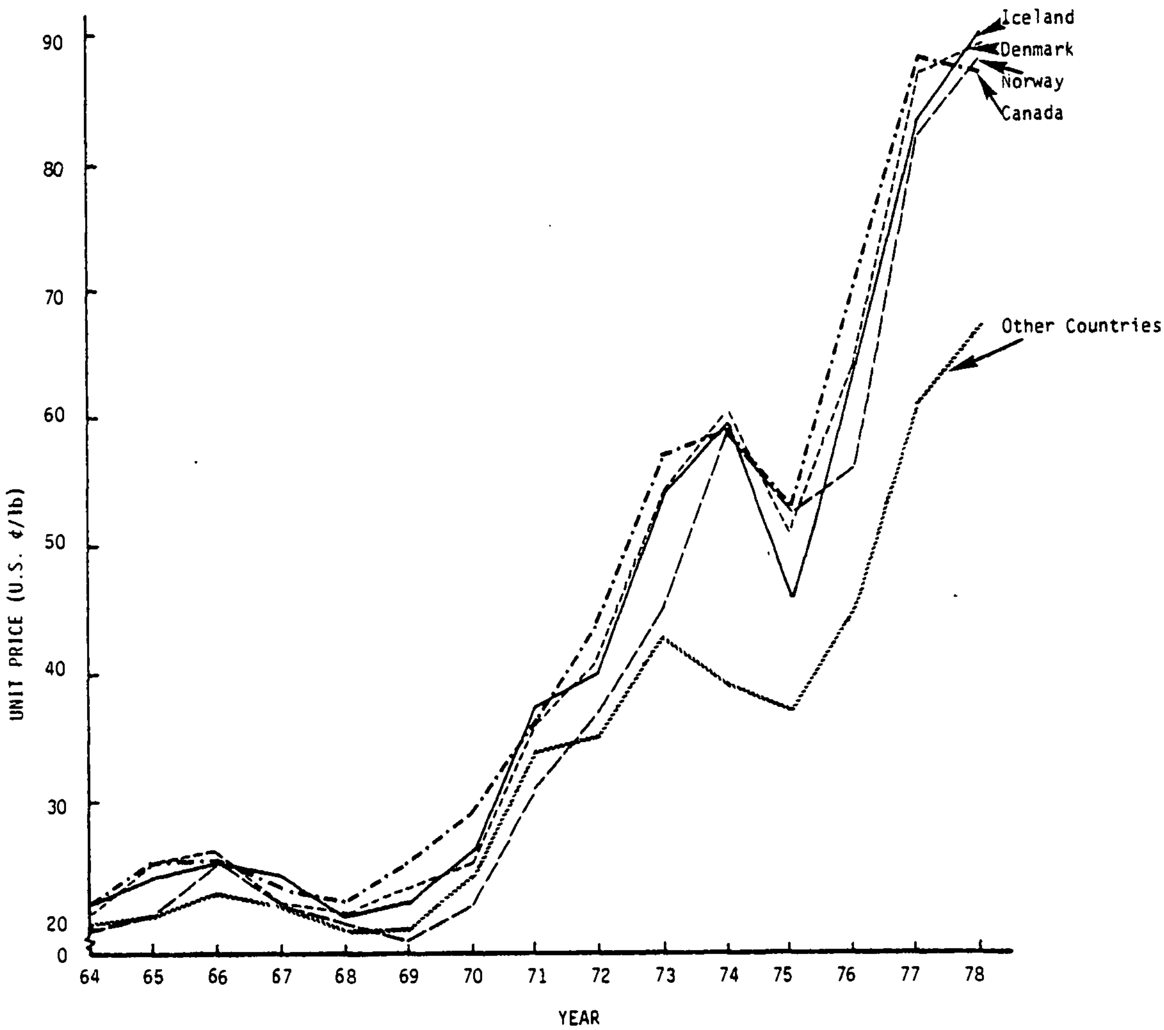

Figure 10. U.S. Import Prices of Frozen Groundfish Blocks by Major Country of Origin by Year (custom value), 1964-1978.

Source: U.S. Department of Commerce, U.S. Import for Consumption (1964-1978).
U.S. Department of Commerce, U.S. Imports (1964-78).

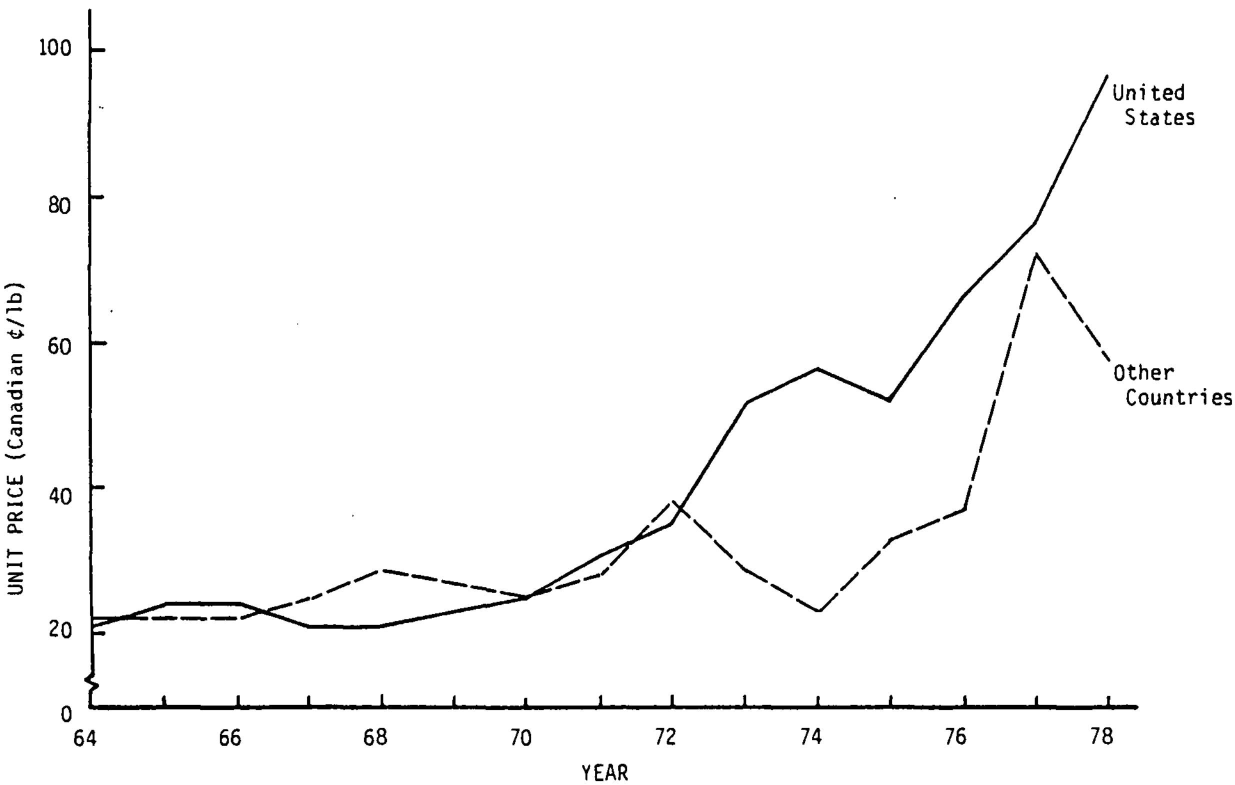

Figure 11. Canadian Export Price (based on export values at the Canada pier) of Frozen Groundfish Blocks by Country of Destination By Year, 1964-1978.

Source: Canada. Statistics Canada. Trade of Canada (1964-78).

is no reason to believe that prices paid by the U.S. for frozen blocks imported from Canada, Iceland, Norway, Denmark or other supplying countries are significantly different from each other.

Prices received by Canadian exporters of blocks from the U.S. and from other buyers are plotted in Figure 11. In this case, these export prices by port of destination did not parallel each other as strikingly, especially after 1972, when the unit export value paid by U.S. buyers was at a higher level than the average of those paid by other consuming countries. However, a test of the statistical difference between them indicated that there is not a significant difference between the average of these two series of export prices at the five percent level (Appendix 1). Nonetheless, it does appear that a shift occurred in 1973, suggesting again, that it is useful to treat the pre- and post-1973 periods as separate sub-periods.

Considering the conjunction of all of these observations it is concluded that a model dealing with international trade of frozen groundfish blocks needs to take into account: (a) the shift in the export-import prices pre- and post-1973; (b) the evidence of non-significant statistical differences among those export-import prices by port of destination or by port of origin.

IV. THE MODEL

Conceptual Model

Having defined the major supplying and consuming countries in the international markets for groundfish blocks and having discussed their main market characteristics, the next step is to delineate a conceptual model in which the conjunction of factors affecting the export supply and import demand of this product form can be represented and quantitatively evaluated.

However, as was pointed out before, available secondary data are sufficiently detailed for only the U.S. and Canada. This implies that to some extent data limitation place restrictions on the model used to satisfy the objectives of the present study. Monthly and quarterly data for a sufficiently long time series are obtainable only in specific national statistical publications. However, these publications for countries other than the U.S. and Canada are not readily available. Also, various international publications for fishing products (such as F.A.O., OECD, etc...) present some information of interest but in a very aggregate form that does not allow their use for the specific purposes of this study.

Therefore, a general model of international markets for frozen groundfish blocks is constructed in such a way that those limitations can be circumvented without excessive over-simplification and/or specification bias.

With this in mind, the first attempt to define a general model was basically to divide the market into two interrelated sectors:(a) the "supply" side; and (b) the "demand" side. From the descriptive and analytical material mentioned earlier, it appeared that the "demand" side of the international market for groundfish blocks could be further sub-divided into two specific areas:(a) the U.S., representing the major consuming country of frozen groundfish blocks traded internationally; (b) the "rest-of-the-world" (R.O.W.), representing all other remaining consuming countries of groundfish blocks, such as the U.K., West Germany and other importing countries. Also, the "supply" side of the international market could be sub-divided into two specific areas: (a) Canada, representing one of the major supplying countries of groundfish blocks; (b) the "rest-of-the-world" (R.O.W.), representing all other remaining suppliers of groundfish blocks on international markets, such as Iceland, Norway, Denmark, etc...

Using this approach a set of four hypothetical equations are defined and graphically presented in Figure 12. In this graph, the cartesian vertical axis represents the unit average export-import prices P, expressed in a common monetary currency. The horizontal axis represents the export-import volumes of groundfish blocks traded in the international markets, Q. Four curves are drawn, assuming all other factors, affecting demand and supply, remain constant over a given unit of time: (a) U.S. import demand, represented by D_{us}; (b) R.O.W. import demand, labelled D_{row}; (c) Canadian export supply, represented by S_c; and (d) R.O.W. export supply, identified as S_{row}.

From these relationships the total "world" supply (S_t) and the total "world" demand (D_t) are derived. As a consequence, the equilibrium "world" price ($\overline{P}_t$) and trade flows of frozen groundfish blocks ($\overline{Q}_t$) can be determined. By definition, total "world" supply, S_t, is obtained by adding horizontally the volumes exported by Canada and the volumes exported by R.O.W. supplying countries at given prices. Following a similar procedure, total "world" demand, D_t, corresponds to the horizontal sum of the quantities imported by the U.S. and the quantities imported by the R.O.W. consuming countries at given prices. The "world" equilibrium export-import price, $\overline{P}_t$, is reached when total "world" supply equals total "world" demand at $\overline{Q}_t$, the equilibrium flow of trade.

As a consequence, a set of four equilibrium trade quantities are determined, corresponding to points on demand and supply curves at $\overline{P}_t$, the equilibrium "world" price. That is, where $\overline{P}_t$ intersects the D_{us} curve, the equilibrium quantity of blocks--Q^D_{us}--that the U.S. market is willing to import is shown. Similarly, at the intersection of $\overline{P}_t$ with D_{row} curve, the equilibrium quantity--Q^D_{row}--is determined, indicating how many frozen blocks the R.O.W. is willing to import. The quantity corresponding to $\overline{P}_t$ on S_c curve is Q^S_c and shows how many frozen blocks Canadian exporters are willing to offer to international markets in

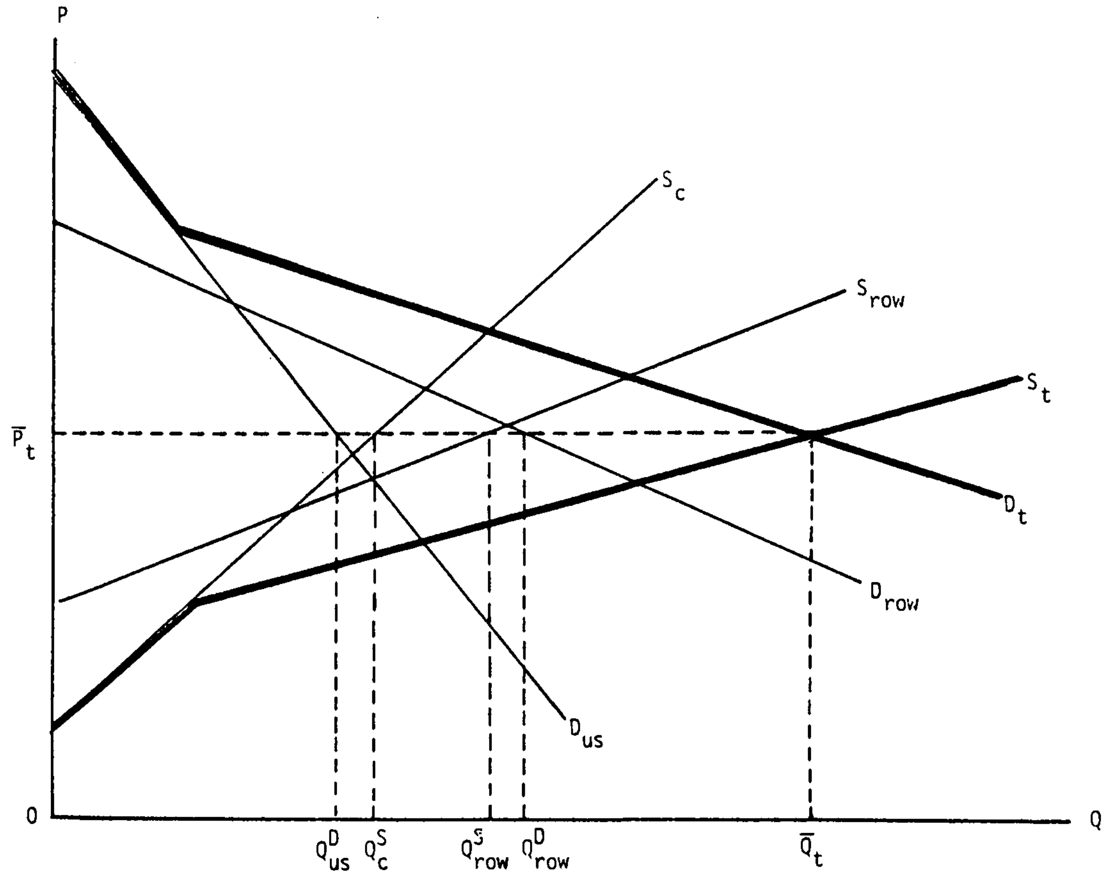

Figure 12. Hypothetical Representation of the Conceptual Model of International Market for Groundfish Blocks.

equilibrium. Finally, Q^S_{row} is reached at the value $\overline{P}_t$ on S_{row} (Figure 12).

Thus, the total "world" flow of trade for frozen blocks, $\overline{Q}_t$, corresponds to the sum of the equilibrium quantities imported by the U.S. (Q^D_{us}) and by the R.O.W. consuming countries (Q^D_{row}) at $\overline{P}_t$, the equilibrium price. Alternatively, this total "world" flow of trade, $\overline{Q}_t$, is also equal to the sum of the equilibrium volumes exported by Canada (Q^S_c) and by the R.O.W. supplying countries (Q^S_{row}) at $\overline{P}_t$. This is no more than the assertion that, in competitive equilibrium, the "world" quantity imported is equal to the "world" quantity exported of frozen blocks in the international market.

For ease of graphical presentation, price-quantity relationships are expressed in terms of a common unit of measurement. Each country's national currency was converted into a common currency by means of the appropriate exchange rate.[1]

Given the impossibility of determining quarterly trade flows for R.O.W. countries, as mentioned earlier, these figures may be indirectly estimated by using Canadian export and U.S. import data. That is, it is hypothesized that the R.O.W. import quantities of frozen blocks, Q^D_{row}, are approximately equal to the volume exported by Canada to all countries but the U.S. Using similar reasoning, the quarterly R.O.W. export quantities of frozen blocks, Q^S_{row}, are assumed to be approximately equal to the volume imported by the U.S. from all countries but Canada.[2]

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[1] The willingness of each country to pay or to receive is decided in relation to each country's own monetary currency. The transportation costs and related transfer costs are implicitly embedded in these price-quantity relationships.

[2] In view of this procedure it would be useful to indicate what percentage of total trade flows of frozen blocks are these figures are accounting for. However, the available data in international publications on trade of fish and fish products do not present the frozen fish items discriminated by either market form (blocks, fillets, etc..) and by species of groundfish.

Also, in the absence of specific quoted import or export prices for R.O.W. countries, estimates can be made based on the U.S. and Canadian statistics. Assuming a competitive "world" market for groundfish blocks, the procedure chosen to estimate such quarterly prices was to allow the prices received by the R.O.W. supplying countries to be represented by the quarterly unit price that the U.S. importers paid for their blocks imports, converted into R.O.W. currencies. In addition, the prices that R.O.W. consuming countries paid for their imports of frozen blocks are assumed to be equal to the quarterly unit price received by Canadian block exporters, converted into these R.O.W. consuming countries' currencies. The underlying assumption which supports such a procedure is the absence of statistically significant differences among the average prices of each country's export or import prices of frozen blocks, in accordance with the previous discussion in Chapter III.[3]

In addition, it is hypothesized that the relationship between the U.S. import prices and Canadian export prices of groundfish blocks can be represented by a behavioral equation instead of an identity. This is based on the evidence that U.S. prices of blocks (in U.S. dollars) are approximately equal to Canadian prices of blocks (in Canadian dollars), adjusted by exchange rate plus some "random error," as discussed in Chapter III. Using similar reasoning, the total "world" demand and the "world" supply relationship is expressed by a behavioral equation, since different sources of data are used to estimate these figures and, consequently, some "random error" may be present. Therefore, the choice of behavioral equations to represent the equilibrium "world" price and trade flow of groundfish blocks was to allow these "random errors" to be accounted for.

Given the simplifying assumptions of competitive determination of trade flows and prices, it became possible to express the conceptual model, algebraically, by a system of six behavioral equations and four identities, as follows:

[3]As it is shown in Appendix 1, there is no reason to believe that U.S. import prices paid to the supplying countries are, on the average, statistically different at the five percent level. In addition, the Canadian export prices received from all consuming countries but the U.S. are not statistically different, at the five percent level, from that received from the U.S. importer.

$$D_{us} : Q^D_{us} = f_1(P^D_{us}, x_1, \ldots. x_n, u_1) \quad (4.1)$$

$$S_c : Q^S_c = f_2(P^S_c, y_1, \ldots. y_n, u_2) \quad (4.2)$$

$$S_{row}: Q^S_{row} = f_3(P^S_{row} z_1, \ldots. z_n, u_3) \quad (4.3)$$

$$D_{row}: Q^D_{row} = f_4(P^D_{row} w_1, \ldots. w_n, u_4) \quad (4.4)$$

$$\overline{P}_t : P^D_{us} = f_5(P^S_c, u_5) \quad (4.5)$$

$$\overline{Q}_t : Q^D = f_6(Q^S, u_6) \quad (4.6)$$

$$\text{Identity 1: } P^S_{row} = (P^D_{us} \cdot e^{us}_{row}) \quad (4.7)$$

$$\text{Identity 2: } P^D_{row} = (P^S_c \cdot e^c_{row}) \quad (4.8)$$

$$\text{Identity 3: } Q^D = Q^S_{us} + Q^D_{row} \quad (4.9)$$

$$\text{Identity 4: } Q^S = Q^S_c + Q^S_{row} \quad (4.10)$$

where:

Q^D_{us} = U.S. total imports of groundfish blocks, in units of volume;

Q^S_c = Canadian total exports of groundfish blocks, in units of volume;

Q^S_{row} = R.O.W. exports of groundfish blocks, in units of volume;

Q^D_{row} = R.O.W. imports of groundfish blocks, in units of volume;

P^D_{us} = U.S. import unit price of groundfish blocks, all origins, in U.S. currency, custom value;

P^S_c = Canadian export unit price of groundfish blocks, all destinations, in Canadian currency, FOB-origin;

P^S_{row} = R.O.W. export unit price of groundfish blocks, in R.O.W. exporting countries currency;

P^D_{row} = R.O.W. import unit price of groundfish blocks, in R.O.W. importing countries currency;

$\overline{P}_t$ = "world" equilibrium price of groundfish blocks, in a common currency, say U.S. dollars;

$\overline{Q}_t$ = "world" equilibrium trade flow of groundfish blocks, in units of volume;

Q^D = "world" imports of groundfish blocks demanded, in units of volume;

Q^S = "world" exports of groundfish blocks supplied, in units of volume;

x_i = factors affecting U.S. volumes of groundfish blocks imported, i = 1...n;

y_i = factors affecting Canadian volumes of groundfish blocks exported, i = 1...n;

z_i = factors affecting R.O.W. volumes of groundfish blocks exported, i = 1...n;

w_i = factors affecting R.O.W. volumes of groundfish blocks imported, i = 1...n;

e^i_{row} = exchange rates, in R.O.W. currencies by unit of U.S. dollars, i = 1, 2;

u_i = stochastic disturbance term, assuming $E(u_i) = 0$ $var(u_i) = \sigma^2$ and $E(u_i u_j) = 0$, $i \neq j$, $i,j = 1...6$

and

Q^D_{us}, Q^S_c, Q^S_{row}, Q^D_{row}, Q^D, Q^S, P^D_{us}, P^S_{row}, P^D_{row} are endogenous variables in the system.

A conceptual model of international markets for frozen groundfish blocks expressed in this way involves a series of assumptions. Besides assuming that the market tends to be competitive, it is also postulated that the aggregate supply of frozen blocks expresses quantities exported as a positive function of export prices, as opposed to supply being either perfectly price elastic or perfectly price inelastic. Thus, in contrast to some earlier research, the present study treats equilibrium prices and trade flows as being determined within the model.

By assuming perfect competition, this implies that the international frozen groundfish blocks has, approximately, the following characteristics: (a) the individual exporters or importers act as if the "world" price is given, in the sense that they are "price-takers" in the market; (b) the frozen groundfish blocks are a relatively homogeneous product, independently of the source of supply.

These conditions are reasonably well approximated in the international markets for groundfish blocks. There is no reason to believe that any individual exporter or importer alone is able to affect international prices. It is likely that competition results in the inability of the economic agents to act as "price-makers" for more than a short period of time. Also, it is reasonable to assume homogeneity of this product, since groundfish blocks need to obey rather strict requirements, regarding the size, the weight and other specifications of this kind to meet the demands of the processors of sticks and portions, irrespective of the country of origin. Also, the groundfish species do not seem to look like different products to the final consumer of sticks and portions, although these species may not be considered as strict substitutes in production.[4] In any event, data limitation preclude a separate analysis of groundfish blocks on a species basis for a sufficiently long time series.

By assuming quantity supplied is positively related to price, the use of a simultaneous equations approach is justified for estimation purposes. Despite the fact that groundfish landings are, in general, given within a year period (or, at least, heavily determined by non-economic factors), the allocation of the catches among mutually exclusive product forms--fillets, blocks or salted groundfish--is likely to be associated with the relative prices of these products, derived from demand forces in the market. Thus, the estimation of import demands for groundfish blocks using a single equation approach tends

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[4] As Bockstael (1976) pp. 65, discussed "...over time, a significant price differential has existed among the species testifies to the fact that they are not perfect substitutes."

to lead to biased estimates, since the supply of blocks cannot be viewed as either perfectly inelastic or perfectly elastic.[5] Leamer and Stern (1970) described this problem when they mentioned studies in the earlier 40's in which under-estimated price elasticities of demand for imports were obtained by the inappropriate use of OLS procedure. These authors indicated as a reason for these inadequate results, the violation of the OLS assumptions of an independent error term. They illustrated graphically how biased estimates of price elasticities of demand for imports may occur in the case where supply is not infinitely elastic and concluded:

> "This discussion suggests that the use of ordinary least square regression may be appropriate when the shifts in the supply schedule are large relative to those of the demand schedule, and/or when the supply schedule is highly elastic." [Leamer and Stern (1970), pp. 31].

Therefore, in the case of international markets for frozen groundfish blocks, econometric procedures other than OLS must be chosen for estimating the parameters of the equations in the model used in the present study.

In addition, the choice of the quarter as the time interval for grouping the relevant data of this study indicates that the actual time lag between observed prices and corresponding quantities should be shorter than the quarter interval. Empirical evidence in Bockstael (1976) showed that a three-month lag for U.S. import price in an equation representing the demand for groundfish blocks produced a better fit than did other time intervals (refer to Chapter III, figures in Table 6).

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5 When the supply schedule is assumed to be infinitely elastic, the demand relationship can be estimated by OLS with quantity as the dependent variable. In contrast, a demand relationship with price as the dependent variable may be estimated, using OLS procedure, when supply is expected to be infinitely inelastic, i.e., quantity offered is given, and the price determined by the demand and supply intersection. In either case, the estimated demand coefficients by OLS are BLUE (Best Linear Unbiased Estimator).

Furthermore, the evident importance of cold storage holdings of frozen blocks (discussed earlier in Chapter III) suggests the use of a simultaneous equations estimator. For example, the current exported quantities will not be equal to current production of blocks, since quantities of blocks can be drawn from or placed in inventory. Thus, current prices and total supply are likely to be simultaneously determined in the presence of inventories even if the production of blocks were predetermined by groundfish landings in any given year.

Model Specification

Having this general model in mind, the next step is to specify in more detail the form of and main variables in each equation of the simultaneous system.

Demand Relationship

Attempts to estimate demand equations can be classified into two general categories. The first includes studies concerned mainly with the allocation aspects of consumer demand for several commodities, that is, with how the consumer allocates his (her) income among commodities. The second includes studies which concentrate on formulating empirically acceptable explanations for demand of an individual commodity. The present study can be classified in this second category, as the intention is to estimate the import demand for frozen groundfish blocks by the U.S. and the R.O.W. importing countries.

U.S. Import Demand

The household gains no utility directly from the consumption of frozen groundfish blocks, but rather from fish sticks and portions. Blocks are used by the U.S. processing firms as the raw material in the manufacture of sticks and portions which may be packed breaded or unbreaded, cooked or uncooked.

Thus, the demand of frozen groundfish blocks by the processors of sticks and portions could be characterized as: (a) an input demand derived from the consumer demand for sticks and portions; and (b) an import demand as U.S. domestic production of blocks is practically non-existent, as discussed previously in Chapter III.

By assuming "rationality" of both consumers of sticks and portions and processors of blocks into sticks and portions in maximizing, respectively, their satisfaction in consumption and their profits in production, the block import demand can be specified into its main variables, in accordance with the theoretical framework discussed in Chapter II.

From the viewpoint of the individual processing firm which converts blocks into sticks and portions in the U.S. market, the quantity of sticks and portions supplied is assumed to result from a profit maximization process, subject to a production function constraint. This maximization process can be stated as:

$$T = (P_s^w \cdot PRS + P_p^w \cdot PRP) - (P_\beta^w \cdot B + W \cdot L + P_o \cdot O_i) + \lambda\ [\ F\ (PRS, PRP, B, L, O_i)\ ] \qquad (4.11)$$

where:

T = Lagrangian equation;

P_s^w = Unit price of sticks received by U.S. processor;

PRS = Quantity of sticks produced by U.S. processor;

P_p^w = Unit price of portions received by U.S. processor:

PRP = Quantity of portions produced by U.S. processor;

P_β^w = Unit wholesale price of frozen groundfish blocks paid by the U.S. processor;

B = Quantity of frozen groundfish blocks applied in the production of sticks and portions by U.S. processor;

W = Wage rate paid by U.S. processors to the labor force utilized in the manufacture of sticks and portions;

L = Quantity of labor applied in the production of sticks and portions by U.S. processor;

P_o = Unit price of all other remaining inputs paid by U.S. processor in the production of sticks and portions, (such as, price of bread crumbs, oil, packing, storage and overhead costs);

O_i = Quantity of all other remaining inputs i applied in the production of sticks and portions by U.S. processor;

λ = Lagrangian multiplier;

F = Multiple outputs - multiple inputs production function.

Denoting outputs PRS and PRP by Y_1 and Y_2 and inputs B, L, O_i by Z_1, Z_2 and Z_3 respectively, one can write the necessary first-order conditions for profit maximization as follows:

$$P_{Y_j} \frac{\partial Y_j}{\partial z_{ij}} = P_{z_i} \qquad \text{for all } i \text{ input and } j \text{ output}, \quad i = 1, 2, 3;\ j = 1, 2. \tag{4.12}$$

where:

Py_j = Prices of the output j (sticks, portions);

$\frac{\partial Y_j}{\partial z_{ij}}$ = marginal physical productivity of the input i (blocks, labor, other inputs) applied on the production of the output j (sticks, portions);

Pz_i = Price of the input i (price of blocks, wage, price of other input).

This implies that, in competitive equilibrium, the processors will employ the resources B, L and O to produce sticks and portions up the point where the values of the marginal contribution of each of those inputs are simultaneously equal to the corresponding costs of acquiring additional units of these inputs.

It follows from the first-order condition that the derivation of a particular input demand relationship - the demand for frozen groundfish blocks by the processors of sticks and portions - can be represented by the expression:

$$B = \ell\ (P^W_\beta, W, P_o, P^W_s, P^W_p) \tag{4.13}$$

assuming that the sufficient conditions for maximization of profits are met. Equation 4.13 indicates that the changes in the quantity of blocks demanded by the processors are expected to be a response to changes in the prices paid for the resources - blocks, labor and all other inputs - applied in the production of sticks and portions and to changes in the received prices of these outputs. In this particular case, the unit prices of sticks and portions received by the processors[6] correspond to two different consuming markets: (a) retailers; (b) institutional buyers. As pointed out earlier in Chapter III, fish portions are predominantly distributed to institutional buyers, while fish sticks are more commonly consumed at the retail level. Therefore, it was considered appropriate to represent the selling price of sticks by that paid by the retailers to the processors and the selling price of portions by the price paid by the institutional buyers to the processors.

The variable measuring cold storage holdings of blocks should be added to this demand relationship,considering the significant role played by inventories in matching the seasonal variation of imports to the apparent disappearance of blocks in U.S. markets. In this regard, inventories of sticks and portions can be looked upon as residual (as discussed in Chapter III) and, as a consequence, they are not considered explicitly in this particular demand relationship. Hence, the demand for frozen groundfish blocks by the processors of sticks and portions in the U.S. should further include the volumes of blocks held in storage.

Also, as noted earlier, because the U.S. production of blocks is insignificant, the demand for blocks in the U.S. market is essentially an import demand function. Therefore, the quantity of blocks demanded can be replaced by the quantity of blocks imported by U.S. processors and the wholesale price of blocks by the correspondent unit import value of these blocks.

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[6] The largest U.S. processors which account for about 80 percent of the production of sticks and portions are: Gorton Group (Gloucester, Mass.), Mrs. Paul's Kitchen Co. (Philadelphia, Pa.); Van De Kamp's Frozen Food (Santa Fe Springs, Ca.), Rick-Seapak Corp. (St. Simon Island, Ga.), and Cold Water Seafood Corp. (Scarsdale, N.Y.) [U.S. International Trade Commission (1980)].

Considering these above-mentioned adjustments, the U.S. import demand of frozen groundfish blocks is expressed by:

$$TIMP = t\ (PB,\ P_s^w,\ P_p^w,\ W,\ P_o,\ HB) \qquad (4.14)$$

where:

TIMP = Total volume of imports of the U.S. of groundfish blocks, in units of volume;

PB = Weighted average price of U.S. imports of groundfish blocks, in cents of U.S. dollar per unit of volume;

HB = First-of-the-month cold storage holdings of groundfish blocks in the U.S., in units of volume;

and the other variables are as defined earlier in equation 4.13.

Further important aspects must be taken into account when the demand for blocks in U.S. markets is to be specified. There is evidence that the production function of sticks and portions is linear, i.e., the ratio of inputs to outputs is constant and, in addition, the process of production is standardized for the industry. As a matter of fact, there are rather strict product specifications, regarding size and weight for blocks, and, for sticks and portions. By definition, blocks are skinless and boneless fish meat, usually fillets or pieces of fillets, compacted together and frozen into blocks, each weighing between 15.5 and 17.5 pounds. Sticks are specified as elongated pieces of fish flesh, cut from blocks, weighing between 3/4 and 1-1/4 ounces, with a thickness of at least 3/8 inches. Portions are also elongated pieces of fish flesh cut from blocks, having strict specifications. This characteristic production function of sticks and portions was also discussed in Newton (1972), pp. 48:

> "...the result would be a linear production function instead of the standard theoretical shape. The observed production function at a point in time will, therefore, indicate a constant input to output function that is linear up to the capacity of the industry. At capacity, the slope of the function will approach zero."

As a consequence, the marginal physical product of blocks in the production of sticks and portions can be treated as a constant. The downward slope of the derived demand for blocks is a consequence of the (postulated) inverse relationship between prices and quantities of sticks and portions at the consumer level. In this regard, the variables affecting the domestic consumption of sticks and portions, besides their own prices, need to be explicitly considered in the import demand for groundfish blocks. In order to select these additional variables, it became necessary to specify a demand relationship for sticks and portions in U.S. markets, based on the theoretical framework summarized in Chapter II.

With the concept of separability of a utility function in mind and considering the applied work developed by George and King (1971), based on deJanvry's (1966) food commodities grouping, one can argue that sticks and portions (as fish products), together with the animal protein group, form a separable subset of food commodities. As a consequence, a separable utility function for this subset can be, hypothetically, expressed by:

$$U_1 = u_1 \left(x_s, x_p, x_f, x_b, x_k, x_y \right) \tag{4.15}$$

where:

U_1 = The individual's separable utility function for animal protein;

x_s = Quantity of sticks consumed;

x_p = Quantity of portions consumed;

x_f = Quantity of fish products consumed other than fish sticks and portion;

x_b = Quantity of beef consumed;

x_k = Quantity of pork consumed;

x_y = Quantity of poultry consumed.

However, based on the diversity of markets in which fish sticks and portions are consumed, a further subdivision on this utility function U_1 (as defined in Equation 4.15) can be made. Since a large proportion of the production of sticks is distributed by processors to retail stores and since portions are predominantly consumed in restaurants, cafeterias, schools, hospitals and other institutional outlets, two further separable utility functions are assumed to exist: (a) a utility function for animal protein consumed at home; (b) a utility function for animal protein consumed away-from-home. That is:

$$U_2 = u_2\ (x_s^r,\ x_f^r,\ x_b^r,\ x_k^r,\ x_y^r) \tag{4.16}$$

$$U_3 = u_3\ (x_p^a,\ x_f^a,\ x_b^a,\ x_k^a,\ x_y^a) \tag{4.17}$$

where:

U_2, U_3 = The individuals' separable utility function for animal protein food consumed at home (U_2) and away-from-home (U_3);

x_s^r = Quantity of sticks consumed at home;

x_p^a = Quantity of portions consumed away-from-home;

x_f^r, x_f^a = Quantity of fish products other than sticks and portions consumed at home and away-from-home, respectively;

x_b^r, x_b^a = Quantity of beef consumed at home and away-from-home, respectively;

x_k^r, x_k^a = Quantity of pork consumed at home and away-from-home, respectively;

x_y^r, x_y^a = Quantity of poultry consumed at home and away-from-home, respectively.

Under this specification, it is assumed that consumers receive no satisfaction from consuming portions at home or from consuming sticks away-from-home. This is an extreme, and probably unrealistic assumption, but is made to emphasize that there appear to be two distinct markets involved. Thus, in the two-stage maximization process, the consumer first decides on the allocation of income among: (a) animal protein prepared at home; (b) animal protein consumed away-from-home; (c) other purposes. In the second step, the consumer allocates: (a) the away from home food budget among the group of animal protein items consumed away-from-home with no further reference to purchases of food consumed at home or other purposes; and (b) the at home food budget among the group of animal protein items prepared at home, irrespective of the away-from-home food consumption.

From the first-order condition of maximization of the consumer's utility functions, subject to a budget constraint, the demand of sticks consumed at home, and the demand of portions consumed away-from-home can be derived, and they are of the general form:

$$X_s^r = s\ (P_s^r,\ P_f^r,\ P_b^r,\ P_k^r,\ P_y^r,\ I) \tag{4.18}$$

$$X_p^a = p\ (P_p^a,\ P_f^a,\ P_b^a,\ P_k^a,\ P_y^a,\ I) \tag{4.19}$$

where:

P_s^r = Unit price of sticks paid by the consumers at retail stores;

P_p^a = Unit price of portions paid by the consumers at away-from-home outlets;

P_f^r, P_f^a = Unit price of other fish products paid by the consumers at retail stores and at away-from-home outlets, respectively;

P_b^r, P_b^a = Unit price of beef paid by the consumers at retail stores and at away-from-home outlets, respectively;

P_k^r, P_k^a = Unit price of pork paid by the consumers at retail stores and at away-from-home outlets, respectively;

P_y^r, P_y^a = Unit price of poultry paid by the consumers at retail stores and at away-from-home outlets, respectively;

I = Total consumer's income.

The equation 4.18 represents the demand of sticks consumed at home and expresses the quantity of sticks demanded as a response to its own price, the prices of closely related animal food protein commodities consumed at home and the consumer's income. Similarly, equation 4.19 specifies the demand of portions consumed away-from-home, where the quantity of portions demanded is assumed to be a function of its own price, the prices of closely related animal food protein consumed away-from-home and the consumer's income.

From these hypothetical demand relationships, it can be seen that the variables representing the prices of related goods in the consumption of sticks and the consumer's income may be explicitly added to the import demand for groundfish blocks (Equation 4.14). However, lack of appropriate data precludes the inclusion of all of the above-mentioned variables as they were defined in Equations 4.18 and 4.19, especially the specific prices of food consumed away-from-the home.[7] Therefore, the actual empirical model used is a modified version of the conceptual model, adjusted for data limitations and anticipated econometric issues discussed below.

To represent the price of fish products other than sticks and portions, the import price of frozen fillets of groundfish was selected, considering that this product form is the closest alternative fish item in the consumption of sticks and portions in the U.S. markets. The consumer's income is represented by U.S. total disposable personal income rather than per capita, in order to combine the affects of rising income and of increasing population, and, in accordance with the specification of import demand relationship in an aggregated form. Under the assumption that the income variable may be also a proxy for other variables that experienced upward trends, like the prices of other animal protein items that were excluded from the model, in order to prevent problems of intercorrelation among explanatory variables. In addition, it was decided to aggregate the wholesale price of sticks and the wholesale price of portions (previously specified in Equation 4.14) into a single variable - the weighted average wholesale price of sticks and portions. This procedure is justified, considering the fact that this aggregation may avoid additional problems of multicollinearity, since those prices have been moving together.

Considering these adjustments, and treating three months as the appropriate time interval, the demand for imports of groundfish blocks by U.S. processors of sticks and portions is defined and expressed

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[7]The Consumer Price Index for food away-from-home is only represented by two broad categories (a) food away-from-home including snacks and (b) restaurants meals. (U.S. Bureau of Labor Statistics - Monthly Labor Review.) The National Marine Fisheries Service conducts a monthly survey of retail prices of some fishery products. Fish sticks and portions are included. Unfortunately, these data series were not initiated until the mid '70's.

as follows:

$$TIMP = f_1 \ (PB, PSP, PFF, HB, W, TY) \qquad (4.20)$$

where:

PSP = Quarterly weighted average of wholesale price of sticks and portions in the U.S., in cents of U.S. dollar per unit of volume;

PFF = Quarterly weighted average price of U.S. imports of groundfish frozen fillets, in cents of U.S. dollar per unit of volume;

TY = U.S. total disposable personal income by quarter, in U.S. dollars;

and the other variables are as defined earlier in equation 4.14, in a quarterly basis.

In equation 4.20, the prices of other inputs applied in the conversion of blocks into sticks and portions (P_0), such as bread crumbs, oil, packaging, storage and overhead, were also excluded, because of the difficulties in obtaining this information. However, the exclusion of these data is not likely to bring further specification error, since most of the variation in those input prices, affecting the demand for blocks, probably is already captured in the model.

In contrast, due to the nature of the import demand, other variables must be explicitly included, under the supposition that they affect the trade flows of groundfish blocks in the international market. Those variables are: transportation costs, import tariffs and exchange rates. Specific data on transportation costs of blocks are available only for the period after January of 1974, in the U.S. imports statistics.[8] To avoid this gap a binary variable, T, was introduced to subdivide the

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[8]Effective with the January 1974 statistics, the foreign trade reports present import value data reported in terms of F.A.S. (Free Alongside Ship), CIF (cost, insurance and freight), in addition to the custom value data previously reported. This specification allows the estimation of the transfer cost of groundfish blocks by difference between the CIF value and custom value for a given species and country of origin. CIF value represents the value at the first port of entry in the U.S. and includes all freight, insurance and other charges incurred in bringing the goods to the U.S. Custom value (as mentioned earlier) is based on the foreign market value of exportation, and, therefore, excludes U.S. import duties, freight, insurance and other charges incurred in bringing the goods to the U.S. F.A.S. value represents the transaction value of imports at the foreign port of exportation and includes all charges incurred in placing the merchandise alongside the ship at the port of exportation.

data into two subperiods: Pre and Post 1973. This is done because major changes in the transportation costs occurred during 1973 when the oil embargo was imposed, as discussed in Chapter III. U.S. import restrictions for frozen blocks consisted of a unit tariff effective until 1972. After that, blocks were imported tariff free (also discussed in Chapter III). This unit tariff was accounted for in the model by adding its unit value directly to the U.S. import price of blocks (as derived from reported custom value that excludes those tariff). The exchange rate was implicitly included by expressing the import price of blocks in U.S. dollars.

Finally, considering the possible seasonal shifts in the demand for blocks, as evidenced by previous studies and in the figures in Chapter III, additional binary variables (S1, S2, S3) were added to the import demand of blocks in the U.S. accounting for those shifts in each quarter (three-month period) of a given year.

Under these specifications, the U.S. import demand for frozen groundfish blocks is expressed,thusly:

$$TIMP = f_1\ (PB, PSP, PFF, W, TY, HB, S1, S2, S3, T, u_1) \qquad (4.21)$$

where:

S1 = Seasonal binary variable, S1 = 10 for January, February and March S1 = 1, otherwise;

S2 = Seasonal binary variable, S2 = 10 for April, May and June, S2 = 1, otherwise;

S3 = Seasonal binary variable, S2 = 10 for July, August and September, S3 = 1, otherwise;

T = Cyclical binary variable T = 1 for 1964 to 1972, T = 10 for 1973 to 1978;

u_1 = Stochastic disturbance term for U.S. import demand;

and the other variables are as defined earlier in equations 4.13, 4.14 and 4.20, on a quarterly basis.

If the model is properly specified, a negative coefficient for the import price of blocks (PB) is expected a priori, other things remaining constant. A positive cross-price coefficient of frozen groundfish fillet (PFF) is expected, if one considers that blocks and fillets can be substitutes in consumption. A positive sign for the income coefficient (TY) is also anticipated, since there is no reason to believe that blocks can be considered an inferior good, despite the mixed results obtained in previous studies of groundfish products, as shown in Table 7, Chapter III. The wholesale price of sticks and portions (PSP) is foreseen to be positively related to the imports of blocks, considering that prices of sticks and portions corresponds to the "output" price as perceived by the processors. The wage rate (W) paid by the fish processing firms is likely to be inversely related to imports of blocks, since it is believed that labor is a complementary input to blocks in the production of sticks and portions. Finally, the level of inventories of blocks (HB) is expected to be negatively associated with imports, under the argument that the higher the level of blocks stocks held by the processors, the lower the level of imports in any given period.

ROW Import Demand

Following a reasoning similar to that used in specifying the variables associated with imports of blocks by U.S. processors, the correspondent volumes of blocks imported by the ROW countries are expected to be related with: (a) the ROW import price of groundfish blocks; (b) the ROW prices of other inputs, hired in converting blocks into fish product suitable for final consumption; (c) the ROW prices of related commodities in consumption; (d) the ROW consumer's income; (e) the ROW cold storage holdings of groundfish blocks; (f) the variables reflecting seasonal and cyclical demand shifts; and (g) the exchange rates between ROW and supplying countries. However, due to data limitations for most of the variables, a series of simplifying assumptions were made. As suggested in the conceptual model section, some ROW import demand variables can be indirectly estimated by using Canadian export data on a quarterly basis. It was assumed that the volumes imported by ROW processors of groundfish blocks could be represented by the amount of groundfish blocks exported by Canada to all countries,but the U.S. The correspondent ROW import price of groundfish blocks was calculated as the Canadian export price to all destinations, converted into U.K. currency. By expressing the ROW import price in pounds sterling, it is implicitly assumed that the U.K., as a major consumer of groundfish blocks can be considered representative of ROW importers of this product form. In this regard, the quarterly Wholesale Food Price Index in Britain was chosen as a proxy for the prices of commodities related to groundfish blocks in ROW consuming markets, in the absence of other more detailed information. However, a search for an appropriate measure of disposable income in the ROW importing country, on a quarterly basis, was unsuccesful. The same kinds of data constraints were found in looking for data on: (a) prices of other inputs utilized in converting blocks to the final consuming forms; (b) prices of the final consuming products; and (c) holdings of groundfish blocks. Nevertheless, it may be reasonable to expect that the Wholesale Food Price Index is picking up some of the influence of the output prices and the price of other inputs under the assumption that they are moving together. As a consequence, the Wholesale Food Price Index may well represent the aggregate changes not only in the price of related commodities in the consumption of groundfish blocks in ROW countries, but also in the prices of output and the other inputs.

The same binary variables used to account for seasonal and cyclical shifts in the U.S. import demand for groundfish blocks (S1, S2, S3, T) were introduced into the ROW import demand relationship, expecting that similar seasonal patterns may be present in the consumption of the blocks by these countries. Finally, the exchange rate of ROW countries is implicitly considered by expressing ROW import prices, in pounds sterling.

Under this specification and given those simplified assumptions, the ROW import demand can be represented by the following expression:

$$XBOI = f_2\ (PUK,\ WPUK,\ S1,\ S2,\ S3,\ T,\ u_2) \qquad (4.22)$$

where:

XBOI = Quarterly imports of groundfish blocks by ROW consuming countries, in units of volume;

PUK = Quarterly weighted average price of ROW imports of groundfish blocks, in pounds sterling per unit of volume;

WPUK = Quarterly Wholesale Price Index for food in the U.K., with 1970 = 100;

u_2 = Stochastic disturbance term for ROW import demand;

and the other variables are as defined in Equation 4.20.

On theoretical grounds, a negative sign is expected on the coefficient for the ROW import price of groundfish blocks (PUK). However, no a priori sign for the prices of commodities related to blocks in ROW markets (WPUK) is expected, if one considers the possibility that this variable may be seen as a proxy for prices of related commodities in consumption, prices of the output and prices of the other inputs.

Supply Relationship

Under the proposed conceptual model, the supply side of the market was subdivided into two areas: (a) Canadian export supply; and (b) ROW export supply. Hence, the intention now is to specify those relationships more explicitly, in accordance with the theoretical framework discussed in Chapter II.

Canadian Export Supply

From the point of view of the processing firms which convert groundfish species into frozen blocks, the quantity of groundfish blocks supplied is assumed to result from a profit maximization process, subject to a production function constraint. This maximization process can be stated as:

$$T = (PC^{W} \cdot BC) - (LC \cdot S + LAN \cdot P_{ex} + OC_{i} \cdot P_{oc}) + \lambda \, [\, F(BC, LC, LAN, O_{ci}) \,] \qquad (4.23)$$

where:

T = Lagrangian equation;

PC^{W} = unit wholesale price of groundfish blocks received by the Canadian processor;

BC = quantity of groundfish blocks produced by the Canadian processor;

LC = quantity of labor applied in the production of groundfish blocks by the Canadian processor;

S = wage rate paid by Canadian processors to the labor utilized in the manufacture of blocks;

LAN = landings of groundfish in Canada;

P_{ex} = weighted average ex-vessel price of groundfish species landed in Canada;

OC_i = quantity of all other remaining inputs i applied in the production of groundfish blocks by Canadian processors;

P_{oc} = unit price of all other remaining inputs i paid by Canadian processors in the production of blocks;

λ = Lagrangian multiplier;

F = frozen groundfish blocks production function in Canada.

Denoting output BC by y_1 and inputs LC, LAN, OC_i by z_1, z_2 and z_3, respectively, one can write the necessary first-order condition for profit maximization as follows:

$$Py_j \frac{\partial y_j}{\partial z_{ij}} = P_{z_i} \quad \text{for all inputs } i \text{ and output } j \quad i = 1,2,3 \text{ and } j = 1. \tag{4.24}$$

where:

Py_j = price of the output j (frozen groundfish blocks);

$\frac{\partial y_j}{\partial z_{ij}}$ = marginal physical productivity of the input i (labor, landings of groundfish species, other inputs); applied in the production of the output j (blocks);

Pz_i = price of the input i (wages, ex-vessel prices of groundfish and other input prices).

This implies that, in competitive equilibrium, the processors of groundfish blocks in Canada will employ the resources LC, LAN, OC_i up to the point where the values of the marginal contribution of each of those inputs are simultaneously equal to the corresponding costs of acquiring additional units of those inputs.

From this first-order condition, the supply of groundfish blocks in Canada can be derived, assuming that second-order conditions are satisfied. This supply equation relates the changes in the quantity of blocks supplied to changes in the prices of blocks received by the processors and the prices of the inputs hired in the production of groundfish blocks in Canada. It is further expected that the quantity of blocks applied in the market will be related to Canadian-held inventories of blocks (as suggested in Chapter III). Thus, the Canadian supply of frozen groundfish blocks can be, algebraically, represented as:

$$BC = b(PC^{W}, S, P_{ex}, P_{oc}, XHB) \quad (4.25)$$

where:

XHB = first-of-the-month cold storage holdings of groundfish blocks in Canada;

and the other variables are as defined earlier in equation 4.23.

The link between the Canadian supply and the export-supply can be represented by the identity that exports, during a given period t, are equal to supply quantities plus net changes in inventories and minus domestic consumption:

$$XBT_t = XHB_t + BC_t - XHB_{t+1} - C_t \quad (4.26)$$

where:

XBT_t = total exports of groundfish blocks by Canadian processors, in period t;

C_t = Canadian domestic consumption of groundfish blocks, in period t;

and the other variables are as defined in equations 4.23 and 4.25.

It is redundant to estimate both supply and export-supply relationships in the same model since almost all Canadian-produced blocks are exported. Hence, the quantity of blocks supplied can be replaced by the quantity of blocks exported by Canadian processors and the wholesale price of blocks by the correspondent unit export value of these exports.

Considering these above-mentioned adjustments, the Canadian export supply of frozen groundfish blocks is represented by:

$$XBT = x(PT, S, P_{ex}, P_{oc}, XHB) \qquad (4.27)$$

where:

PT = weighted average price of Canadian exports of groundfish blocks, in cents (Canadian) per unit of volume;

and the other variables are as defined in equations 4.23 and 4.25.

However, lack of appropriate data precludes the inclusion of all of the above-mentioned variables in equation 4.27: such is the case for the variables S and P_{oc}. In contrast, variables that may be affecting the flows of trade between Canada and the consuming countries need further consideration. In this regard, the effect of the exchange rate on Canadian exports is implicitly considered by expressing the export price of groundfish blocks in Canadian currency, FOB-value. Also, the effect of changes in transfer costs which occurred during 1973 on Canadian exports is considered by introducing the binary variable T, that sub-divides the data into two sub-periods: pre- and post-1973 (as shown in Chapter III).

In addition, it was judged appropriate to include binary variables accounting for possible seasonal shifts in this sector of the market. These variables--S1, S2, S3--serve to: (a) permit any seasonal shifts in supply, not accounted for by the explanatory variables discussed above; and (b) include any seasonal shifts in Canadian domestic demand for blocks, which may affect export supply.

Under this specification and treating three months as the appropriate time interval for the data, the supply of groundfish blocks for exports by Canadian processors is defined and expressed as follows:

$$XBT = f_2\ (PT, P_{ex}, XHB, S1, S2, S3, T, u_3) \qquad (4.28)$$

where:

S1 = seasonal binary variable, S1 = 10 for January February and March, S1 = 1 otherwise;

S2 = seasonal binary variable, S2 = 10 for April, May and June, S2 = 1, otherwise;

S3 = seasonal binary variable, S3 = 10 for July, August and September, S3 = 1, otherwise;

T = cyclical binary variable, T = 1 for 1964 to 1972, T = 10 for 1973 to 1978;

u_3 = stochastic disturbance term for Canadian export demand;

and the other variables are as defined earlier in equations 4.23, 4.25 and 4.27 on a quarterly basis.

On theoretical grounds, the own price coefficient (PT) in equation 4.28 is expected to be positive, implying that Canadian exports increase when there is an increase in the export price of blocks, other things constant. The input price (P_{ex}) is likely to be inversely related to blocks export volumes, since an increment in ex-vessel prices of groundfish species paid by Canadian processors may induce a reduction in the production of blocks, other things constant. The coefficient of the XHB variable is forecasted to have a positive sign, since the larger the inventories of blocks held by Canadian block processors at the beginning of the period, the more blocks are available to be supplied for exports from Canada, other things unchanged.

ROW Export Supply

Following the same basic theoretical approach as just described for the Canadian export supply relationship, the correspondent volumes of groundfish blocks exported by the ROW countries, on a quarterly basis, are expected to be related with: (a) the export price of groundfish blocks as received by ROW countries; (b) the input prices paid by ROW processors in converting groundfish species into frozen blocks; (c) the inventories of blocks held by the ROW block processors; (d) seasonal and cyclical shifts affecting ROW exports of blocks; (e) the exchange rates between ROW and consuming countries.

Once more due to data limitations in ROW exporting countries, several adjustments were made and proxies developed for those variables, hypothesized to be related to ROW exports of groundfish. As described in the discussion of the conceptual model earlier in this Chapter, ROW export volumes and prices were indirectly estimated by using U.S. import data, on a quarterly basis. That is, the ROW exports are represented by the amount of groundfish blocks imported by the U.S. from all countries but Canada. The proxy for the ROW import price was the weighted average price of U.S. imports of groundfish blocks, converted into ROW major supplying countries' national currencies. Considering that Iceland is, after Canada, the most important single supplier of blocks to U.S. markets (as shown by the figures presented in Chapter III), the Icelandic krona was chosen as the currency in which to express ROW export prices as received by the ROW processors of blocks. In addition, to determine the sensitivity of the results to this choice,it was decided, as an alternative, to express ROW export prices in Norwegian kroner[9]. By expressing the ROW export price in those currencies, the exchange rate is implicitly included in the ROW export supply relationship.

In the absence of data on quarterly input prices paid by ROW processors in the production of groundfish blocks--in particular, the ex-vessel groundfish prices--this variable was replaced by the quarterly landings of cod in Iceland, Norway and Denmark. Cod was chosen to represent groundfish landings in ROW countries not only because it is the species predominantly employed in the production of blocks (as shown in Chapter III) but also because it is the only species for which the seasonal distribution of landings in those

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[9]Another alternative way is to represent this ROW export price by a combined price index, weighted by each country's export volumes to the U.S. However, this procedure was not used here, because of the lack of significative differences among the import prices received by each major supplying country, as shown in Appendix 1.

ROW countries was available.[10] As published by FAO, the annual landings of cod in Iceland, Norway and Denmark were distributed by quarter, according to the percentages shown in Table 44. These percentages were calculated from the data presented in Figure 6. The resulting estimates of quarterly cod landings obtained by country were added into a unique variable: FAO. Data on the inventories of blocks held by ROW producing countries were not available.

Table 44. Cod Landings (Gadus Morhua). Percentage of Distribution by Quarter in Denmark, Iceland and Norway.

	Quarter (%)			
Country	First	Second	Third	Fourth
Denmark (1)	37	30	18	15
Iceland (2)	23	55	13	9
Norway (2)	30	25	23	22

Source: (1) Denmark. Fiskeriministeriet. Fiskeriberetning For Aret 1972-74.

(2) U.S. Department of Commerce. Food Fish Market Review (May 1971).

[10]In Figure 6, Chapter III, the allocation of the cod (Gadus Morhua) landings by month for Norway, Denmark and Iceland was shown. For other groundfish species, such information was not available, precluding the estimates of the seasonal patterns of landings for other groundfish in these countries by quarter.

Following the argument used in specifying the Canadian export supply relationship and under the same assumptions, binary variables were included in the ROW export supply relationship to represent seasonal and cyclical shifts in trade flows of groundfish blocks. As before, these variables are: S1, S2, S3 and T.

Considering those adjustments, the alternative functional form for expressing the ROW export supply of frozen groundfish blocks, with export prices measured in Icelandic currency or in Norwegian currency, can be represented by:

$$IBOI = f_4(PICE, FAO, S1, S2, S3, T, u_4) \quad (4.29)$$

or

$$IBOI = f_5(PNW, FAO, S1, S2, S3, T, u_5) \quad (4.30)$$

where:

IBOI = quarterly exports of groundfish blocks by ROW producing countries, in units of volume;

PICE = quarterly export price of groundfish blocks of ROW producing countries, in Icelandic kronur per unit of volume;

PNW = quarterly export price of groundfish blocks of ROW producing countries, in Norwegian kroner per unit of volume;

FAO = quarterly landings of Atlantic Cod in ROW supplying countries (Iceland, Denmark and Norway), in units of volume;

S1 = seasonal binary variable, S1 = 10 for January, February and March, S1 = 1, otherwise;

S2 = seasonal binary variable, S2 = 10 for April, May and June, S2 = 1, otherwise;

S3 = seasonal binary variable, S3 = 10 for July, August and September, S3 = 1, otherwise;

T = cyclical binary variable, T = 1 for 1964-72, and T = 10 for 1973-78.

In these equations, it is expected _a priori_ that ROW export prices (PICE or PNW) are positively related to ROW export volumes, _ceteris paribus_. The higher the prices received by the ROW exporters, the larger the volumes of groundfish blocks offered in the international market. The expectation for the landings of cod variable (FAO) is a positive coefficient, since a large availability of raw material--the catches of groundfish blocks, in this case--tends to increase volumes of groundfish blocks exported, all other things remaining unchanged.

Supply and Demand Relationship

On the basis of the foregoing discussion, the conceptual model proposed in the beginning of this chapter can be specified in its main variables for the set of four sectors into which the international market of groundfish blocks was, hypothetically, divided: U.S. and ROW import demands and Canadian and ROW export supplies.

The summary of the complete system of simultaneous equations in its structural form is presented in Table 45. It contains six behavioral equations and four identities. The six behavioral equations are: (1) U.S. import demand (EQ1); (2) Canadian export supply (EQ2); (3) ROW export supply (EQ3(a) or EQ3(b)); (4) ROW import demand (EQ4); (5) equilibrium export-import prices (EQ5); and (6) equilibrium export-import trade flows (EQ6). These latter two equations represent the "world" equilibrium position, in terms of prices and quantities. It was decided to express those relationships with behavioral equations instead of identities because of the nature of the data. As pointed out before, the import-export prices and quantities were obtained from two different sources, and, as a consequence, they can not be considered identically equal. In some sense, the differences may be regarded as "random errors". Thus, a simple identity between the U.S. import price and the Canadian export price for expressing the competitive equilibrium position is not appropriate in this case. The same order of argument is valid in the representation of the equilibrium position for trade flows. Therefore, behavioral equations EQ5 and EQ6 were chosen in such a way as to allow these "random errors" to be accounted for. Equation EQ5 permits consideration of the fact that actual transactions for groundfish blocks may take place at exchange rates different than the "official" rates.

Table 45. Structural Form of the International Model for Frozen Groundfish Blocks.

Equation (t = quarter)	Variables
Behavioral Equations:	
EQ1: U.S. Import Demand	$TIMP_t$ (PB_t, PSP_t, PFF_t, HB_t, W_t, TY_t, S1, S2, S3, T, u_{1t})
EQ2: Canadian Export Supply	XBT_t (PT_t, PEX_t, XHB_t, S1, S2, S3, T, u_{2t})
EQ3 (a): ROW Export Supply (in Icelandic currency)	$IBOI_t$ ($PICE_t$, FAO_t, S1, S2, S3, T, u_{3t})
EQ3 (b): ROW Export Supply (in Norwegian currency)	$IBOI_t$ (PNW_t, FAO_t, S1, S2, S3, T, u_{4t})
EQ4: ROW Import Demand (in the UK currency)	$XBOI_t$ (PUK_t, $WPUK_t$, S1, S2, S3, T, u_{5t})
EQ5: Export-Import Price Equilibrium	PB_t (PT_t, u_{6t})
EQ6: Export-Import Equilibrium	TD_t (TS_t, u_{7t})
Identities:	
ID 1:	$TD_t = TIMP_t + XBOI_t$
ID 2:	$TS_t = XBT_t + IBOI_t$
ID 3(a):	$PICE_t = PB_t \div ICE_t$
ID 3(b):	$PNW_t = PB_t \div NW_t$
ID 4:	$PUK_t = PT_t \div UK_t \cdot ER_t$

Endogenous Variables (TIMP, XBT, IBOI, XBOI, PB, PT, PICE or PNW, PUK, TD, TS)

Exogeneous Variables (PFF, PSP, HB, W, TY, PEX, XHB, FAO, WPUK, ICE or NW, UK, ER, S1, S2, S3, T)

These differences are reflected in the intercept and error term. Furthermore, there are lags between shipment dates and arrival dates which could lead to discrepancies between the prices reported by those two sources. Equation EQ6 is specified without a constant term[11] and the slope is expected to be, approximately, equal to one, since the "world" groundfish blocks exported and imported may, approximately, be equal to each other, given some "random error". These "errors" are assumed to be present, due to differences in reporting periods associated with the differences between shipment and arrival dates and captured by the stochastic error μ_6.

The identities ID1 through ID4 complete the system. Equations ID1 and ID2 identify the composition of the "world" demand quantity and the "world" supply quantity, respectively. Equations ID3 and ID4 define the ROW export price and the ROW import price by transformation of U.S. and Canadian prices into the respective currencies of Iceland or Norway, and of the U.K., via the appropriate exchange rates. A stochastic term is not introduced here, because these identities correspond to the definition of the proxy variable used in obtaining the ROW export price and ROW import price for which no actual data were available.

In Table 46, a summary of the definition of the variables selected for this model is reported in alphabetical order, with their corresponding sources of information.

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[11]The equation EQ6 is specified passing through the origin, since the existence of the total "world" export volumes must correspond to a trade flow in the opposite direction (i.e. imports volumes).

Table 46. Summary of the Variables for the International Market of Groundfish Blocks Model and Respective Sources

Symbol	Definition	Source	Remarks
FAO	quarterly landings of Atlantic Cod in Iceland, Norway and Denmark, in thousand pounds of round weight	Food Alimentation Organization of the United Nations. Yearbook of Fisheries Statistics	The variable is a proxy for quarterly landings in these countries, based on the proportions defined in Table 44.
HB	quarterly first-of-the-month cold storage holdings of groundfish blocks in the U.S., in thousand pounds of product weight	U.S. Department of Commerce. Fisheries Statistics of the U.S. and U.S. Department of Commerce. Frozen Fishery Products	
ER	quarterly averaged exchange rate of Canadian currency in relation to U.S. currency, in cents of U.S. dollar per unit of Canadian dollar	U.S. Board of Governors. Federal Reserve System. Federal Reserve Bulletin	
IBOI	quarterly exports of the ROW producing countries of groundfish blocks, in thousand pounds of product weight	U.S. Department of Commerce. U.S. Imports	The variable corresponds to the quarterly volume of groundfish blocks imported by the U.S. from all origins, but Canada
ICE	quarterly averaged exchange rate of Icelandic currency in relation to U.S. currency, in cents (U.S. dollar) per unit of krona	United Nations. Department of Economic Affairs. Monthly Bulletin of Statistics.	
LAN	quarterly landings of groundfish in Canada (includes cod, cusk, flounder-sole, haddock, hake, pollock, ocean perch, and other groundfish), in thousand pounds of common landed form	Canada. Statistics Canada. Monthly Review of Canadian Fisheries Statistics.	

(Table 46. Continued.)

Symbol	Definition	Source	Remarks
NW	quarterly averaged exchange rate of Norwegian currency in relation to U.S. currency, in cents (U.S. dollars) per unit of Norwegian krone	U.S. Board of Governors. Federal Reserve System. Federal Reserve Bulletin.	
PB	quarterly weighted average price of U.S. imports of groundfish blocks (includes cod, haddock, flatfish, pollock, and other groundfish species), in cents (U.S. dollar, custom value) per pound of product weight	U.S. Department of Commerce. U.S. Imports.	
PFF	quarterly weighted average price of U.S. imports of groundfish frozen fillets (includes cod, cusk, haddock, hake, pollock, flatfish) in cents (U.S. dollar, custom value) per pound of product weight	U.S. Department of Commerce. U.S. Imports.	
PICE	quarterly export price of ROW producing countries of groundfish blocks, in kronur (Iceland) per pound of product weight	U.S. Department of Commerce. U.S. Imports.	The variable corresponds to the quarterly weighted average price of U.S. imports of groundfish blocks, converted into Icelandic currency by the appropriate exchange rate.

(Table 46. Continued.)

Symbol	Definition	Source	Remarks
PNW	quarterly export price of ROW producing countries of groundfish blocks, in Norwegian kroner per pound of product weight	U.S. Department of Commerce. U.S. Imports.	The variable corresponds to the quarterly weighted average price of U.S. imports of groundfish blocks, converted into Norwegian currency by the appropriate exchange rate.
PSP	quarterly weighted average of wholesale price of sticks and portions in the U.S. in cents (U.S. dollar) per pound of product weight	U.S. Department of Commerce. Food Fish Market Review.	
PT	quarterly weighted average price of Canadian exports of groundfish blocks (cod, haddock, ocean perch, pollock, sole-flounder, other seafish blocks), in cents (Canadian dollar, FOB-value) per pound of product weight	Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	
PUK	quarterly weighted average of import price of ROW consuming countries of groundfish blocks, in pound sterling per pound of product weight	Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	The variable corresponds to the quarterly weighted average price of Canadian exports of groundfish blocks, converted into UK currency by the appropriate exchange rate.
S1	Seasonal binary variable where S1 = 10 for January-February-March, and S1 = 1, otherwise		

(Table 46. Continued.)

Symbol	Definition	Source	Remarks
S2	Seasonal binary variable where S2 = 10 for April-May-June, and S2 = 1 otherwise		
S3	Seasonal binary variable where S3 = 10 for July-August-September, and S3 = 1 otherwise		
T	Cyclical binary variable where T = 1 for 1964-72 and T = 10 for 1973-78		
TD	quarterly "world" demand of groundfish blocks, in thousand pounds of product weight	U.S. Department of Commerce. U.S. Imports and Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	The variable corresponds to the sum of the quarterly imports of the U.S. and the quarterly imports of the ROW importing countries.
TIMP	quarterly imports of the U.S. of groundfish blocks (includes cod, haddock, flatfish, pollock, and other groundfish blocks), in thousand pounds of product weight	U.S. Department of Commerce. U.S. Imports	
TS	quarterly "world" supply of groundfish blocks, in thousand pounds of product weight	U.S. Department of Commerce. U.S. Imports and Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	The variable corresponds to the sum of the quarterly exports of Canada and the quarterly exports of the ROW exporting countries.
TY	U.S. total disposable personal income, by quarter, in millions of U.S. dollars	U.S. President. Economic Report of the President	

(Table 46. Continued.)

Symbol	Definition	Source	Remarks
UK	quarterly averaged exchange rate of the UK currency in relation to the U.S. currency, in cents (U.S. dollars) per unit of pound sterling	U.S. Board of Governors. Federal Reserve System. Federal Reserve System.	
W	quarterly average earnings of workers in the U.S. fish processing sector (canned, cured and frozen seafood products), in U.S. dollars per hour	U.S. Department of Labor. Employment and Earnings.	
WPUK	quarterly wholesale price index for food in the UK, 1970=100	OECD. Main Economic Indicators.	
XEX	quarterly weighted average ex-vessel prices of groundfish species in Canada (includes cod, cusk, flounder-sole, haddock, hake, pollock, ocean perch and others), in cents of dollar (Canadian) per pound of common landed form	Canada. Statistics Canada. Monthly Review of Canadian Fisheries Statistics.	
XHB	quarterly first-of-the-month cold storage holdings of groundfish blocks in Canada, in thousand pounds of product weight	Canada. Statistics Canada. Fish Freezings and Stocks.	

(Table 46. Continued.)

Symbol	Definition	Source	Remarks
XBOI	quarterly imports of the ROW consuming countries of groundfish blocks, in thousand pounds of product weight	Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	The variable corresponds to the quarterly volume of groundfish blocks exported by Canada to all destinations, but the U.S.
XBT	quarterly exports of Canada of groundfish blocks (includes cod, haddock, ocean perch, pollock, sole-flounder and other seafish blocks), in thousand pounds of product weight	Canada. Statistics Canada. Trade of Canada: Exports by Commodities.	

Criteria for Evaluation

The proposed model that expresses the fundamental quantitative relationships among factors affecting the international market for frozen blocks is simultaneous in natura, as pointed out earlier in this chapter. Therefore, in a simultaneous system such as this, Ordinary Least Square (OLS) estimates will lead to biased and inconsistent estimates, because of the expected correlation between the right hand side endogeneous variables and the error terms. Since all equations are over-identified[12], the econometric techniques available for parameter estimation include: (a) in the limited-information approach: Two Stage Least Squares (2SLS or TSLS) and Limited-Information Maximum Likelihood (LIML); (b) In the full information approach: Three Stage Least Squares (3SLS), and Full-Information Maximum Likelihood (FIML). Among them, 3SLS was the chosen technique to estimate the structural coefficients in this study. The 3SLS can provide asymptotic gains in efficiency over 2SLS, the most widely used technique in applied studies with over-identified simultaneous equations.[13] When compared to FIML, 3SLS is computationally less complex and costly.

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[12] The simple necessary condition for over-identification exists if the number of excluded exogenous variables in all the equations is greater than the number of included endogenous variables less one [Johnston, (1963)].

[13] Monte Carlo studies comparing available simultaneous equations estimators "...give no clear guidelines for the choice of an estimator for econometric models...2SLS may well be the best estimator to choose since it is the cheapest and easiest method to compute". [Johnston, (1960), pp. 418]. As a full-information estimation technique, 3SLS represents an improvement over 2SLS. The OLS estimator takes no account of the difference between explanatory endogenous variables and exogenous variables. The 2SLS takes this difference into account but does not consider possible correlation between explanatory endognous variables in one equation with the errors in the other equations. The 3SLS takes the 2SLS results and corrects them using this cross-equation variance-covariance matrix of errors. If this matrix is diagonal, 3SLS results are identical to 2SLS [Intriligator (1978)].

Under 3SLS, one estimates all parameters of the structural form simultaneously and the first two stages correspond to those of 2SLS. In the first stage, the values of the endogeneous variables are predicted by OLS, using all exogeneous variables. In the second stage, the structural coefficients are determined using the values of the endogeneous variables predicted by the first stage. The third stage, is, according to Intriligator (1978):

> "...the generalized least-squares estimation of all the structural coefficients of the system, using a covariance matrix for the stochastic disturbance terms of the structural equations that is estimated from the second-stage residuals." [Intriligator, (1978), pp. 403)].

The 3SLS estimator is equivalent to the Generalized Least Squares approach, applied to single equation models when the assumptions of homoskedasticity and absence of serial correlation are dropped [Intriligator, (1978)]. Hence, it is expected that the possible violations of these assumptions in the present model can be circumvented by using the 3SLS estimation technique.

The empirical results are presented and evaluated in the next Chapter. Each estimated structural parameter is analyzed with respect to a priori theoretical expectations (discussed earlier in this chapter). The 3SLS estimated values of these coefficients are calculated, together with their respective estimated standard errors. However, the "t" test for individual coefficients is not strictly valid under 3SLS procedures (and 2SLS), since the distribution of these structural form estimates is approximately, but not exactly, normal.[14]

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[14] According to Christ (1963) pp. 515, the structural parameters ($\hat{\beta}_i$ and $\hat{\gamma}_k$) have "...normal distribution approximately (not exactly) for several reasons: $\hat{\beta}_i$ and $\hat{\gamma}_k$ are only approximately normal, not exactly, and their expectations in general do not exist and so they cannot be unbiased; the $\hat{\sigma}$,s are estimators of the approximate (not the exact) standard deviations of the $\hat{\beta}$,s and $\hat{\gamma}$,s and the $\hat{\sigma}^2$ presumably have the χ^2 distribution only approximately at best". (Note: $\hat{\beta}_i$ and $\hat{\gamma}_k$ are the structural coefficients for the endogenous variables and for the exogenous variables, respectively. The symbols $\hat{\sigma}$ and $\hat{\sigma}^2$ are also defined by Christ as the estimated variance and standard error of the parameters, respectively).

Christ (1963) suggests that, in order to draw an "approximate" statistical inference about the parameters a ratio similar to the "t" statistic can be calculated, under the assumption that this ratio has "approximately" a normal distribution. As an arbitary and subjective criterion in the present study, a coefficient on the structural form is considered, approximately, different from zero, when this ratio between the estimated value of the coefficient and its estimated standard error is greater than 1.67.[15]

The R^2 statistic (coefficient of determination) and the Durbin-Watson statistic for each equation of the system are not applicable in this case, and therefore are not calculated.[16] For that reason, in order to validate the structural forecasting model, two "goodness-of-fit" measures, suggested by Kost (1980), were chosen. Those are: (a) the root-mean square (RMS) percentage error; and (b) "Cohen-Cyert" test.

The RMS percentage of error is defined by the formula:

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[15]If the table of values for the Student "t" distribution is used, this number corresponds to a significance level of 10 percent with degrees of freedom between 40 and 50 (the number appropriate for most of the equations of the simultaneous system).

[16]The Durbin Watson test is valid only for single equation models that do not include endogenous variables as explanatory variables. As discussed by Intriligator (1978), it is possible to calculate a coefficient of determination, R^2, for 2SLS. However, this statistic does not have the same interpretation as does the R^2 statistics in OLS (i.e., the proportion of variance explained by the regression) and it can assume negative values, but cannot exceed the unity. Therefore, its calculation is not performed, considering the reduced interest here.

$$\text{RMS percentage error} = \sqrt{\frac{1}{N} \sum_{t=1}^{N} \left[\frac{\hat{Y}_t - Y_t}{Y_t}\right]^2} \tag{4.31}$$

where:

N = number of observations, or, periods;

t = time period;

$\hat{Y}_t$ = estimated value of the endogeneous dependent variable, at time period t;

Y_t = actual value of the endogeneous dependent variable, at time period t;

The smaller the RMS percentage error, the better the fit.

The test suggested by Cohen and Cyert for goodness-of-fit of the equations, [Kost, (1980)], postulates a regression of actual values of the endogeneous dependent variable on its estimated values, under the assumption that the estimated values of the variables should be approximately equal to the actual values, for all observations, for a "perfect" fit. This regression is represented by the expression:

$$Y_t = \beta_0 + \beta_1 \hat{Y}_t + e_t \tag{4.32}$$

where:

β_0 = intercept coefficient;

β_1 = slope coefficient;

e_t = error term

and the other variables are as defined in equation 4.30. The resulting regression is hypothesized to have an intercept equal to zero ($\beta_0 = 0$) and an unit slope coefficient ($\hat{\beta}_1 = 1$)[17]. In addition, the corresponding coefficient of determination (R^2)

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[17] In this case the "t" test hypothesis of significance of these coefficients are: (H_0: $\beta_0 = 0$) and (H_1: $\beta_0 \neq 0$) and the hypothesis (H_0: $\beta_1 = 1$) and (H_1: $\beta_1 \neq 1$), respectively.

is calculated and evaluated for the regression expressed in 4.31. As discussed by Kost (1980), it is expected that reliable models have low RMS percentage error, slope coefficients between the actual and predicted values close to one and high R^2 coefficients for this regression.

In addition, for comparison purposes, the corresponding results from 2SLS are estimated and reported with their respective estimated standard errors on Tables 47 and 48, together with 3SLS results.

The actual observed values of the variables are presented in Appendix 2. In general, each variable has 60 observations from quarterly data for each of the 15 years under consideration (1964-1978).

Furthermore, as indicated earlier, OLS results obtained for the same equations of the system are also estimated and reported in Appendix 3, for further consideration and comparison purposes.

V. EMPIRICAL RESULTS

In this chapter, the estimated parameters of the proposed model of international markets for groundfish blocks are presented, evaluated and analyzed. The behavioral equations (EQ1 to EQ6) are specified in double-logarithm form. This form offers two advantages over alternatives. First, as discussed earlier, it has been selected by other researchers for use in demand analysis for groundfish. Thus, comparisons with these earlier results are facilitated. Second, alternative functional forms of the relationship were considered, but the double-log form led to results which were the most "satisfactory" on statistical grounds, suggesting that the relationship among the variables selected are multiplicative rather than additive. Furthermore, while the estimated relationships do not represent retail demand or domestic supply relationships, under strict neoclassical definitions, the double-log form is useful in that it permits satisfaction of the homogeneity conditions. Some other forms, such as the linear, do not satisfy this condition unless prices are expressed in relative terms. A summary of the results obtained by 3SLS and 2SLS for the structural form coefficients is shown in Tables 47 and 48. Table 47 details MODEL I, which measures the ROW export supply prices in terms of Iceland's currency (log PICE), in equation EQ3(a). Table 48 details MODEL II in which the ROW export price is expressed, alternatively, in Norwegian currency (log PNW), in equation EQ3(b).

As a general overview of the results, it is observed that parameters estimated by 3SLS have smaller standard errors than have those estimated by 2SLS. This relative gain in "efficiency" associated with 3SLS estimators is guaranteed by the estimation process itself.[1] It is also observed that the signs of the 3SLS regression coefficients in MODEL I and MODEL II are the same and, in almost all cases, they are both in accordance with <u>a priori</u> expectations. Hence, the use of alternative currencies to measure ROW export prices does not seem to matter with respect to the general inferences that can be drawn from this analysis. In MODEL I, the estimated standard errors of the parameters are smaller

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[1]As discussed by Pindyck and Rubinfeld (1978), Zellner and Theil (1962) provided comparisons between 2SLS and 3SLS estimates of a model, showing that 3SLS parameter estimates have smaller variances than 2SLS.

Table 47. MODEL I. Empirical Results of the Simultaneous Equation System: Estimated Structural Coefficients under 2SLS and 3SLS, Estimated Standard Errors and Ratios Between Estimated Regression Coefficients and Estimated Standard Errors, Double-log, Quarterly Data, 1964-1978.

Equation	Variable		2SLS			3SLS		
	Left Hand Side	Right Hand Side	Regression Coefficient (1)	Standard Error (2)	Computed ratio (1) to (2)	Regression Coefficient (3)	Standard Error (4)	Computed ratio (3) to (4)
EQ1 - U.S. Import Demand	$TIMP_t$	Constant	3.3846	3.0047	1.13	6.9752*	2.3693	2.94
		PB_t	-2.6580*	1.1505	-2.31	-1.8807*	0.9423	-2.00
		PSP_t	2.3061*	1.1820	1.95	1.4313	0.9503	1.51
		PFF_t	2.7305*	1.0801	2.53	2.0327*	0.8925	2.28
		HB_t	-0.3723*	0.1364	-2.73	-0.1829	0.1107	-1.65
		W_t	-1.6448*	0.5759	-2.86	-0.4494	0.4692	-0.96
		TY_t	0.4139	0.7267	0.57	-0.0726	0.5714	-0.13
		S1	-0.0238	0.0767	-0.31	-0.0523	0.0741	-0.70
		S2	-0.0104	0.0106	-0.10	0.0331	0.0947	0.35
		S3	0.2989*	0.0084	3.56	0.2751*	0.0786	3.50
		T	-0.2880*	0.1302	-2.21	-0.2589*	0.1212	-2.14
EQ2 - Canadian Export Supply	XBT_t	Constant	1.4784	3.4397	0.43	0.4600	3.0253	0.15
		PT_t	0.4156*	0.2212	1.88	0.3168	0.2035	1.56
		LAN_t	0.3773	0.2288	1.65	0.4932*	0.2016	2.45
		XHB_t	0.2688*	0.1192	2.26	0.2531*	0.1033	2.45
		S1	0.0640	0.1842	0.35	0.1861	0.1654	1.12
		S2	-0.0851	0.1850	-0.46	-0.0544	0.1657	-0.33
		S3	0.1625	0.2152	0.76	0.1894	0.1928	0.98
		T	-0.8355*	0.2234	-3.74	-0.7242*	-0.2056	-3.52
EQ3 (a) - Rest-of-the World Export Supply	$IBOI_t$	Constant	8.0132*	0.3753	21.35	8.1470*	0.3377	24.12
		$PICE_t$	0.5989*	0.0851	7.04	0.6016*	0.0807	7.46
		FAO_t	0.0454*	0.0142	3.19	0.0352*	0.0121	2.91
		S1	0.0085	0.1110	0.76	0.1001	0.1083	0.92
		S2	0.2403*	0.1110	2.16	0.2309*	0.1082	2.13
		S3	0.2515*	0.1106	2.27	0.2500*	0.1079	2.32
		T	-0.2008	0.1544	-1.30	-0.2515*	0.1493	-1.68
EQ4 - Rest of the World Import Demand	$XBOI_t$	Constant	-22.8322*	10.8805	-2.10	-19.1969*	10.6428	-1.80
		PUK_t	-7.7556*	2.8516	-2.72	-6.1678*	2.7966	-2.20
		$WPUK_t$	10.1192*	3.5976	2.81	8.5231*	3.5168	2.42
		S1	-0.6252	0.8644	-0.72	-0.3940	0.8590	-0.46
		S2	-0.7052	0.8619	-0.82	-0.6575	0.8564	-0.77
		S3	0.8202	0.8622	0.95	0.9604*	0.8567	1.12
		T	0.6413	1.5274	0.42	-0.0617	1.5160	-0.04
EQ5 - Export-Import Price	PB_t	Constant	0.5323*	0.0795	6.69	0.5296*	0.0795	6.66
		PT_t	0.8512*	0.0218	38.94	0.8519*	0.0218	39.01
EQ6 - Export-Import Volume	TD_t	TS_t	1.0012*	0.0006	170.04	1.0012*	0.0006	170.04

Identities

ID1: $TD_t = TIMP_t + XBOI_t$

ID2: $TS_t = XBT_t + IBOI_t$

ID3 (a): $PICE_t = PB_t + ICE$

ID4: $PUK_t = PT_t \cdot ER_t \div UK_t$

The symbol * indicates a ratio between the estimated regression coefficient and standard error greater than 1.67.
Source: Original Data from Appendix 2.

Table 48. MODEL II. Empirical Results of the Simultaneous Equation System: Estimated Structural Coefficients under 2SLS and 3SLS, Estimated Standard Errors and Ratios Between Estimated Regression Coefficients and Estimated Standard Errors Double-log, Quarterly Data, 1964-1978.

Behavior Equation	Variable		2SLS			3SLS		
	Left Hand Side	Right Hand Side	Regression Coefficient (1)	Standard Error (2)	Computed ratio (1) to (2)	Regression Coefficient (3)	Standard Error (4)	Computed ratio (3) to (4)
EQ1 - U.S. Import Demand	$TIMP_t$	Constant	3.3846	3.0047	1.13	6.8930*	2.4531	2.81
		PB_t	-2.6580*	1.1505	-2.31	-2.3184*	0.9843	-2.35
		PSP_t	2.3061*	1.1820	1.95	1.9641*	0.9952	1.97
		PFF_t	2.7305*	1.0801	2.53	2.8207*	0.9349	3.02
		HB_t	-0.3723*	0.1364	-2.73	-0.2469*	0.1161	-2.13
		W_t	-1.6448*	0.5759	-2.86	-1.1049*	0.4934	-2.24
		TY_t	0.4139	0.7267	0.57	-0.4174	0.5940	-0.70
		S1	-0.0238	0.0767	-0.31	-0.0653	0.0742	-0.88
		S2	-0.0104	0.0106	-0.10	0.0044	0.0965	0.05
		S3	0.2989*	0.0084	3.56	0.2793*	0.0792	3.53
		T	-0.2880*	0.1302	-2.21	-0.2532*	0.1217	-2.08
EQ2 - Canadian Export Supply	XBT_t	Constant	1.4784	3.4397	0.43	0.7316	2.9396	0.25
		PT_t	0.4156*	0.2212	1.88	0.3061	0.2032	1.51
		LAN	0.3773	0.2288	1.65	0.5105*	0.1953	2.61
		XHB_t	0.2688*	0.1192	2.26	0.2068*	0.0996	2.08
		S1	0.0640	0.1842	0.35	0.1661*	0.1625	1.02
		S2	-0.0851	0.1850	-0.46	-0.1113	0.1622	-0.69
		S3	0.1625	0.2152	0.76	0.1681	0.1886	0.89
		T	-0.8356*	0.2234	-3.74	-0.7128*	0.2052	-3.47
EQ3 (b) - Rest of the World Export Supply	$IBOI_t$	Constant	9.1010*	0.3521	25.84	8.9176	0.3040	29.33
		PNW_t	1.2313*	0.2757	4.47	1.5815	0.2543	6.22
		FAO_t	0.0329*	0.0171	1.92	0.0309*	0.0140	2.21
		S1	0.0301	0.1348	0.22	0.0568	0.1271	0.45
		S2	0.2080	0.1350	1.54	0.1860*	0.1272	1.46
		S3	0.2079	0.1345	1.54	0.2019*	0.1269	1.59
		T	0.1670	0.1590	1.05	-0.0580	0.1496	-0.38
EQ4 - Rest of the World Import Demand	$XBOI_t$	Constant	-22.8322*	10.8805	-2.10	-18.4733*	10.4785	-1.76
		PUK_t	-7.7556*	2.8516	-2.72	-5.6642*	2.7693	-2.04
		$WPUK_t$	10.1192*	3.5976	2.81	8.1153*	3.4665	2.34
		S1	-0.6252	0.8644	-0.72	-0.3696	0.8589	-0.43
		S2	-0.7052	0.8619	-0.82	-0.6632	0.8562	-0.77
		S3	0.8202	0.8622	0.95	0.9500	0.8565	1.11
		T	0.6413	1.5274	0.42	-0.3293	1.5115	-0.22
EQ5 - Export-Import Price Relation-Relationship	PB_t	Constant	0.5323*	0.0795	6.69	0.5281*	0.0795	6.64
		PT_t	0.8512*	0.0218	38.94	0.8523*	0.0218	39.03
EQ6 - Export-Import Volume Relationship	TO_t	TS_t	1.0012*	0.0006	170.04	1.0012*	0.0006	170.04

Identities

I01: $TO_t = TIMP_t + XBOI_t$

I02: $TS_t = XBT_t + IBOI_t$

I03 (b): $PNW_t = PB_t \div NW_t$

I04: $PUK_t = PT_t \cdot ER_t \div UK_t$

The symbol * indicates a ratio between the estimated regression coefficient and standard error greater than 1.67.

Source: Original Data from Appendix 2.

than those in MODEL II for equations EQ1 and EQ3(a) and larger for equations EQ2 and EQ4. However, the results from MODEL I may give more general information, since Icelandic export volumes are greater than those of Norway, as previously shown in Tables 12 and 13 of Chapter III. Nonetheless, the MODEL II results are discussed in order to provide an alternative specification with which to compare the MODEL I results, i.e., to evaluate possible changes in the estimated 3SLS regression coefficients,[2] when a different currency is used in the ROW export supply equation.

To evaluate the empirical results, the procedure chosen is: (a) firstly, to discuss the 3SLS estimated values of the structural parameters in both models and compare these results with those of previous studies and with corresponding 2SLS estimates; (b) secondly, to compare the reliability of MODELS I and II, using the RMS (Root Mean Square) percentage of error and the Cohen and Cyert regression coefficient between actual and estimated values of the endogenous dependent variables, that were the chosen measures of "goodness-of-fit" of each equation in the system.

U.S. Import Demand

Equation EQ1 represents the U.S. import demand for frozen groundfish blocks. The estimated 3SLS regression coefficients, the associated estimated standard errors, and the ratios of the two are reported for both models, in Tables 47 and 48.

Except for the log TY variable, the signs of the 3SLS estimated regression coefficients agree with a priori expectations. In MODEL I, the magnitude of the estimated coefficients and their respective estimated standard errors are smaller than the corresponding values in MODEL II. The computed ratios between the estimated structural coefficients and respective standard errors in 3SLS are generally greater than the chosen 1.67 value, in both models, except for the log TY variable and the binary variables S1 and S2.

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[2]As can be seen in Tables 47 and 48, the 2SLS coefficients are the same for equation EQ1, EQ2, EQ4 in both models, since the only difference between the models is the change in an explanatory endogenous variable (ROW export price).

The estimated value of the coefficient on the import price of groundfish blocks (log PB) is negative and its magnitude suggests that a one percent increase in the U.S. import price of blocks is likely to be associated with a 1.88 percent (MODEL I), or a 2.31 percent (MODEL II) decrease in the import volumes demanded, ceteris paribus (Tables 47 and 48). The magnitudes of these coefficients indicate, for the U.S., the price elasticity of import demand for groundfish blocks is relatively high, over the relevant range. These findings can be considered consistent with those of other empirical demand estimates of the U.S. demand for groundfish products, in total, summarized earlier in Table 7, Chapter III. However, if one compares the present results with those of studies that attempted to estimate import demand relationships for groundfish blocks, in particular, such as Newton (1972) and Bockstael (1976), some important discrepancies can be observed. Under Newton's (1972) specification of demand of groundfish blocks in U.S. market, using annual (1958-1969) observations and the double-log form, a lower price elasticity was estimated, equal to -0.06 (LIML) or -0.04 (2SLS).[3] Under Bockstael's (1976) specification of the U.S. import demand for groundfish, using monthly observations (1964-1974) and the linear form, the value of the estimated direct price coefficient indicates that import volumes of blocks by the U.S. are not very sensitive to changes in import prices.[4] The present study, using a simultaneous equation, four-sector trade model and quarterly data generates an estimated price elasticity for U.S. imports of groundfish blocks considerably in excess of previous import demand estimates for this product.

Because of the way that the present model is specified, from the values of the estimated price elasticity, it is also possible to suggest that a one percent increase on the import price, due exclusively to a decrease in the exchange rate between U.S. dollars and the supplying countries' currencies tends to reduce the quantity of groundfish blocks demanded by the U.S. by 1.88 percent (MODEL I), or, by 2.31 percent

[3]The ratio between the estimated coefficients and the estimated standard errors in Newton's model are -0.16 (2SLS) and -0.21 (LIML), as reported in Table 5, Chapter III.

[4]As a matter of fact, Bockstael's "t" statistic computed for that coefficient is low and equal to -0.13 (2SLS).

(MODEL II), at given prices measured in the supplying countries' currency.

In both Models, the quarterly wholesale price of sticks and portions received by the processors (log PSP) is shown to be directly related to volumes of groundfish blocks imported by the U.S., ceteris paribus (Tables 47 and 48). The sign of this estimated coefficient is in accordance with prior expectations. The higher the output price - the wholesale price of sticks and portions - the larger the volumes of groundfish blocks American processors are willing to import. More specifically, a one percent increase in the wholesale price of sticks and portions induces a 1.43 percent increment in the quantity of groundfish blocks the U.S. wants to import, according to the results of MODEL I (Table 47). Similarly, in MODEL II, the estimated coefficient suggests that a one percent increase in wholesale prices of sticks and portions tends to increase the quantity of groundfish blocks demanded by 1.96 percent (Table 48). Thus, the results of both models indicate that, on the demand side, quarterly imports of blocks are relatively sensitive to changes in selling prices of the processed product - sticks and portions. However, in MODEL I the ratio of this estimated regression coefficient to its estimated standard error is lower than the 1.67 value (Table 47), subjectively selected as the lower bound for "statistical significance."

The positive sign in the estimated coefficient for U.S. quarterly import prices of frozen groundfish fillets (log PFF), in both Models, allows one to infer that, blocks and fillets, (both of which are made from groundfish species) are probably substitute goods in U.S. markets (Tables 47 and 48). Importers tend to increase the quantity of blocks they would import by 2.03 percent in MODEL I, when U.S. import prices of frozen groundfish fillets rise by one percent (Table 47). In MODEL II, the corresponding estimated coefficient is 1.96 (Table 48).

The beginning inventories of blocks (log HB) appear to have an inverse relationship with import volumes of groundfish blocks, ceteris paribus (Tables 47 and 48). The 3SLS estimated negative coefficent indicates that the higher the quantity of inventories of groundfish blocks, held by sticks and portions processors in the U.S. at the beginning of the quarter, the lower is the volume of groundfish blocks they are willing to import during that quarter. MODEL I indicates that a one percent increase in blocks inventories effects a decrease of 0.18 percent in import volumes of blocks demanded (Table 47). The MODEL II results also show that the same one percent increase in inventories of blocks tends to reduce blocks imports by 0.25 percent (Table 48). However, in MODEL I the ratio of the estimated coefficient to its estimated standard error registers a magnitude lower than the 1.67 value.

The estimated coefficient between wages paid in the U.S. seafood processing industry (log W) and import volumes of groundfish blocks has a negative sign, ceteris paribus (Tables 47 and 48). This supports the hypothesis that groundfish blocks and labor, applied in the conversion of blocks into sticks and portions, are complementary inputs. Hence, a one percent increase in the wages paid within the U.S. seafood industry induces a decrease in the amount of blocks imported of 0.45 percent (MODEL I), or, of 1.10 percent (MODEL II). However, different magnitudes are found in the size of the ratio between the estimated coefficients and the standard error in each model. While in the MODEL II this computed ratio equals -2.13, in MODEL I the corresponding value is much lower and equals -0.96.[5]

The estimated coefficient for the U.S. total disposable personal income variable (log TY) suggests that this variable is inversely related to import volumes of groundfish blocks in both Models (Tables 47 and 48). However, the computed ratios between those coefficients and their estimated standard errors are extremely low (-0.13 in MODEL I and -0.70 in MODEL II). This result contradicts the hypothesis that groundfish blocks (and, by extension, the sticks and portions) are a "normal" commodity in consumption. It is possible to imagine that sticks and portions, made from blocks, may be classified as "inferior goods," in the sense that as income increases, the individual will tend to consume

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[5]The drastic change in this ratio is due to a change in the value of the estimated regression coefficient, since the corresponding estimated standard error is stable in the two models (between 0.46 and 0.49). Therefore, considering the formula for estimating the structural parameters in 3SLS, the different magnitudes of the ratios may originate from differences in the values of the coefficient covariance matrix (referring to the covariance of Log PICE or Log PNW with log W values) and/or the residual covariance matrix values corresponding to Equation EQ1 with EQ3(a) or EQ3(b).

less of these fish products. However, it is also possible to hypothesize that the estimated negative sign results from problems with the data and/or with the procedure chosen to estimate the coefficient. Because income and population levels have been increasing, it is possible that the effects of both are combined here. In addition, variable log TY may also be a proxy for all other variables that experienced a similar trend, in the period under consideration, such as other price variables. On the other hand, a comparison of the 2SLS and the 3SLS results, shows contradictory signs of this estimated coefficient. Furthermore, the negative income coefficient estimated by 3SLS (which is asymptotically more efficient than that from 2SLS) is not surprisingly different from findings of previous groundfish demand studies, at various market levels (refer to Table 7, Chapter III), in which mixed signs and statistically non-significant results were obtained. In a double-log demand function for sticks and portions estimated at retail, with monthly observations, and reported in Bockstael's (1976) study (pp. 105), the estimated income coefficient was found to be negative (-0.18) and to have a low "t" value (-0.38).

Perhaps a factor contributing to these results is the failure to distinguish among the variables affecting the retail consumption of sticks and those affecting the retail consumption of portions in the present model. Rising incomes may be associated with increased consumption of food away from the home and decreased consumption at home. This lack of proper specification of the variables associated with the consumption of sticks at home and with the consumption of portions away-from-home in the U.S. import demand, may lead to an unexpected sign for the estimated income coefficient in the import demand for blocks. Perhaps, then, a more complete specification would yield different results. The diversity of the markets in which sticks and portions are distributed may call for a set of demand equations, such as those discussed in Chapter IV, equations 4.18 and 4.19. As pointed out earlier, Prochaska and Schrimper (1973) discussed a similar problem related to the apparent inconsistency between the decline in expenditures on food consumption away-from-home and increase in income levels in the U.S., during the last two decades:

> "...suggested that either specification errors may have affected previous income elasticity estimates or there have been sufficient changes in other factors, including relative price changes, to have more than offset any differential income effects" [Prochaska and Schrimper (1973), pp. 596].

For these reasons, Prochaska and Schrimper, when estimating the demand for food away-from-home, introduced the opportunity cost of the homemaker's time as a variable and obtained the expected positive relationship between income and food consumed away-from-home. Thus, an investigation of the factors associated with the consumption of sticks and portions at home and/or away-from-home would be an interesting extension of the present work.

The estimated coefficients for the seasonal binary variables, in both models, indicate an upward shift in the demand of groundfish imported by the U.S. during the third quarter of the year (log S3), other things remaining constant (Tables 47 and 48). That increment in imports of blocks may be related to the expected increase,during the third quarter, in the consumption of sticks and portions with the re-opening of public schools, as discussed in Chapter III.

The binary variable accounting for the post-1972 period (log T) has a negative estimated coefficient, indicating that events of the 1972-73 period, such as increases in freight costs due to the 1973 oil embargo and the dock strikes at U.S. ports among other factors, tended to reduce the U.S. demand for groundfish blocks.

Canadian Export Supply

Estimated regression coefficients (3SLS), respective estimated standard errors and their computed ratios are reported for the Canadian export supply of groundfish blocks, in equation EQ2, for MODELS I and II, in Tables 47 and 48. The signs of the estimated coefficients agree with expectations. In MODEL I, most of the estimated coefficients are larger than their corresponding values in MODEL II. However, the 3SLS estimated standard errors in the latter are consistently smaller than in the former. The computed ratio of estimated parameters to their standard errors registered values greater than 1.67, in both models, for the variables Log LAN, log XHB and T.

The estimated positive direct price elasticity coefficient of log PT supports the hypothesis that the higher the export price of Canadian groundfish blocks, the greater the quantities of blocks Canadian suppliers wish to export (Table 47 and 48). Other things being constant, an increase of one percent in the Canadian export price is associated with an increase in exports of blocks of 0.32 percent (MODEL I), or of 0.31 percent (MODEL II). From these figures, (but with caution due to the large size of the standard errors) one may conclude that the Canadian export supply of blocks is relatively price inelastic. That is, the Canadian exporters do not change, to a large degree, their quarterly export volumes in response to changes in the corresponding export prices, <u>ceteris paribus</u>. In contrast, the 2SLS results yielded a greater estimated regression coefficient, i.e., a higher supply price elasticity, and this value is associated with a larger ratio of this coefficient to its standard error. Therefore, the conclusion that Canadian exports respond relatively little to changes in prices needs to be viewed with some reservation, since some variables selected initially to be considered in this export supply, on theoretical grounds, were excluded because of lack of data (refer to Chapter IV). Fluctuations in exchange rates, between Canadian and other importing countries' currencies, may also change the export volumes by the same percentage magnitude indicated by the direct price coefficient, for given prices measured in the consuming countries' currency.

The 3SLS estimated regression coefficient for groundfish landings in Canada (log LAN) has a positive sign in both MODELS, as was expected. The quantity of blocks available for export is directly related to the volume of groundfish landings in Canada available to be processed into blocks (Tables 47 and 48). <u>Ceteris paribus</u>, a one percent increment in Canadian groundfish landings tends to increase blocks exports from Canada by 0.49 percent (MODEL I), or, by 0.20 percent (MODEL II). The reason that landings were substituted for ex-vessel groundfish prices, PEX, (which is the variable initially specified in the proposed Canadian export supply, equation 4.28, Chapter IV) is that collinearity problems were found in estimating this equation when PEX was included. The ex-vessel prices were replaced by landings, under the assumption that landed volumes are assumed to be exogenously determined by non-economic factors and are affecting ex-vessel prices directly. The levels of landings tend to determine the ex-vessel prices and not vice-versa. In the majority of the previous studies of seafood prices at the ex-vessel level, inverse demand equations were estimated, under this assumption. Referring to Table 7, it is observed that most of the equations correspond to inverse demand relationships.

Inventories of blocks (log XHB), held at the beginning of the period by Canadian processors,present a positive estimated coefficient (3SLS) in both MODELS I and II (Tables 47 and 48). The size of these coefficients indicates that, other things constant, an increase in inventory levels of groundfish blocks in Canada by one percent leads to a growth in the quantities exported of 0.25 percent (MODEL I), or, of 0.21 percent (MODEL II). As was expected, the inventory holdings on the supply side of the market play a different role than do those inventories held by the blocks consuming countries. From the point of view of Canadian processors, inventories of blocks, held by them, constitute an additional source of product available for export. In contrast, the inventories of blocks, held by U.S. sticks and portions processors,are used for a different purpose: to adjust seasonal consumption patterns of sticks and portions to the seasonal variations of imports of blocks.

The high estimated standard errors associated with low estimated seasonal coefficients of the binary variables (log S1, S2 and S3) may indicate that there is little seasonality in Canadian export supply not already accounted for. That is, possible seasonal shifts in supply not included in other variables in this equation and/or seasonality associated with domestic consumption of blocks in Canadian markets may not be important to export of blocks from this country, as initially proposed.

A negative coefficient estimated (3SLS) for the cyclical variable (log T) supports the hypothesis that there is a downward shift in groundfish blocks supplied by Canada after 1972, other things remaining constant (Tables 47 and 48). Events since 1972, when major changes occurred in the magnitude of freight costs, induced by the oil embargo, were translated into a steady increase in export prices (refer to Figures 8 and 9, Chapter III), reducing the export supply by Canada after 1972.

The 2SLS estimated structural coefficients in this equation, in general, agree with those obtained by 3SLS in terms of their respective signs.

ROW Export Supply

The estimated structural regression coefficients (3SLS) for the ROW export supply for groundfish blocks, the respective estimated standard errors and their computed ratios are reported in equations EQ3(a) (MODEL I) and EQ3(b) (MODEL II), in Tables 47 and 48.

The signs of these estimated coefficients agree with expectations. By and large, the 3SLS estimated standard errors in the MODEL I are smaller than these in the MODEL II. The ratio of the estimated coefficients to their standard errors are always larger in the former than in the latter.

The 3SLS estimated positive direct price elasticity (the coefficients of log PICE or log PNW) confirms the hypothesis that the higher the price of groundfish blocks, received by the ROW exporters, the larger the volumes exported, ceteris paribus (Tables 47 and 48). In MODEL I, a change of one percent in the export prices of blocks received by Icelandic suppliers is associated with a 0.60 percent change in the volumes exported by the ROW (Table 47). At given prices abroad, a similar magnitude of increase in the export volumes is expected, if the exchange rate between Iceland and the consuming countries' currencies changes. In MODEL II, an increment of one percent in the export price of blocks received by Norwegian suppliers is associated with a change, in the same direction,of 1.58 percent in ROW exported volumes of blocks (Table 48). Recognizing the limitation of these equations because of lack of data, one can infer that ROW export supply tends to be comparatively more price elastic than is the Canadian supply. Perhaps the smaller magnitude of the Canadian export supply elasticity is associated with the smaller importance of the domestic market there. The lower the volumes of blocks that are absorbed by domestic processors, the lower the sensitivity of the volumes of blocks available for export to changes in the export prices received by the blocks producers in Canada, other things constant. In contrast, the volumes exported by the major ROW block producers countries may be relatively more sensitive to changes in export prices than Canadian exporters, because of more alternatives in their domestic markets.

In both models, positive coefficients estimated for the cod landings variable (log FAO), suggest that the higher the quarterly availability of cod species in these countries (the raw material in the manufacture of blocks), the larger the volumes of blocks exported by the ROW producing countries, other things constant (Tables 47 and 48). For a given one percent increase in Atlantic cod landings, the quantity exported by ROW countries increases by 0.04 percent (MODEL I), or by 0.03 percent (MODEL II). The small magnitude of this coefficient relative to that in the Canadian equation could perhaps be associated with the differences between the variables representing ROW and Canadian landings. The former only includes cod species, while the latter, all groundfish.

With respect to the seasonal variables, it appears that, in the second and third quarter, (log S2 and S3) there are seasonal shifts in the ROW exports of blocks not captured by the remaining variables in this supply function. These may relate to consumption patterns in the ROW exporting countries, as suggested earlier.

The binary variable log T, representing a possible shift in the ROW exports after the 1972 period due to increase in freight costs from the oil embargo, shows an estimated negative coefficient, ceteris paribus, in both Models (Table 47 and 48). However, comparing the size of this coefficient between MODEL I and MODEL II, it is apparent that, when the ROW export supply price is expressed in Icelandic currency (log PICE in MODEL I), the percentage decrease in ROW export supply is more accentuated than when Norwegian currency is considered (log PNW in MODEL II).

Except for the binary variable log T, equation EQ3(b) in MODEL II, the signs of the 2SLS estimates are equal to those of the 3SLS estimates.

ROW Import Demand

Equation EQ4 is the ROW import demand for frozen groundfish blocks. The estimated regression coefficients (3SLS), respective estimated standard errors and their computed ratios are reported, for both Models, in Tables 47 and 48.

Although the standard errors estimated by 3SLS are lower than those estimated by 2SLS in this equation EQ4, these differences are small. This probably means that 3SLS contributed very little to the gains in efficiency of the estimated results obtained from 2SLS in this particular equation. The values of the computed ratios between estimated coefficients and standard errors are low, except for the ROW import price variable (log PUK) and the Wholesale Price Index for food in the U.K. (log WPUK).

Hence, the empirical results in this equation need to be interpreted with particular caution, due to possible specification errors associated with severe data limitations. In both models, a negative direct price coefficient (log PUK) is obtained, as was expected (Tables 47 and 48). This suggests that the higher the price paid for block imports by the ROW consuming countries, the lower are the volumes imported by these countries, <u>ceteris paribus</u>. A one percent increase in ROW import prices tends to induce a reduction in ROW import volumes by 6.2 percent (MODEL I), or, by 5.7 percent (MODEL II). If this coefficient is reflecting the "actual" magnitude of the demand price elasticity of the ROW consuming countries, one can infer that the ROW import demand is highly price-elastic. Furthermore, the ROW import demand is more price-elastic than the estimated U.S. import demand relationship (which is 1.89 percent, or, 2.32 percent in MODEL I and II, respectively). Perhaps this is found to be the case because, in the U.K., a smaller proportion of the domestic consumption of groundfish blocks is drawn from imports. As mentioned earlier in Chapter III, the U.K. does not rely exclusively on imports of blocks to satisfy its demand for sticks and portions (or similar types of seafood products sold at retail), such as is the case of the U.S. The U.K., besides being a net fish importer, is one of the largest European fish producing countries. Thus, because of this competition from domestic product, it is not surprising that the price elasticity of ROW import demand, represented by the U.K. market, is higher than that of the U.S. import demand for groundfish blocks.[6]

The estimated 3SLS coefficient for the Wholesale Price Index for food in the U.K. is found to be positive in both models (Tables 47 and

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[6]As shown in Table 40 and 41, the U.K. gradually increased domestic frozen fish production, in the 1970-77 period.

48). However, due to the level of aggregation for this variable, it is difficult to arrive at a clear-cut interpretation of the coefficient. In general, it can be inferred, by the magnitude of this estimate, that a one percent increment in the Wholesale Food Price Index in the U.K. induces an increase in ROW imports of blocks by 8.11 percent (MODEL I), or, by 8.52 percent (MODEL II), ceteris paribus. Furthermore, this variable may be serving as a proxy for other variables. This may be the case for the selling price of products produced with groundfish blocks (the output prices) and for the prices of other inputs, hired in the conversion of blocks into a product form suitable for individual consumption. In the former case, a positive estimate would be expected while either a positive or a negative coefficient is consistent with the latter interpretation, depending upon whether these other inputs are substitutes or complementary with groundfish blocks in production.

The estimated coefficients for the seasonal binary variables indicate an upward shift in the ROW import demand for groundfish blocks during the third quarter of the year (log S3), in both MODEL I and MODEL II, ceteris paribus (Tables 47 and 48). These results seem to suggest a seasonal pattern in the ROW consumption of blocks similar to that discussed in the U.S. import demand, although the coefficient of this binary variable, log S3, has a relatively high standard error in the ROW import equation, EQ4.

The negative coefficient estimated for the variable which distinguishes between the pre and post 1972 period (log T), contrary to the coefficients for the same variable in the other equations of the system, shows a ratio of this coefficient over the estimated standard error, which is extremely low in both MODELS I and II (Tables 47 and 48). Perhaps a possible explanation for this empirical result is that fuel cost may be a less significant part of the costs of blocks for the ROW consuming countries.

"World" Export-Import Price and Trade Relationship

As previously discussed in Chapter IV, equations EQ5 and EQ6 were chosen, respectively, to represent the "equilibrium conditions" for: (a) import-export prices of groundfish blocks; and (b) the import-export quantities traded in the "world" market of groundfish blocks. Identities, normally utilized to represent these market equilibrium positions in a simultaneous system, were avoided because export and import sources of data differ, as do the monetary units expressing each sector of the market.

The estimated regression coefficient obtained indicates that a one percent change in the Canadian export price (log PT) is associated with a 0.85 percent change in the U.S. import price of groundfish blocks (log PB) in the same direction in both Models (Tables 47 and 48).

The estimated relationship between the "world" export volume (log TS) and the "world" import volume (log TD) of groundfish blocks indicates that a one percent change in the latter corresponds to the same one percent change in the former in the same direction, ceteris paribus (Tables 47 and 48). This indicates that despite the use of different sources of data to construct these two proxy variables for "world" trade flows, the estimated slope coefficient approximately one, as would have been the case, if that relationship had been expressed by an identity, instead. The advantage of the former expression over the latter, is that a stochastic error term was considered explicitly.

Identities

With the identities ID1 through ID4 the sytem of equations is fully identified (Tables 47 and 48). As mentioned previously, the ID1 and ID2 identities represent the composition of the total "world" demand and supply, respectively. The ID3 and ID4 identities correspond to the transformations of: (a) the U.S. import price into the ROW export price and; (b) the Canadian export price into the ROW import price.

Model Validation

Using the proposed measures to evaluate the goodness-of-fit of the models discussed in Chapter IV, it is possible to infer that the estimated 3SLS values of the dependent endogenous variables of the system are reliable representations of the actual values of these variables, except for equation EQ4. As shown in Table 49, the calculated RMS percentage of error is low for the first three behavioral equations

Table 49. Summary of Goodness-of-Fit Statistics for Each Endogeneous Variable in MODEL I and MODEL II, Estimated by 3SLS, 1964-1978.

Equation & model	Dependent Endogeneous Variables	Mean of the log of actual value	RMS percentage of error[1]	Cohen & Cyert Test			
				Slope Coefficient (b)			
				Estimated Value (slope)	"Standard" error	"t" (2)	R^2
MODEL I							
EQ 1	log TIMP	11.1313	0.0161	0.9679	0.0815	0.39	0.70
EQ 2	log XBT	9.8051	0.0368	0.7296	0.8459	0.32	0.56
EQ 3	log IBOI	10.7235	0.0339	0.8495	0.0982	1.53	0.56
EQ 4	log XBOI	5.4704	13.2128	0.6938	0.2622	1.17	0.12
MODEL II							
EQ 1	log TIMP	11.1313	0.0165	0.9486	0.0820	0.63	0.70
EQ 2	log XBT	9.8051	0.0317	0.9611	0.0940	0.41	0.64
EQ 3	log IBOI	10.7235	0.0348	0.8906	0.1061	1.03	0.55
EQ 4	log XBOI	5.4704	13.2047	0.7286	0.2720	0.99	0.11

[1]RMS stands for Root Mean Square

[2]Hypothesis test is $H_0: b = 1$ against the alternative $H_1: b \neq 1$ at 5 percent of significance

of the system, especially for equation EQ1 in which this percentage is 0.02, in both MODEL I and MODEL II. The equations EQ2 and EQ3 also have low values, around 0.03 percent, in both models. However, a large error of 13.21 percent is associated with the estimated values of EQ4. According to this test, equation EQ4 is not a wholly satisfactory representation for the ROW import demand for groundfish blocks. An alternative specification of this relationship would be desirable, if the lack of data is eliminated. The results of the RMS test seem to indicate that with respect to "goodness-of-fit", whether one measures the export price of ROW producing countries with Icelandic (MODEL I) or Norwegian currency (MODEL II) makes little difference. In Appendix 4, the individual values for RMS for each equation are reported for further evaluation.

By the same token, the resulting regression between actual and estimated values of the dependent endogenous variables of the system, as suggested by Cohen and Cyert, demonstrates that the slope coefficients are not significantly different from one, at the 5 percent level in all equations of the system, in both models (Table 49). However, the computed coefficients of determination (R^2) for these regressions show that equation EQ4 is able to "explain" only 12 percent of the changes in the actual values of the dependent variable. Equation EQ1 registered the largest R^2 value, 0.70, suggesting that 30 percent of the change in the volumes imported by the U.S. is left "unexplained" by this estimated equation. The calculated R^2 values for equations EQ2 and EQ3 are between 0.55 and 0.64.

Based on two measure results, further improvements on the specification, especially for equation EQ4, representing the ROW imports, would be desirable. Perhaps, the proposed model specification in Chapter IV, would yield "better" results, by statistical criteria, when appropriate data are available.

VI. SUMMARY AND CONCLUSIONS

Summary

This study is an empirical analysis of the international market for frozen groundfish blocks. The primary objective is to improve understanding of the interrelationships among production, consumption and trade flows, considering the emerging changes from extended jurisdiction over fish resources. The choice of this particular frozen product for analysis is related to the fact that: (a) groundfish are likely to be the fish species most strongly affected by this extended jurisdiction; (b) groundfish blocks represent a significant portion of the international flows of trade of fish products and; (c) demand for "ready-to-eat" seafood products - made from blocks - has trended upwards worldwide.

In pursuing this objective, a simultaneous equations model is built, attempting to determine and quantitatively evaluate the more relevant forces affecting the import-demand and export-supply for frozen groundfish blocks in the international market. The period of analysis is 1964-1978, the data used are quarterly and the estimation procedure is 3SLS (Three Stage Least Squares). The model of the present study is constructed with reference to: (a) the framework provided by the supply and demand theory, international trade models and their implications for applied work; (b) the contributions of previous empirical studies of groundfish markets in general, and of markets for groundfish blocks in particular; and (c) the available secondary data on trade flows and related information for frozen groundfish blocks.

The empirical implementation of the proposed economic model is constrained by the impossibility of obtaining the desirable monthly or quarterly data for the major importing and exporting countries, other than the United States (U.S.) and Canada. The other countries' specific national fisheries statistical publications in which most of these desirable quarterly data are reported were not readily available. Therefore, an adjusted model of international trade is constructed, in such a way that those limitations could be circumvented, without incurring, necessarily, excessive oversimplification and/or specification bias.

The resulting partial equilibrium model of international markets for groundfish blocks contains two sectors: the "demand" and the "supply" side. The "demand side" is composed of two specific areas: the U.S. market and the rest-of-the-world (ROW) importing countries' market. Similarly, the "supply side" of the market is subdivided into two areas: the Canadian market and the rest-of-the-world (ROW) exporting countries' market. Given the mentioned impossibility of determining quarterly trade flows and import-export prices of groundfish blocks for ROW countries, these figures are, indirectly, estimated by using Canadian export and U.S. import data. It is assumed that: (a) the quarterly ROW import volumes of blocks are, approximately, equal to the quarterly Canadian export volumes to all destinations, but the U.S., (b) the quarterly ROW export volumes of blocks are, approximately, equal to the U.S. import volumes from all origins,but Canada; (c) the quarterly ROW unit import price of blocks is represented by the Canadian weighted average export price to all destinations, converted into the ROW importing countries' currency (the U.K. currency); (d) the ROW unit export price of blocks is represented by the U.S. weighted average import price of blocks from all origins, converted into the ROW exporting countries' currency (Icelandic or Norwegian currency). In MODEL I, this ROW export price is expressed in Icelandic currency (the Krona). In MODEL II, this ROW export price is, alternatively, expressed in Norwegian currency (the Krone), in order to determine the sensitivity of the results to changes in the ROW chosen currencies.

In the model, it is assumed, by hypothesis, that the international market for frozen groundfish blocks tends to be competitive and that the quarterly equilibrium prices and trade flows are determined within the system. This justifies the use of a simultaneous equations approach for estimation purposes. Three Stage Least Squares (3SLS) is the procedure chosen to estimate the structural coefficients, since 3SLS can provide asymptotic gains in efficiency over 2SLS (Two Stage Least Squares) for large samples. These results are compared with those obtained with 2SLS and the behavioral equations of the system are estimated in double-log form.

The construction of the demand sector of the model (MODEL I and II), that is, the equations representing the net quarterly imports of groundfish blocks in the U.S. and in the ROW consuming countries, hypothesizes that trade flows vary with respect to: (a) the import price of groundfish blocks; (b) the price of the seafood products that utilize groundfish blocks as their raw material, such as fish sticks and portions; (c) the prices of alternative products in consumption; (d) the prices of other inputs applied in the conversion of groundfish blocks into product forms suitable to individual consumption; (e) cold storage holdings of blocks at the beginning of the period in the importing countries; (f) the possible seasonal and cyclical factors, affecting the demand for groundfish blocks; (f) the total income; (g) the exchange rate.

Most of the signs of the 3SLS estimated structural regression coefficients for the import demand of blocks were in accordance with a priori expectations. In the U.S., the block demand price elasticity seems to be relatively high in both Models, with a value around -2.00. Because of the way the model was formulated, the same inverse change in U.S. imports of blocks is expected to occur from fluctuations in the exchange rates between U.S. and supplying countries' currencies, at given prices expressed in the currencies of the supplying countries. An increase in the wholesale price of sticks and portions, or, in the import price of frozen groundfish fillets is associated with an increment in the U.S. imports volumes of groundfish blocks. Demand for blocks also increases in the third quarter of the year. In contrast, a change in the inventories of blocks at the beginning of the quarter in the U.S., or, in the wages paid to labor in the U.S. seafood industry induces a change in the opposite direction in the volume of blocks imported by the U.S. Quarterly demand also, apparently, fell during the post 1972 period. However, contrary to prior expectations, the estimated structural coefficient for U.S. total disposable personal income is negative, suggesting that either specification errors may be present in this variable, or that groundfish blocks (and sticks and portions, by extension) may be classified as "inferior" goods in consumption in the U.S. market.

For the ROW importing countries, the U.K. data are used for several variables. The estimated ROW demand price elasticity is extremely high, around -6.00, considering the results of MODELS I and II. A possible explanation for this coefficient value when compared with that for the U.S., is that, in the ROW importing countries a smaller proportion of domestic consumption of blocks is drawn from imports. A positive relationship between ROW imports and the U.K. Wholesale Price Index for food is found but, due to the level of aggregation of this variable, it is difficult to interpret this result. This variable may serve simultaneously as a proxy for the price of commodities related to groundfish blocks in consumption, the selling price of products produced from groundfish blocks and/or the price of other inputs. The expected seasonal and post-1972 shifts in the U.S. import demand for blocks are not observed to be relevant in the case of the ROW demand relationship.

In developing the supply sector of the present model, that is, the equations expressing the net quarterly exports of groundfish blocks in Canada and in the ROW exporting countries, it is assumed that the amount exported varies with respect to: (a) the export price of groundfish blocks; (b) the ex-vessel prices of groundfish species, paid by the groundfish block producers; (c) the cold storage holdings of blocks in the exporting countries, at the beginning of the period; (d) the seasonal and cyclical binary variables, representing at the same time, supply related factors that may be not captured by the remaining variables in this equation and/or domestic patterns in the consumption of blocks within the ROW exporting countries' markets; (e) the exchange rate.

The structural coefficients estimated by 3SLS for the export supply relationships are in accordance with a priori hypotheses for both MODELS I and II. In Canada, the block export price elasticity is relative low, around 0.30. Fluctuations in exchange rate, implicity included in this export price variable, may also change the Canadian export volumes by the same amount, for given prices in the consuming countries. Increments in the groundfish landings in Canada tend to change the export volumes of blocks in the same direction. The landing variable replaced the initially proposed ex-vessel prices of groundfish species in Canada, in order to eliminate collinearity problems with the export prices. This variable substitution is supported by the assumption that catch directly affects ex-vessel prices and is exogenously determined by non-economic factors. The inventories of blocks, held by Canadian processors, are positively related to the level of exports, since stocks constitute an additional source of product availability for exports. The seasonal shift variables do not play a predominant role in the Canadian export supply of groundfish blocks, while a downward turn in supply is observed after the 1972 period.

In the ROW exporting countries, the estimated block supply price elasticity, 0.60 and 1.58 in MODEL I and II, respectively, is higher than that found for Canadian block exports. This can possibly be explained by the fact that the role of domestic consumption of blocks in Canada is relatively small and there may be fewer alternatives for Canadian producers. In both MODELS I and II, the larger the quarterly cod landings in Iceland, Norway and Denmark, the greater the volumes exported by ROW supplying countries. It appears that the binary variables representing the second and third quarter of the year uncover an increase in the ROW export supply not captured by the remaining supply related variables and/or reflecting some seasonal pattern in the consumption of blocks in ROW block producing countries. In contrast, in the period after 1972, a reduction is observed in the ROW supplying countries' exports of groundfish blocks.

The equilibrium position of "world" trade flows and prices in this simultaneous system are represented by behavioral equations instead of the usual identities, since different sources of data were used to estimate these figures. As a consequence, "random errors" are expected and can be accounted for by using behavioral equations. With four additional identities, the system of equations in the model is fully identified: (a) the former two identities express the composition of the variables representing volumes of total "world" demand and total "world" supply, traded in the international markets of groundfish blocks; (b) the latter two identities correspond to the definitions of the ROW export price and the ROW import price of groundfish blocks.

In addition, it is observed that the structural parameters estimated by 3SLS have smaller standard errors than have those estimated by 2SLS, indicating that gains in "efficiency" are associated with 3SLS, for this data set. Also, it is observed that the signs of the 3SLS estimated structural coefficients are the same in both MODEL I and MODEL II, and in almost all cases, are in agreement with prior expectations, suggesting that alternative currencies used to measure ROW import price do not change the basic inferences drawn from the analysis.

Using the RMS (Root Mean Square) percentage of error to measure the goodness-of-fit of the equations, it is possible to infer that the 3SLS estimated values of the dependent endogenous variables of the system are reliable approximations of the actual values, over the relevant range. An exception to this is made for the equation representing the ROW imported volumes. By the same token, the resulting regression between actual and estimated values of these dependent endogenous variables, suggested by Cohen and Cyert for simultaneous model validation, indicates that the slope coefficients are not significantly different from unity at the 5 percent level of significance. This lends further support to the reliability of the model, except for the ROW import demand equation.

Conclusions and Suggested Directions for Future Research

Despite the many data constraints, the results suggest that the equilibrium prices and trade flows of groundfish blocks in the international markets can be viewed as being simultaneously determined on a quarterly basis, considering the conjunction of forces underlying the markets for the U.S., Canada and the ROW importing and exporting countries for this product form. The estimated structural equation coefficients, in almost all cases, are consistent with prior expectations, and predicted values of the endogenous dependent variables are very close to the observed values.

If important data limitations could be eliminated, a more detailed analysis might emerge, enlarging upon the conclusions reached in the present study, especially in the representation of the ROW import demand relationship.

There are a number of lines along which the research done in this study could be extended and improved. Firstly, the U.S. import demand of groundfish blocks could be refined by introducing an investigation of the factors associated with the consumption of sticks and portions at home and/or away-from-home, in order to avoid specification errors that may have affected the income elasticities estimated in this study.

In pursuing this investigation, there is no need to obtain a longer series of data on retail prices of sticks and portions, such as that recently begun by the N.M.F.S. (National Marine Fisheries Service) for 10 cities in the U.S. By the same token, it may be of interest to determine specific information on transportation costs of frozen groundfish blocks imported by the U.S. These data could replace the binary variables that attempted to represent gross changes in transportation costs, particularly those that have taken place since the 1973 oil embargo.

Secondly, the Canadian export supply for groundfish blocks deserves better specification, permitting all variables selected on theoretical grounds to be included. Such is the case of other input prices and the prices of alternative production uses of groundfish blocks in Canada. In this respect, Canadian prices and volumes of frozen groundfish fillets and salted groundfish exported - the other main uses for the Canadian groundfish catch - could be eventually introduced in the model and treated as endogenously determined in the system. Also, the inventories of blocks held by Canadian processors could be treated as an endogenous variable (instead of pre-determined as was done here), if one argues that Canadian and other suppliers are holding these inventories at levels dictated by the current and expected prices.

Thirdly, the ROW demand and supply for groundfish blocks needs to be estimated with actual quarterly data collected from those countries fisheries statistics, in order to compare the present results, obtained by using proxies for those relevant variables.

Finally, as a suggestion with respect to methodology, the international trade for groundfish blocks could be constructed as a spatial equilibrium model, using the preliminary information suggested by this study, and collecting the additional data to estimate the supply and demand relationships for groundfish blocks in most of the major exporting and importing countries, together with data on transportation costs. By the same token, a temporal equilibrium model can also be constructed with this data by substituting transportation costs by storage costs. Alternatively, a combination of temporal and spatial model could be performed as a further refinement of the study of groundfish blocks traded internationally.

BIBILOGRAPHY

Aegir, 1979. Rit Fiskifedlags Islands, Reykjavik: Mai. (Iceland)

Anderson, L., 1977. The Economics of Fisheries Management. Baltimore: The John Hopkins University Press.

Armington, P.S., 1969. "A Theory of Demand for Products Distinguished By Place of Production." International Monetary Fund Staff Papers, 16: 159-78.

Artus, J. and R. Rhomberg, 1973. "A Multilateral Exchange Rate Model." International Monetary Fund Staff Papers, 20: 591-608.

Bates, T. and A. Schmitz, 1969. A Spatial Equilibrium Analysis of the World Sugar Economy. Giannini Foundation Monograph 23, University of California, Berkeley.

Batie, S., 1974. "The United States' Importation of Fishery Products: An Econometric Case Study of the Southern Atlantic and Gulf Shrimp Industry." Unpublished Ph.D. Dissertation, Oregon State University.

Bawden, D.L., 1966. "A Spatial Price Equilibrium Model of International Trade." Journal of Farm Economics, 48(4): 862-74.

Bell, F., 1968. "The Pope and the Price of Fish." The American Economic Review, 58(5): 1346-50.

_____, 1978. Food From the Sea: The Economics and Politics of Ocean Fisheries. Boulder: Westview Press Inc.

_____ et al., 1970. A World Model of Living Marine Resources. In: Labys, W., Quantitative Models of Commodity Markets. Cambridge: Ballinger Publ. Co., 1975.

Bockstael, N., 1976. "Analysis of Investment Behavior and Price Determination." Unpublished Ph.D. Dissertation, University of Rhode Island.

Brain, K. and R.L. Jack, 1973. Interregional Competition in the Fresh Apple Industry. West Virginia Agricultural Experimental Station Bulletin, 612.

Canada. Department of Fisheries and Oceans, 1979. Worldwide Fisheries Marketing Study: Prospects to 1985. Overview. Ottawa: Fisheries Economic Development and Marketing, Department of Fisheries and Oceans.

Canada. Statistics Canada, 1964-1978. Fish Freezing and Stocks. Ottawa: Canada Bureau of Statistics.

_____, 1964-1978. Monthly Review of Canadian Fisheries Statistics. Ottawa: Canada Bureau of Statistics.

_____, 1964-1978. Trade of Canada: Export by Commodities. Ottawa: Canadian Bureau of Statistics.

Charbonneau, J. and R. Marasco, 1975. A Positive Spatial Equilibrium Model of Oyster Markets: A Simultaneous Equation Approach. Agricultural Experimental Station MP 873, University of Maryland, College Park.

Christ, C.F., 1966. Economic Models and Methods. New York: John Wiley & Sons, Inc.

Dantiz, G.B., 1951. Programming of Interdependent Activities: Mathematical Model. In: Koopmans, T., Analysis of Production and Allocation. New York: John Wiley & Sons, Inc.

Dean, G. and N. Collins, 1967. World Trade in Fresh Oranges: An Analysis of the Effects of European Economic Community Tariff Policies. Giannini Foundation Monograph 18, University of California, Berkeley.

deJanvry, A.C., 1966. "Measurement of Demand Parameters under Separability." Unpublished Ph.D. Disseration, University of California, Berkeley.

Denmark. Fiskeriminsteriet, 1972-1974. Fisherikeretining For Aret 1972-73-74. København; Fiskeriminsteriet.

Enke, S., 1951. "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue." Econometrica, 19:40-48.

Farrell, J. and H. Lampe, 1967. The Revenue Implications of Changes in Selected Variables Examined in the Context of a Model of Haddock Market. In: Bell, F., and J. Hazleton, Recent Developments and Research in Fisheries Economics. New York: Oceana Pub. Inc.

Fishing News International, 1980. "Too Much Cod!". England: August, vol. 19, no. 8.

Food and Agricultural Organization (F.A.O.) of the United Nations, 1964-1977. Yearbook of Fishery Statistics. Rome: Food and Agricultural Organization of the United Nations.

Forrester, J.W., 1971. World Dynamics. Cambridge: Wright Allen Press.

Fox, K., 1953. "A Spatial Equilibrium Model of the Livestock Feed Economy." Econometrica 21: 547-66.

_____ and R. Tauber, 1955. "Spatial Equilibrium Models of the Livestock-Feed Economy." American Economic Review,45(4): 584-608.

George, P. and G. King, 1971. Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannini Foundation Monograph 26, University of California.

Goldman, S. and H. Uzawa, 1964. "A Note on Separability in Demand Analysis." Econometrica 32(3): 387-98.

Greennes, T. et al., 1978. The Economics of World Grain Trade. New York: Praeger Publishers.

Guedry, L. and G. Judge, 1965. The Spatial Structure of the Feed Grain Economy. University of Illinois: Dept. Ag. Econ. AERR-78.

Hall, H., et al., 1968. "Quadratic Programming Solution of Competitive Equilibrium for United States Agriculture." American Journal of Agricultural Economics, 50: 536-555.

Hassan, Z. and S.R. Johnson, 1976. Consumer Demand for Major Food in Canada. Ottawa: Agriculture Canada, Economic Branch Publication, 76/2.

Henry, W. and C. Bishop, 1957. North Carolina Broilers in Interregional Competition. North Carolina State College Agricultural Exp. Inform. Service, 56.

Houck, J., 1965. "The Relationship of Direct Price Flexibility to Direct Elasticties." Journal of Farm Economics, 43(3).

Hsiao, J. and M. Kottke, 1968. Spatial Equilibrium Analysis of the Dairy Industry in the Northeast Region: An Application of Quadratic Programming. Connecticut Agricultural Experimental Station Bulletin, 405, (Storrs).

Intriligator, M., 1978. Econometric Models, Techniques and Applications. Englewood Cliffs: Prentice-Hall, Inc.

Johnston, J., 1960. Econometric Methods. New York: McGraw-Hill, Co.

Johnston, R., 1976. Gen. Ed. The U.S. Food Industry: Description of Structural Changes, Vol. I: Some Structural Changes in the Food Service Industry. Colorado State University Experimental Station Fort Collins Tech. Bulletin 129.

Judge, G., et al., 1965. "An Interregional Model, its Formulation and Application to the Livestock Industry." Agricultural Economics Review, 17: 1-9.

_____ and T. Takayama, 1973. Studies in Economic Planning Over Space and Time. Amsterdam: North-Holland Publ. Co.

_____ and T.D. Wallace, 1958. "Estimation of Spatial Price Equilibrium Model." Journal of Farm Economics, 40: 801-820.

_____, 1959. Spatial Price Equilibrium Analyses of the Livestock Economy. Oklahoma Agricultural Experimental Station Technical

Kindleberger, C. and P. Lindert, 1978. International Economics. Homewood: Richard D. Irwin Inc.

King, R.A., 1963. Interregional Competition Research Methods. North Carolina State University, Agricultural Policy Institute (Raleigh).

King, G. and L. Schrader, 1963. "Regional Location of Cattle Feeding. A Spatial Equilibrium Analyses." Hilgardia, vol. 34, no. 10, University of California.

Koopmans, T., 1949. "Optimal Utilization of the Transport System." Econometrica, 17: 136-146.

Kost, W.E., 1980. "Model Validation and the Net Trade Model." Agricultural Economics Research, Vol. 32, April.

Labys, W., 1975. Quantitative Models of Commodity Markets. Cambridge: Ballinger Publ. Co.

Leamer, E. and R. Stern, 1970. Quantitative International Economics. Chicago: Aldine Publ. Co.

Leath, M. and L. Blakley, 1971. An Interregional Analysis of the U.S. Grain Marketing Industry 1966/1967. USDA Technical Bulletin No. 1444.

Lee, T. and S. Seaver, 1971. "A Simultaneous Equation Model of Spatial Equilibrium and its Application to the Broiler Markets." American Journal of Agricultural Economics, 63: 70-

_____, and D. Storey, 1970. Fish Retailing Practices and Consumer Demand for Fish in a Case-Study: Massachusetts Grocery Chain. University of Massachusetts Agricultural Experiment Station Bulletin 590, (Amherst).

Meadows, D., et al., 1972. The Limits of Growth. New York: Universe Books.

Nash, D., 1967. Demand for Fish and Fish Products with Special Reference to New England. In: Bell, F., and J. Hazleton, Recent Research Development and Research in Fisheries Economics. New York: Oceana Publ.

_____, and F. Bell, 1969. An Inventory of Demand Equations for Fishery Products. Working Paper 10, Bureau of Commercial Fisheries, U.S. Dept. of the Interior. Washington, D.C.: U.S. Goverment Printing Office.

Newton, C., 1972. "The Effect of Tariff Reduction on the Production of Fish Sticks and Portions in the United States." Unpublished Ph.D. Dissertation, University of Rhode Island.

Organization for Economic Cooperation and Development (OECD), 1960. Fishery Policies in Western Europe and North America. Paris: Organization for Economic Cooperation and Development.

———, 1964-1978. Main Economic Indicators. Paris: Organization for Economic Cooperation and Development.

———, 1969. Market for Frozen Fish in OECD Member Countries, 1964-1968. Paris: Organization for Economic Cooperation and Development.

———, 1966. Price System in the Fishing Industry. Paris: Organization for Economic Cooperation and Development.

———, 1970-1977. Review of Fisheries. Paris: Organization for Economic Cooperation and Development.

O'Rourke, A. and D. Deloach, 1971. The California Fresh and Frozen Fishery Trade. Agricultural Experimental Station Bulletin 850, University of California.

Phlips, L., 1974. Applied Consumption Analysis. Amsterdan; North-Holland Pub. Co.

Pindyck, R.S. and D.L. Rubinfeld, 1978. Econometric Models and Economic Forecasts. New York: Mc-Graw-Hill Inc.

Prochaska, F. and R. Schrimper, 1973. "Opportunity Cost of Time and other Socioeconomic Effects on Away-From-Home Food Consumption." American Journal of Agricultural Economics, 55(4):595-603.

Rhomberg, R., 1970. "Possible Approaches to a Model of World Trade and Payments." International Monetary Fund Staff Papers, 17:1-22.

Rojko, A., et al., 1971. "World Demand Prospects for Grain in 1980." Foreign Agricultural Economic Report 75: Washington, D.C., USDA.

Ryan, T., 1979. International Trade Models: An Overview. Forecast Support Group, Commodity Economic Division, Working Paper, USDA.

Samuelson, P., 1952. "Spatial Price Equilibrium and Linear Programming." American Economic Review, 42(3):283-303.

Schaefer, M., 1954. Some Aspects of the Dynamics of Population Important to the Management of Commercial Marine Fisheries. Inter-American Tropical Tuna Commission Bulletins 1 and 2.

Schmitz, A. and D. Bawden, 1973. The World Wheat Economy: An Empirical Analysis. Giannini Foundation Monograph 32. University of California, Berkeley.

Snider, D., 1975. Introduction to International Economics. Homewood: Richard D. Irwin Inc.

Takayama, T., 1966. "International Trade and Mathematical Programming." Australian Journal of Agricultural Economics, 36-47.

———, 1967. Spatial Economic Analysis. Inaugural Public Lecture at Armidale, New South Wales, Sydney: Halstead Press.

———, and H. Hashimoto, 1976. "World Food Projection Models, 1973 and 1974." Illinois Agricultural Economics, 16(2):1-8.

———, and G. Judge, 1964. "Spatial Equilibrium and Quadratic Programming." Journal of Farm Economics, 46, (1): 67-93.

———, 1971. Spatial and Temporal Price and Allocation Models. Amsterdan: North-Holland Publ. Co.

Tenthold, R. and D.L. Bawden, 1966. An Annotated Bibliography of Spatial Studies. Research Report 25, College of Agriculture, University of Wisconsin.

Truman, E.M., 1974. "The Distribution of West European Trade Under Alternative Tariff Policies." Review of Economic and Statistics. 56: 83-91.

———, and S. Resnick, 1973. "An Empirical Examination of Bilateral Trade in Western Europe." Journal of International Economics, 3:305-35.

United Nations. Department of Economic and Social Affairs, 1964-1978. Monthly Bulletin of Statistics. New York: Dept. of Economics and Social Affairs, Statistical Office.

U.S. Board of Governors, Federal Reserve System, 1964-1978. Federal Reserve Bulletin. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Commerce, 1964-1978. Fish Sticks, Fish Portions and Breaded Shrimp. NMFS, NOAA. Washington, D.C.: U.S. Government Printing Office.

———, 1964-1978. Fisheries of the United States. NMFS, NOAA, Washington, D.C.: U.S. Government Printing Office.

———, 1964-1977. Fishery Statistics of the United States. Statistical Digest, NMFS, NOAA. Washington, D.C.: U.S. Government Printing Office.

———, 1964-1978. Food Fish Market Review. NMFS, NOAA. Washington, D.C.: U.S. Government Printing Office.

———, 1964-1978. U.S. Imports for Consumption. Bureau of Census. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Interior, 1969. Report of the Secretary of the Interior to the President and the Congress on the Effects of Imports on the United States Groundfish Industry. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Labor, 1964-1978. Employment and Earnings. Bureau of Labor Statistics, Washington,D.C.: U.S. Government Printing Office.

U.S. President, 1964-1978. Economic Report of the President. Washington, D.C.: U.S. Government Printing Office.

U.S. Senate, U.S. International Trade Commission, 1980. Certain Fish. Report to the President on Investigation no. TA-201-41 under section 201 of the Trade Act of 1974. Washington, D.C.: USITC Publication 1028. U.S. Government Printing Office.

Waugh, F. and V. Norton, 1969. Some Analyses of Fish Prices. Agriculture Experiment Station Bulletin, University of Rhode Island, Kingston.

West, D. and G. Brandow, 1973. "Space-Product Equlibrium in the Dairy Industry of the Northeastern and North Central Regions." Journal of Farm Economics, 46: 719-731.

White Fish Authority, 1980. European Supplies Bulletin. Edinburgh: Fishery Economics Research Unit, Sea Fisheries House, no. 5, March.

Zellner, A. and H. Theil, 1962. "Three-Stage Least Squares Estimation." Econometrica, 30: 54-78.

Zusman, P. , et al., 1969. Possible Trade and Welfare Effects of EEC Tariff and Reference Price Policy on the European-Mediterranean Market for Winter Oranges. Giannini Foundation Monograph 24, University of California, 24.

APPENDICES

APPENDIX 1

Comparative analysis among the yearly weighted average Import-Export Price of groundfish blocks by country of origin or destination.

Table 1A. Analysis of Variance of the Difference among the U.S. Yearly Weighted Average Import Price of Groundfish Blocks by origin (Canada, Norway, Iceland, Denmark and other), 1964-1978.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	"F" calculated
Among Origins	4	988.98	247.24	0.4877[1]
Residual	66	33458.44	506.95	
Total	70			

[1] "F" value calculated is non-significant at 5 percent level.

Table 1B. Analysis of Variance of the Difference Among the Canadian Yearly Weighted Average Export Price of Groundfish Blocks by Destination (the U.S. and other), 1964-1978.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	"F" calculated
Among Destinations	1	696.39	696.39	1.71[1]
Residual	28	11415.84	407.70	
Total	29			

[1] "F" value calculated is non-significant at 5 percent level.

APPENDIX 2

The Data

CASE-NO	ER	UK	NU	ICE	TS	TD
1	92.533	279.788	13.969	2.322	36358.	35835.
2	92.498	279.750	13.988	2.322	38895.	38207.
3	92.692	278.660	13.963	2.322	53516.	53971.
4	93.041	278.630	13.964	2.322	45575.	48430.
5	92.844	279.290	13.978	2.322	33711.	35275.
6	92.554	279.520	13.980	2.322	60273.	63015.
7	92.627	279.280	13.981	2.322	71937.	73940.
8	92.982	280.300	13.999	2.322	52294.	47435.
9	92.944	280.050	13.990	2.322	46997.	48353.
10	92.858	279.180	13.973	2.322	50239.	54495.
11	92.971	278.890	13.984	2.322	55124.	66227.
12	92.449	279.090	13.992	2.322	52955.	44726.
13	92.522	279.380	10.981	2.322	46404.	47281.
14	92.441	279.580	13.992	2.322	37144.	37901.
15	92.897	278.540	13.982	2.322	72492.	72750.
16	92.904	261.710	13.987	1.752	40172.	38934.
17	92.105	240.600	14.001	1.752	53856.	59270.
18	92.725	239.190	14.000	1.752	67263.	66491.
19	93.173	238.950	13.900	1.752	77384.	80102.
20	93.185	238.660	13.990	1.135	66701.	66785.
21	93.043	239.000	13.992	1.135	55770.	56198.
22	92.789	238.970	14.007	1.135	58158.	60140.
23	92.667	238.660	13.997	1.135	89382.	92031.
24	92.929	239.460	13.992	1.135	60014.	60190.
25	93.197	240.360	13.991	1.135	60590.	62956.
26	94.225	240.250	13.991	1.135	80158.	78170.
27	97.728	238.790	13.981	1.135	68679.	72843.
28	98.060	238.940	14.003	1.135	62199.	61191.
29	99.153	241.410	14.005	1.135	44176.	47117.
30	98.763	241.840	13.882	1.135	91050.	88686.
31	98.433	244.080	14.270	1.144	107519.	116114.
32	99.737	250.350	14.664	1.144	61167.	60186.
33	99.617	259.760	15.034	1.056	82556.	85274.
34	101.214	259.720	15.223	1.056	95147.	96634.
35	101.716	244.530	15.304	1.056	99844.	104904.
36	101.120	236.340	15.157	1.021	67934.	69483.
37	100.280	241.870	16.040	1.021	63561.	64013.
38	100.000	253.010	17.272	1.132	80791.	79856.
39	99.612	247.720	18.375	1.190	102056.	103985.
40	100.014	237.790	17.736	1.190	112439.	111039.
41	102.044	227.980	17.275	1.151	95886.	95698.
42	103.584	239.750	18.450	1.053	72430.	85518.
43	101.954	235.060	18.253	.842	59710.	58970.
44	101.400	232.920	18.481	.842	52707.	51957.
45	100.146	239.200	19.971	.668	60169.	61017.
46	97.854	232.380	20.213	.648	63708.	63769.
47	97.006	212.740	18.460	.620	81127.	86130.
48	98.272	204.240	18.064	.593	97107.	93566.
49	100.481	199.920	18.037	.568	86191.	84561.
50	102.133	180.610	18.135	.548	85264.	85351.
51	102.303	176.470	18.159	.538	114626.	114990.
52	100.823	165.140	18.986	.527	81619.	82226.
53	97.135	171.350	18.962	.523	79261.	79122.
54	95.005	171.890	18.927	.517	103277.	104112.
55	93.475	173.500	18.704	.492	113296.	111368.
56	90.762	181.450	18.539	.472	79528.	74963.
57	89.828	192.610	19.067	.413	79606.	80760.
58	88.711	183.500	18.477	.386	104924.	104117.
59	87.450	193.170	18.910	.362	125723.	128637.
60	84.851	198.480	19.878	.318	73979.	76020.

(Appendix 2, continued)

CASE-NO	TIMP	P8	H8	W	PFF	PSP	TY
1	33990.	23.59	25834.	1.90	27.80	43.47	422.657
2	38103.	23.38	10878.	1.96	27.50	43.85	433.615
3	51003.	22.94	14035.	1.98	26.70	43.48	440.390
4	43066.	23.79	22699.	1.87	26.80	45.12	446.446
5	35126.	24.65	20010.	1.88	27.20	47.63	456.050
6	62986.	25.61	8446.	1.89	28.60	46.72	463.914
7	70821.	25.66	19670.	1.88	28.40	47.02	479.360
8	45874.	25.48	40293.	1.65	29.30	48.41	489.376
9	46521.	26.90	37367.	1.67	30.10	50.48	497.496
10	54491.	25.23	27590.	1.86	30.80	49.57	503.370
11	63033.	25.52	27343.	1.89	30.00	49.66	512.367
12	42531.	25.29	44327.	1.86	31.90	48.91	522.084
13	45205.	28.25	35237.	1.87	33.40	48.36	534.352
14	37715.	24.69	23327.	1.99	31.10	45.27	541.654
15	70514.	22.94	19792.	1.94	30.60	46.01	550.391
16	36063.	23.51	34001.	1.88	30.70	45.44	562.588
17	57315.	23.97	32345.	1.97	32.00	46.12	574.848
18	64444.	23.36	22010.	2.11	31.50	44.74	588.259
19	76549.	22.39	27530.	2.15	30.70	44.94	595.531
20	62775.	21.51	41313.	2.14	30.80	45.29	605.882
21	55076.	21.18	44416.	2.19	33.40	45.04	612.082
22	59545.	22.36	27208.	2.32	35.30	47.17	623.066
23	92031.	23.74	32272.	2.31	35.90	48.65	640.634
24	60190.	24.22	60254.	2.31	37.10	50.79	650.642
25	62956.	24.34	43018.	2.41	37.40	48.24	667.960
26	78146.	24.81	20414.	2.39	38.60	48.50	687.251
27	70767.	27.28	31252.	2.40	39.10	50.04	699.069
28	60787.	29.55	48057.	2.32	41.00	52.56	704.025
29	47107.	33.93	30560.	2.38	45.10	56.56	725.592
30	88656.	34.91	15702.	2.47	45.70	58.10	742.847
31	115568.	36.55	36445.	2.47	46.40	61.32	750.469
32	59829.	37.81	75784.	2.38	46.30	63.77	758.474
33	85249.	38.11	62709.	2.47	48.90	64.44	774.723
34	96424.	39.96	49849.	2.59	52.60	66.61	790.097
35	104309.	40.67	62913.	2.66	54.00	67.11	807.157
36	69480.	39.63	104361.	2.63	55.40	68.10	838.020
37	63982.	40.05	75815.	2.72	59.40	70.25	866.479
38	79817.	46.76	40355.	2.80	61.90	71.39	891.690
39	103973.	54.06	36413.	2.87	66.50	72.90	914.047
40	110955.	53.21	62930.	2.90	68.60	81.46	939.717
41	95566.	46.72	80598.	2.97	71.90	86.43	953.962
42	85436.	54.07	101740.	3.06	76.80	80.06	968.412
43	58890.	46.67	92483.	3.13	69.70	77.80	996.417
44	51918.	51.31	90894.	3.22	69.80	76.80	1016.015
45	61009.	47.71	75689.	3.31	64.40	72.37	1025.515
46	63526.	44.17	72097.	3.38	71.60	71.30	1092.086
47	85757.	47.76	60736.	3.48	69.10	71.30	1095.807
48	92560.	44.52	58681.	3.53	74.90	71.89	1124.212
49	83543.	48.31	79014.	3.76	75.40	74.50	1152.445
50	85317.	54.15	50194.	3.85	84.70	83.54	1170.607
51	114214.	61.19	48304.	3.90	86.20	89.92	1192.774
52	81888.	59.77	66574.	3.99	84.20	95.60	1221.581
53	78444.	70.89	61083.	4.04	91.90	104.20	1247.941
54	103188.	76.30	40639.	4.08	94.30	107.83	1285.322
55	110276.	82.58	48399.	4.12	99.60	113.70	1319.153
56	74601.	79.87	86682.	4.24	101.80	116.63	1359.637
57	80115.	81.48	73174.	4.54	103.80	116.20	1391.708
58	103403.	82.14	43846.	4.56	104.60	115.84	1433.292
59	127774.	84.50	52618.	4.95	102.80	115.84	1468.371
60	75638.	78.67	88628.	4.88	102.40	116.50	1511.352

(Appendix 2, continued)

CASE-NO	XHB	LAN	XEX	XBT	PT
1	12877.	97173.	4.32	19717.	21.01
2	5354.	269635.	3.77	20562.	21.79
3	17147.	466654.	3.78	34559.	21.91
4	19570.	174640.	3.64	32024.	21.90
5	5687.	120968.	4.15	17435.	22.26
6	3930.	271652.	4.00	29621.	24.51
7	17210.	441815.	3.88	45906.	24.31
8	18616.	188362.	3.89	30238.	24.18
9	8619.	143012.	4.77	21007.	23.56
10	6360.	322176.	4.21	19891.	25.03
11	21993.	477465.	3.95	27392.	24.01
12	32019.	223442.	4.00	28410.	23.92
13	25910.	117332.	4.70	22950.	21.98
14	8603.	271126.	4.28	19333.	22.61
15	16219.	485794.	4.01	35286.	21.79
16	19283.	209285.	3.77	25181.	22.59
17	12010.	136583.	4.55	16051.	23.39
18	6278.	337985.	4.15	24750.	22.89
19	19932.	483166.	3.87	39396.	22.58
20	21737.	203588.	3.82	30142.	22.50
21	8937.	160260.	4.64	18456.	21.99
22	5799.	346019.	4.96	17007.	23.38
23	16990.	644418.	2.68	26892.	24.14
24	25406.	194243.	4.07	22822.	23.75
25	10349.	160126.	4.95	18408.	23.84
26	3656.	403672.	3.69	16075.	25.08
27	10942.	435546.	4.42	27868.	25.70
28	10406.	210927.	6.53	20369.	28.05
29	2902.	143559.	5.71	13238.	27.85
30	3037.	349186.	3.71	22443.	30.31
31	11001.	415265.	5.56	37186.	32.70
32	10494.	182593.	5.01	16266.	33.93
33	4975.	118147.	5.66	11078.	31.11
34	3510.	240521.	6.91	11206.	36.85
35	10528.	408805.	5.80	27366.	36.51
36	10850.	193373.	5.65	13720.	36.04
37	5754.	135310.	7.41	9390.	39.23
38	4402.	317244.	6.63	11832.	47.04
39	9179.	399733.	7.58	28109.	53.38
40	13517.	213102.	7.51	15993.	62.60
41	10369.	97959.	8.68	8084.	64.71
42	8287.	221012.	8.83	4217.	59.16
43	13547.	301707.	9.02	10763.	53.32
44	18881.	159335.	8.48	12408.	54.37
45	13002.	46004.	9.13	8509.	52.35
46	6606.	243638.	8.61	6806.	52.98
47	10703.	335580.	9.03	12646.	52.04
48	14411.	170850.	8.42	10419.	49.17
49	9238.	129115.	8.28	9809.	53.93
50	6127.	261632.	10.09	8764.	65.81
51	8891.	358557.	14.03	23480.	66.27
52	10715.	113082.	10.10	9797.	71.38
53	7016.	106233.	11.89	9435.	79.61
54	4688.	225432.	16.90	14731.	87.75
55	11377.	384652.	11.93	41327.	93.89
56	12837.	175221.	11.63	17672.	67.17
57	10863.	113505.	12.72	14787.	88.49
58	8381.	211465.	12.88	21556.	95.48
59	15166.	357168.	13.86	37432.	97.66
60	13300.	242915.	13.70	14338.	98.62

(Appendix 2, continued)

CASE-NO	I80I	X80I	FAO	PUK	WPUK	PNW	PICE
1	16641.	1845.	400753.	6.950	80.	1.689	10.159
2	18333.	104.	576279.	7.205	81.	1.671	10.069
3	18957.	2968.	282820.	7.288	81.	1.643	9.879
4	13551.	5364.	213832.	7.313	82.	1.704	10.245
5	16276.	149.	428150.	7.400	83.	1.763	10.616
6	30652.	29.	566824.	8.116	83.	1.832	11.029
7	26031.	3119.	274926.	8.063	83.	1.835	11.051
8	22056.	1561.	237106.	8.021	83.	1.820	10.973
9	25990.	1832.	462576.	7.819	84.	1.923	11.585
10	30348.	4.	611190.	8.325	84.	1.806	10.866
11	27732.	3194.	295049.	8.004	84.	1.825	10.991
12	24545.	2195.	254318.	7.924	84.	1.807	10.891
13	23454.	2076.	444877.	7.279	85.	2.573	12.166
14	17811.	186.	545247.	7.476	86.	1.765	10.633
15	37206.	2236.	287291.	7.267	86.	1.641	9.879
16	14991.	2871.	251411.	8.019	86.	1.681	13.419
17	37805.	1955.	506700.	8.954	88.	1.712	13.682
18	42513.	2047.	623071.	8.874	89.	1.669	13.333
19	37988.	3553.	329475.	8.805	90.	1.611	12.780
20	36559.	4010.	289231.	8.785	90.	1.538	18.952
21	37314.	1122.	577981.	8.561	91.	1.514	18.661
22	41151.	595.	728674.	9.078	92.	1.596	19.700
23	62490.	0	381601.	9.373	93.	1.696	20.916
24	37192.	0	335051.	9.217	94.	1.731	21.339
25	42182.	0	609009.	9.244	96.	1.740	21.445
26	64083.	24.	773384.	9.836	98.	1.773	21.859
27	40811.	2076.	402934.	10.518	101.	1.951	24.035
28	41830.	404.	353478.	11.512	104.	2.110	26.035
29	30938.	10.	635193.	11.439	106.	2.423	29.894
30	68607.	30.	747927.	12.378	109.	2.515	30.758
31	70333.	546.	419907.	13.187	111.	2.561	31.949
32	44901.	357.	372146.	13.517	111.	2.578	33.051
33	71478.	25.	627676.	11.931	112.	2.535	36.089
34	83941.	210.	718349.	14.361	112.	2.625	37.841
35	72478.	595.	411421.	15.187	115.	2.657	38.513
36	54214.	3.	365115.	15.420	118.	2.615	38.815
37	54171.	31.	514942.	16.265	122.	2.497	39.226
38	68959.	39.	631313.	18.592	127.	2.707	41.307
39	73947.	12.	328991.	21.465	136.	2.942	45.429
40	96446.	84.	286322.	26.329	145.	3.000	44.714
41	87802.	132.	524640.	28.964	157.	2.704	40.591
42	68213.	82.	643678.	25.560	161.	2.931	51.349
43	48947.	80.	335052.	23.127	166.	2.557	55.428
44	40299.	39.	291654.	23.670	178.	2.776	60.938
45	51660.	8.	536520.	21.917	193.	2.389	71.422
46	56902.	243.	674468.	22.310	197.	2.185	68.164
47	68481.	373.	341597.	23.729	201.	2.587	77.032
48	86688.	1006.	295777.	23.659	208.	2.465	75.076
49	76382.	1018.	610220.	27.106	215.	2.678	85.053
50	76500.	34.	751322.	37.215	222.	2.986	98.814
51	91146.	776.	390570.	38.418	234.	3.370	113.736
52	71822.	338.	340143.	43.580	252.	3.148	113.416
53	69826.	678.	655557.	45.129	267.	3.739	135.545
54	88546.	924.	828660.	48.500	283.	4.031	147.582
55	71969.	1092.	420149.	50.584	255.	4.415	167.846
56	61856.	362.	364630.	33.599	295.	4.308	169.216
57	64819.	645.	-1.	41.269	300.	4.273	197.288
58	83368.	714.	-1.	46.159	308.	4.446	212.798
59	88291.	863.	-1.	44.212	315.	4.469	233.425
60	59641.	382.	-1.	42.160	318.	3.958	247.390

APPENDIX 3. Empirical Results Obtained by O.L.S. (Ordinary Least Squares) for the Equations Representing Import Demand and Export Supply for Groundfish Blocks, double-log form, 1964-1978.

EQUATION	Variables		OLS Results			
	Dependent	Independent	Regression coefficients	Standard error	Computed "t" value	Calculated "F" value, coefficient of determination (R^2) and Durbin Watson (DW)
EQ 1	TIMP	Constant	3.7239	2.7074	1.37	
		PB	-1.0644	0.4797	-2.22**	
(U.S.		PSP	0.7932	0.6116	1.30	
Import		PFF	1.5814	0.7142	2.21**	F = 14.89**
Demand)		HB	-0.2443	0.0985	-2.48**	R^2= 0.75
		W	-1.2923	0.4786	-2.70**	DW= 1.60
		TY	0.8557	0.6047	1.41	
		S1	-0.0089	0.0687	-0.13	
		S2	0.0445	0.0904	0.49	
		S3	0.2970	0.0758	3.91**	
		T	-0.2829	0.1176	-2.40**	
EQ 2	XBT	Constant	1.7183	3.4160	0.50	
		PT	0.3778	0.2122	1.78*	
(Canadian		LAN	0.3728	0.2286	1.63	F = 14.12**
export		XHB	0.2624	0.1187	2.21**	R^2= 0.66
supply)		S1	0.0552	0.1836	0.30	DW= 1.01
		S2	-0.0905	0.1848	-0.49	
		S3	0.1652	0.2151	0.77	
		T	-0.8014	0.2161	-3.71**	
EQ 3(a)	IBOI	Constant	8.1066	0.3708	21.86	
(Row		PICE	0.5747	0.0837	6.86**	
export		FAO	0.0436	0.0142	3.07**	F = 22.24**
supply)		S1	0.0823	0.1110	0.74	R^2= 0.72
		S2	0.2389	0.1109	2.15**	DW= 1.11
		S3	0.2502	0.1105	2.26**	
		T	-0.1640	0.1526	-1.07	
EQ 3(b)	IBOI	Constant	9.3087	0.3410	27.30	
(Row		PNW	1.0229	0.2623	3.90**	
export		FAO	0.0274	0.0169	1.62	F =12.34**
supply)		S1	0.0284	0.1340	0.21	R^2= 0.59
		S2	0.2076	0.1342	1.55	DW= 0.75
		S3	0.2097	0.1338	1.57	
		T	0.2590	0.1542	1.68*	
EQ 4	XBOI	Constant	-9.6217	9.2262	-1.04	
		PUK	-3.3487	2.1883	-1.53	
(Row Import		WPUK	5.0434	2.8904	1.74*	F = 1.17
Demand)		S1	-0.5085	0.8319	-0.61	R^2= 0.12
		S2	-0.8223	0.8295	-0.99	DW= 1.14
		S3	0.6790	0.8293	0.82	
		T	-0.4576	1.4124	-0.32	
EQ 5	PB	Constant	0.5643	0.0790	7.14	
		PT	0.8423	0.0217	38.81	F = 1506.63**
						R^2= 0.96
						DW= 0.99
EQ 6	TO	Constant	0.0872	0.2323	0.37	
		TS	0.9934	0.0208	47.62	F = 2267.91**
						R^2= 0.97
						DW= 2.54

Observations: The Symbol** indicates a 5 percent level of significance and * a 10 percent level of significance.
Source: Original Data from Appendix 2.

Appendix 4. R.M.S. (Root Mean Square) Percentage Error for Equations EQ1 through EQ4 in Model I and Model II by Individual Observation

CASE-NO	EM3	EM4	EX3	EX4	EX03	EX04	EM03	EM04
1	-1.07528	-1.09679	2.42758	2.22728	-4.95734	-3.87196	23.57327	22.73893
2	-2.30799	-2.22945	2.10207	7.04004	-5.18660	-4.25524	-14.56342	-16.24875
3	-.83314	-.89470	-.70644	-.77961	-4.49005	1.35069	13.46599	12.46920
4	.77051	.75040	4.74877	4.65766	-6.56857	-4.98340	30.02228	29.20037
5	-1.32184	-1.25442	1.60323	1.81943	-5.92454	-4.40619	-13.72647	-14.64891
6	1.45350	1.90511	5.80740	10.69795	-1.35106	.40712	-43.87977	-44.71912
7	2.07422	2.23293	1.91403	1.82195	-2.94474	3.77438	19.38954	19.94495
8	-.40411	.42745	3.65109	3.58417	-2.45527	-.22413	24.05522	23.66132
9	.04563	.95841	1.54874	1.59082	-2.41643	-.14303	27.37580	27.07903
10	-.32335	.16209	.06742	4.95756	-1.25017	.37237	-248.83328	-250.48839
11	-.40175	.00473	-3.88936	-4.08253	-2.24126	4.37763	17.06714	16.47537
12	-2.00527	-1.45930	1.15356	.87196	-1.28369	.85616	24.75273	24.20741
13	.19356	.47451	1.36705	.87570	-8.02366	-1.44389	21.37451	20.51591
14	-2.26681	-2.61855	.35394	5.09766	-6.35557	-4.87812	-7.13964	-8.74997
15	-.95303	-.54617	-.57626	-.61753	2.22055	7.66599	4.41031	3.07343
16	-3.02595	-2.97982	1.51404	1.45509	-5.27956	-5.52933	25.99017	25.43095
17	1.44389	1.34431	-1.63017	-1.75262	2.93962	2.43741	32.83674	33.24063
18	2.17093	1.51935	2.28149	7.08964	3.11763	2.36177	35.16137	34.98240
19	1.64002	1.02115	-.00871	-.14408	2.64893	6.33389	18.59589	18.28991
20	2.26487	1.55519	3.13950	3.02371	4.95312	1.40106	30.64831	30.43691
21	-.19493	-.62495	-.20204	-.14881	4.62925	.49850	19.84576	19.68745
22	-1.67539	-1.95319	-1.50341	3.52940	3.43365	-.19966	20.71584	20.48468
23	.48951	.38565	-5.07071	-5.09703	6.25713	7.82490	-.654E+04	-.655E+04
24	-.53921	-.73317	.20718	.00246	3.28449	.83438	-.582E+04	-.583E+04
25	1.04489	.38524	-.78485	-.80965	3.64669	.84135	-.561E+04	-.561E+04
26	.22065	-.00714	-2.14313	3.15872	5.78001	3.22617	-61.99712	-62.04026
27	-.98401	-1.37335	-2.04901	-1.94945	.39248	3.32021	13.14789	13.34468
28	.40161	.15783	-.01326	.19156	1.39356	.78733	10.12536	11.12173
29	-2.87190	-2.72524	-1.42923	-.87354	-4.31867	-4.07870	-126.46003	-123.27918
30	1.01823	1.21670	1.80237	6.96771	1.40676	1.98454	-37.52660	-35.39014
31	2.36760	2.52760	.26846	.33039	1.38469	6.48779	3.88516	5.36954
32	.44437	.37703	-2.19235	-2.03372	-.92631	.08664	14.98379	16.93925
33	2.77442	2.82102	-3.96209	-3.61221	2.35985	2.70912	-67.99308	-65.73239
34	1.84290	2.02512	-4.43320	.95337	2.57380	2.64123	24.13428	26.68575
35	.54742	.81525	-2.88743	-2.91810	1.13439	5.74077	12.96021	15.30003
36	-.86825	-.61521	-4.59192	-4.44306	.62190	.93313	-331.50299	-317.24054
37	-1.10095	-.42558	.19160	.49542	1.19659	2.14570	-17.74932	-19.93083
38	1.14461	1.53310	.96947	6.35779	.97293	2.74810	10.32108	3.89181
39	1.93997	2.48259	3.59393	3.79237	.45575	7.33683	-86.52306	-87.01878
40	3.30446	4.14594	1.70087	1.31601	4.28622	7.42980	30.56165	32.21862
41	-1.36819	.14618	-2.69254	-2.80824	4.27412	6.11095	42.96242	43.31362
42	.54044	1.11815	-11.46795	-5.86838	-.25525	1.47082	22.52475	22.77290
43	-5.31486	-4.83629	-5.69102	-5.71805	-1.29848	2.68192	-32.87356	-34.14359
44	-1.41892	-1.63173	.35311	.27033	-2.44028	-1.95060	-45.40912	-47.12909
45	2.15011	1.16096	2.35260	2.00283	1.39646	-1.61756	-189.91912	-195.17510
46	-1.83998	-2.26943	-5.07217	.37498	2.30939	-1.73219	-6.29095	-8.85255
47	.83136	.07231	-3.86734	-3.75638	1.58368	3.83256	-22.62172	-24.68714
48	.53976	.47229	-.97732	-.90196	6.11362	3.80943	4.62795	2.79447
49	2.45817	1.56547	-1.19880	-1.18061	3.18267	.94197	17.25391	16.57491
50	-1.21586	-1.26706	-3.10591	2.21562	.46157	-1.07503	-10.61896	-8.66742
51	-.16445	-.04378	1.82947	2.00420	.35326	4.14618	13.63618	14.52879
52	-.58952	-.67326	.06450	.16785	1.03448	-.07249	19.32860	21.08737
53	-.56277	-.49399	-1.22101	-1.14669	-2.34308	-2.39128	29.40923	31.26079
54	.81541	.88441	2.92441	8.02765	-2.45328	-1.92634	36.14266	37.66219
55	-1.07186	-.63277	5.23108	5.26539	-5.59144	.00523	30.05888	32.38318
56	-2.11085	-1.86209	3.61465	3.71059	-4.92072	-3.63148	-26.37568	-27.34890
57	-.51443	-.73332	1.83518	1.74570	-1.20303	-.86197	6.55868	7.00067
58	.18338	.01254	5.49237	10.11169	-.64665	-.17794	19.03375	19.71403
59	1.85754	1.11932	4.02066	3.91295	-.35000	4.05985	-3.83252	-8.69582
60	-.60079	-1.43514	-1.53775	-1.44111	-.34923	-1.95341	-13.98050	-14.13723

Table 4.A. Variable definition of Model I and Model II in Appendix 4.

Symbol		Variable Definition
Model I	Model II	
EM 4	EM 3	$(\frac{\hat{LTIMP} - LTIMP}{LTIMP}) * 100$
EX 4	EX 3	$(\frac{\hat{LXBT} - LXBT}{LXBT}) * 100$
EX04	EX03	$(\frac{\hat{LBOI} - LBOI}{LBOI}) * 100$
EMO 4	EMO 4	$(\frac{\hat{LXBOI} - LXBOI}{LXBOI}) * 100$