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Title: AN ECONOMETRIC STUDY OF THE CANADIAN SOCKEYE SALMON MARKET

Abstract approved: Richard S. Johnston

Naturally accrued salmon stocks are common property resources, the characteristics of which frequently dictate government intervention in the exploitation of the resources. A danger of government intervention is that decisions are made whose consequences are not foreseen.

The objectives of this study are to assess the impacts of government intervention in a common property fishery, specifically, Canadian fishery management programs, on the Canadian sockeye fishery. This study focuses on the impacts of fishery management programs on the prices of canned sockeye salmon at different market levels and on the return to fishing effort employed in the fishery. The fishery programs under consideration are the salmon enhancement programs, the limited entry programs of 1969, and the time and area closure rules. The salmon enhancement programs are designed to

increase the size of exploitable salmon stocks and thereby the amount of salmon landed. The limited entry program is primarily designed to limit or to curtail the amount of fishing effort employed in the salmon fisheries. The time and area closure rules limit the length of fishing time and the area that can be fished. Thus the size of sockeye salmon stocks, the quantity of sockeye landings, the amount of fishing effort and the average number of fishing days per unit of fishing effort are the policy variables considered in this study.

An econometric model, emphasizing the distinctive characteristics, is constructed for the multi-leveled sockeye market. The model treats the policy variables as being exogenously subject to the influence of the fishery programs. The demand and supply at the different market levels are estimated by applying regression analysis methods to two sets of time series data.

The major conclusions are as follows: at the final consumption level, the demand for canned sockeye is price inflexible, indicating a high price elasticity of demand. The cross price flexibility with respect to the retail price of canned pink salmon is relatively low. The income flexibility is negative, indicating that canned sockeye may be an inferior good or that the "correct" econometric model has not been specified in this research. Non-price promotions at the retail level have shifted the demand curve for canned sockeye outward. It is found that changes in consumer tastes have significantly reduced the demand for canned sockeye. The foreign and domestic demand curves for canned sockeye at wholesale levels are found to be price elastic. This implies that both retailers and canners facing price-elastic demand will experience increases in sales revenues with the success of the salmon enhancement programs. Variables representing the size of sockeye salmon stocks, the amount of effort employed in fishing, the limited entry program, and the average number of fishing days per unit of fishing effort were found to have significantly influenced the average return to fishing effort employed in the sockeye fishery. This implies that the salmon enhancement programs, the limited entry program, and the time and area closure rules have substantially affected fishermen's income.

An Econometric Study of the Canadian Sockeye Salmon Market

by

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I. INTRODUCTION

A) Fish stocks as open access resources and their accruing problems

Naturally occurring fish stocks are often widely dispersed, and free to roam vast bodies of water. To attach private user rights to a particular stock and then to defend such rights is virtually impossible. Furthermore, even when possible, it is felt that the costs of appropriating and defending exclusive user rights frequently outweigh the added returns that appropriation might provide (11). As a result there exists a lack of incentive to claim exclusive rights to the fish stocks, and thus the stocks remain an open access resource. Under these circumstances user rights pertaining to the fish stock remain either undefined or incompletely defined. 1/

In the absence of private ownership, whoever deems it profitable to exploit the stock can enter the fishery without restriction and

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1/ Charging a nominal entry fee is one means of claiming exclusive rights to a fish stock. However, in most instances where this has been attempted, the charge has been too small to achieve economic efficiency in the exploitation of the fish stock, where economic efficiency is defined to mean that level of exploitation which maximizes the rent accruing to that fishery.

compete for a share of the resource. Wherever economic rent in the form of pure profit exists, it will attract new entrants into the fishery. Given this situation a mature fishery is frequently characterized by an overcommitment of harvesting capacity and depletion of the fish stock. Any economic rent to the resource that is produced in the short run is dissipated among its users in the long run. Furthermore, the expectation of big catch, imperfect knowledge about the fishery possessed by participants, and the asymmetrical exit and entry conditions in fisheries due to the isolated nature of many fishery communities lead to persistently low and unstable incomes. The following well-established model may help to clarify the above points (11, 14, 45, 47, 48).

A steady state fishery yield-effort function (Yw) shown in Figure 1 represents an equilibrium relationship between yield and fishing effort.[2/] In the long run, the steady state yield of a fish stock is determined by four factors: 1) growth rates of individual fish; 2) recruitment of new individuals; 3) natural mortality, and 4) fishing mortality (14). For the fishery the long run biological equilibrium (for a population of given size and age composition) is reached when marginal increments from growth and recruitment of

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[2/] Fishing effort is the total fishing gear in use for a specified period of time. When two or more kinds of gear are used, they must be adjusted to some standard type (43, p. 19).

new individual fish are exactly offset by the marginal decrement caused by natural mortality and man's own predation. Thus, any point on the Yw curve is an equilibrium point in the biological sense. The catch equals the rate of natural increase in total biomass.

Schaefer (47, 48) derives a steady state yield function as follows:[3/]

For each fish population of given biomass, there is a certain rate of natural increase, which is, under average environmental conditions, some single valued function of population size. In mathematical notation,

$$\frac{dP}{dt} = f(P) \text{ - - - - -} \qquad (1\text{-}1)$$

where P = fish population of given biomass

t = time

The catch or landings (Yw) during a year is some function of the size of population and a composite of productive inputs (labor, vessel, etc.) which collectively is termed "fishing effort", E. Thus,

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3/ The salmon resources have special properties which may not be consistent with what the Schaefer model assumes. However, the outcome with respect to exploitation of open access resources elucidated in the model is, to some extent, applicable to the case of the salmon resource.

$$Yw = \emptyset\ (P, E) \text{ - - - - -} \qquad (1\text{-}2)$$

In biological equilibrium the catch is exactly equal to the rate of natural increase (assuming dt = 1 year). Thus the equilibrium catch represents the long-term annual production of the fishery for a given level of population and effort.

$$f(P) = \emptyset\ (P, E)$$

$$P = \psi\ (E) \text{ - - - - -} \qquad (1\text{-}3)$$

In order to further develop the model, the functional forms of (1-1), (1-2) and (1-3) must be specified. According to Schaefer, the following specifications of (1-1), (1-2) and (1-3) are good approximations, being based upon data from experimental animal populations and from the commercial fisheries.

The function pertaining to the rate of natural increase is a positive, single value function with zero value at P=0 and at P=M where M is the maximum population biomass taking into account certain environmental parameters. Then:

$$f(P) = k_1 P(M-P) \text{ - - - - -} \qquad (1\text{-}4)$$

where $f(P)$ = natural increase per period

k_1 = constant

M = constant

P = current population

k_1 is a constant, whose magnitude is determined by the biological characteristics of the species in question. M is a constant and is determined by the environmental conditions on both spawning and rearing grounds. Further, Schaefer argues that:

$$Yw = k_2EP \text{ - - - - -} \qquad (1\text{-}5)$$

where Yw = catch or landings or yield per period

k_2 = constant

E = the measure of fishing effort in standardized gear

P = current population

k_2 is a constant which is determined by the efficiency of the standardized gear. E is the amount of standardized gears employed in the fishery.

From (1-4) and 1-5), the population at equilibrium can be derived as (1-6).

$$P = M - \frac{k_2}{k_1} E \text{ - - - - -} \qquad (1\text{-}6)$$

According to (1-6), in biological equilibrium, population is a linear function of fishing effort.

Finally, from (1-5) and 1-6) the yield-effort function is derived as (1-7).

$$Yw = k_2E(M - \frac{k_2}{k_1} E) \text{ - - - - -} \qquad (1\text{-}7)$$

where Yw, k_1, k_2, M, E are defined as above.

The yield-effort function is depicted in Figure 1, with average yield (APP) and marginal yield (MPP) shown in the same figure.

The yield function increases at a decreasing rate and reaches a maximum, $Y_w = (\frac{1}{4}) M^2 k_1$ at MPP=0 where $E = \frac{Mk_1}{2k_2}$. After reaching maximum, the yield decreases continuously and equals zero at $E = \frac{Mk_1}{k_2}$.

The average and marginal yield functions are derived at (1-8) and (1-9) below.

$$APP = \frac{Yw}{E} = k_2 M - \frac{k_2^2}{k_1} E \text{ - - - - - } \quad (1\text{-}8)$$

$$MPP = \frac{\partial Yw}{\partial E} = k_2 M - \frac{2k_2^2}{k_1} E \text{ - - - - } \quad (1\text{-}9)$$

The APP and MPP functions are inversely related to E, declining from k_2M at zero effort to zero at $E = \frac{Mk_1}{k_2}$ and $E = \frac{Mk_1}{2k_2}$, respectively.

A change in either M or k_1 or both, implies a change in either the environmental conditions or the species biological characteristics or both. This will cause the yield-effort curve to shift and result in a change in maximum yield (the APP and MPP will shift accordingly). Suppose, for example, environmental carrying capacity is expanded through such measures as water pollution control, improvement of spawning grounds, predator control and so forth, allowing M to increase to M'. This increase in M shifts to Yw, APP and MPP

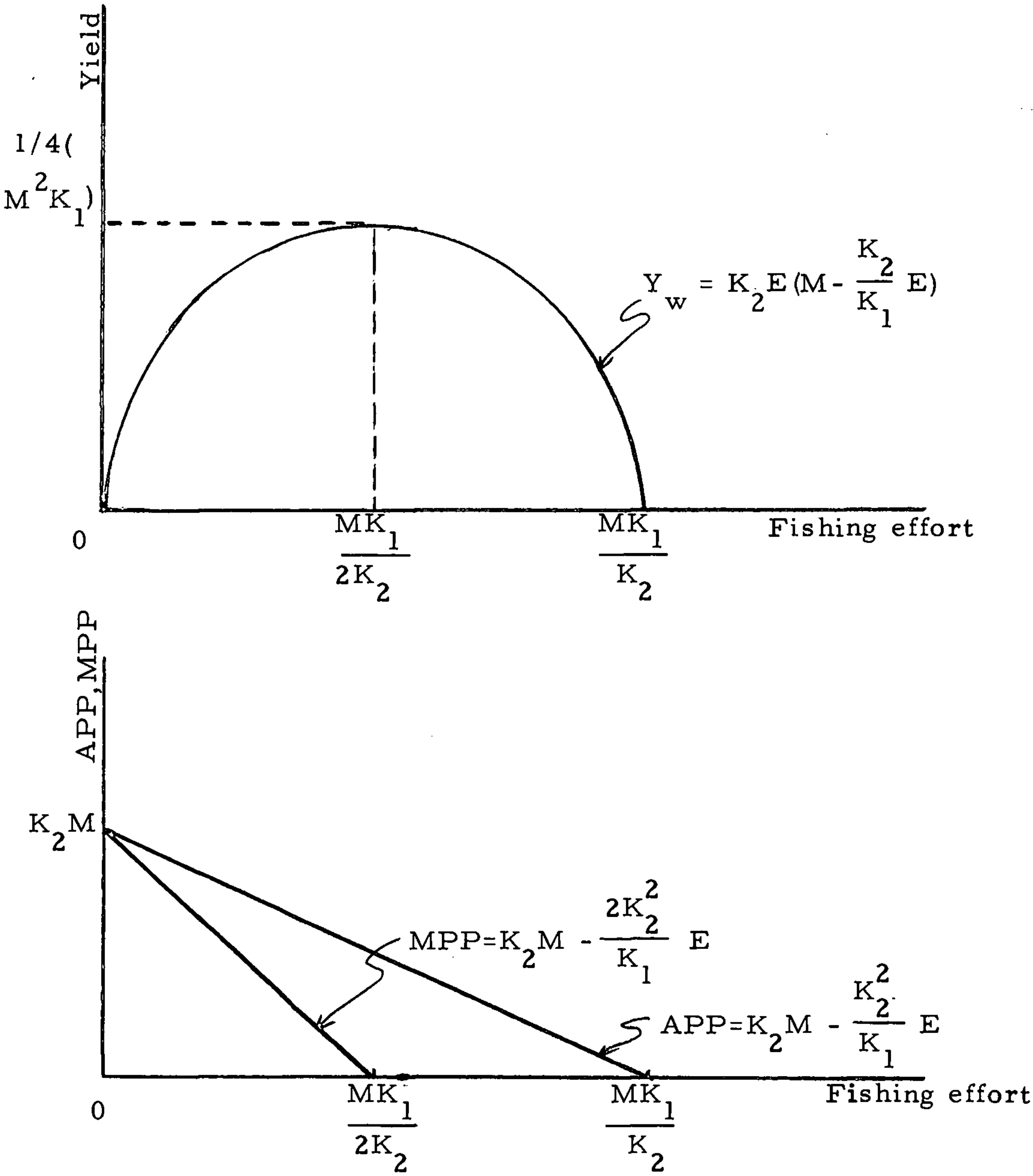

Figure 1. The yield-effort function, its average physical yield (APP) and marginal physical yield (MPP)

curves to the right as Yw', APP' and MPP', and raises the maximum yield to a new level, as shown in Figure 2.

A change in k_2, representing a change in the efficiency of fishing gear does not alter maximum yield, since maximum yield ($\frac{1}{4}M^2k_1$) is independent of the k_2 values. However, the yield-effort function (with the same maximum yield and the same shape of curves) expands (contracts) with respect to decreases (increases) in the value of k_2. The APP and MPP curves will shift accordingly, as illustrated in Figure 3.

An increase in k_2, indicating that an advancement in fishing technology has occurred, is normally expected, while a decrease in k_2, representing a fallback in fishing technology, is unreasonable. Furthermore, it is assumed that an increase in fishing technology results in increased efficiency.

So far this discussion has been concerned with biological equilibrium, with no economic considerations. In order to depict some characteristics of a fishery under both biological and economic equilibria, a bionomic model is constructed as follows:

For the sake of simplicity, it is assumed that the demand for fish is perfectly price-elastic. Therefore the yield function in term of values retains the same shape.[4/] In addition it is assumed that the

4/ Another assumption resulting in the same shape of the yield curve is that the price elasticity of demand for the fish over the relevant range is greater than unity.

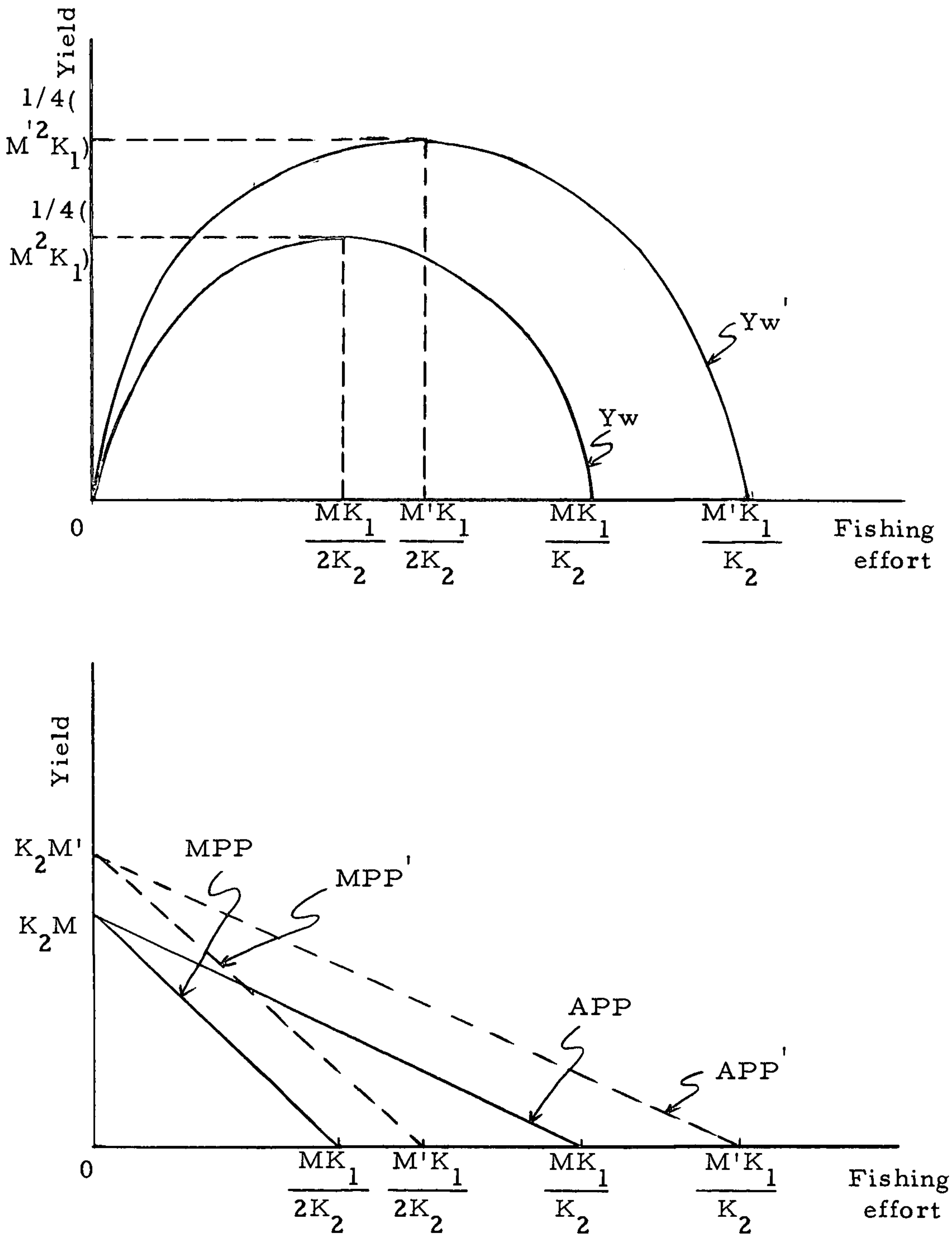

Figure 2. The shifts of Yw, APP and MPP due to increases in M to M' (M'>M).

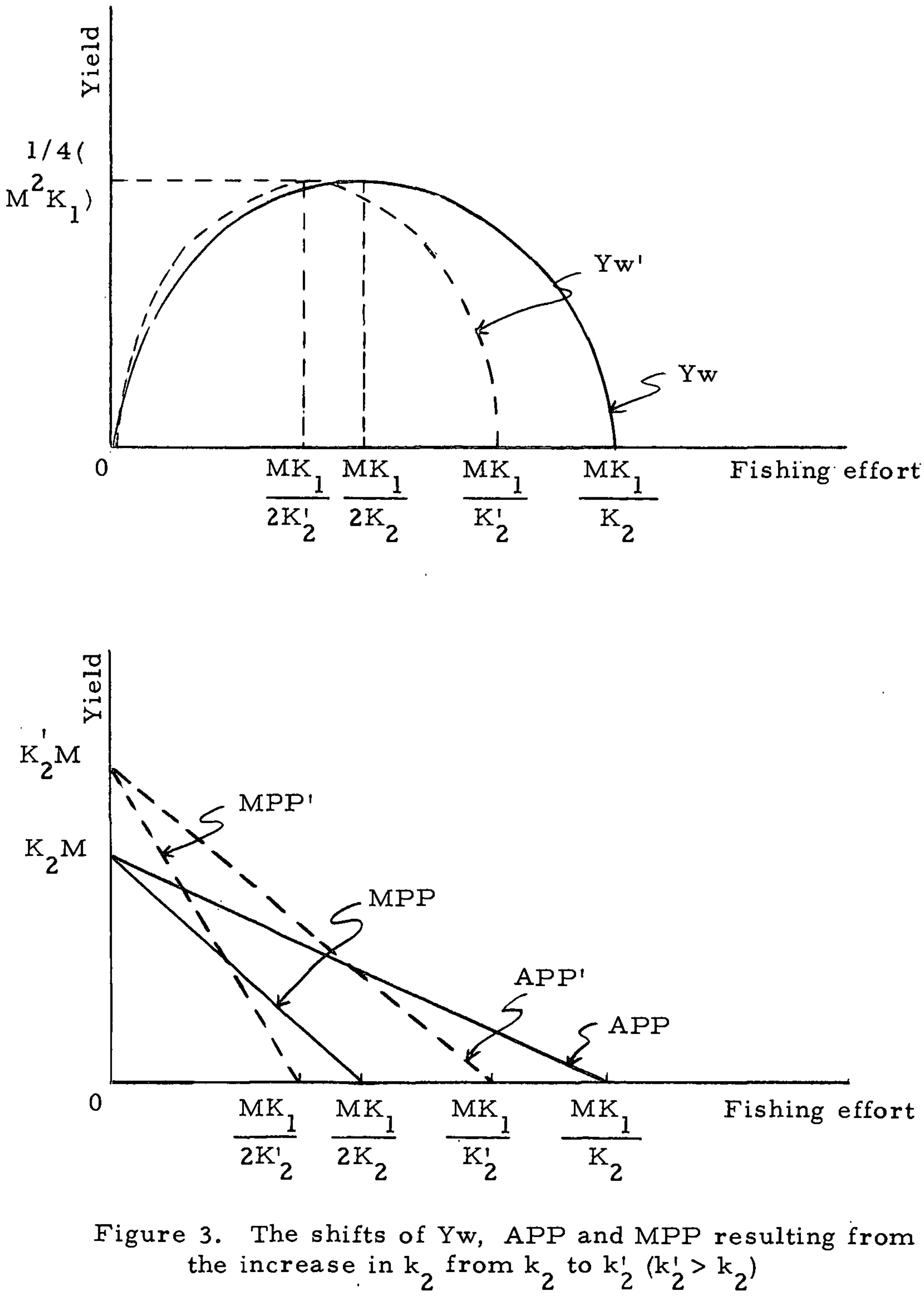

Figure 3. The shifts of Yw, APP and MPP resulting from the increase in k_2 from k_2 to k'_2 ($k'_2 > k_2$)

total cost of fishing is a linear function of fishing effort. Such a linear cost relationship implies that units of effort are homogeneous, and the total cost of fishing effort is directly proportional to the amount employed. Total revenue (TR) is obtained by multiplying total yield by the unit price of fish. The total cost (TC) is the product of effort unit cost times the number of units employed in fishing.

The model in terms of costs and revenues is shown in Figure 4.

Given terms of open access, exploitation requires no payment for the use of the resource. As a consequence the users will exploit the resource to the point where total revenue from fishing just covers total cost. Thus the fishery under the price-cost structure outlined above is exploited at p where TR = TC and AR (average revenue) = AC (average cost). At p fishing effort OE_2 is applied, and the yield is LE_2, which, in this particular case, is less than the maximum yield. This fishery is exploited at less than the maximum yield and an increase in fishing effort should increase yield before the maximum yield indicated by Q is reached. However this is not likely to occur for the case of a mature fishery.

For the mature fishery, demand for fish may have been stimulated to the extent that the price of the fish is high relative to the cost of fishing, high enough to bring the fishery to the declining portion of the yield function. Therefore, under the cost-price structure

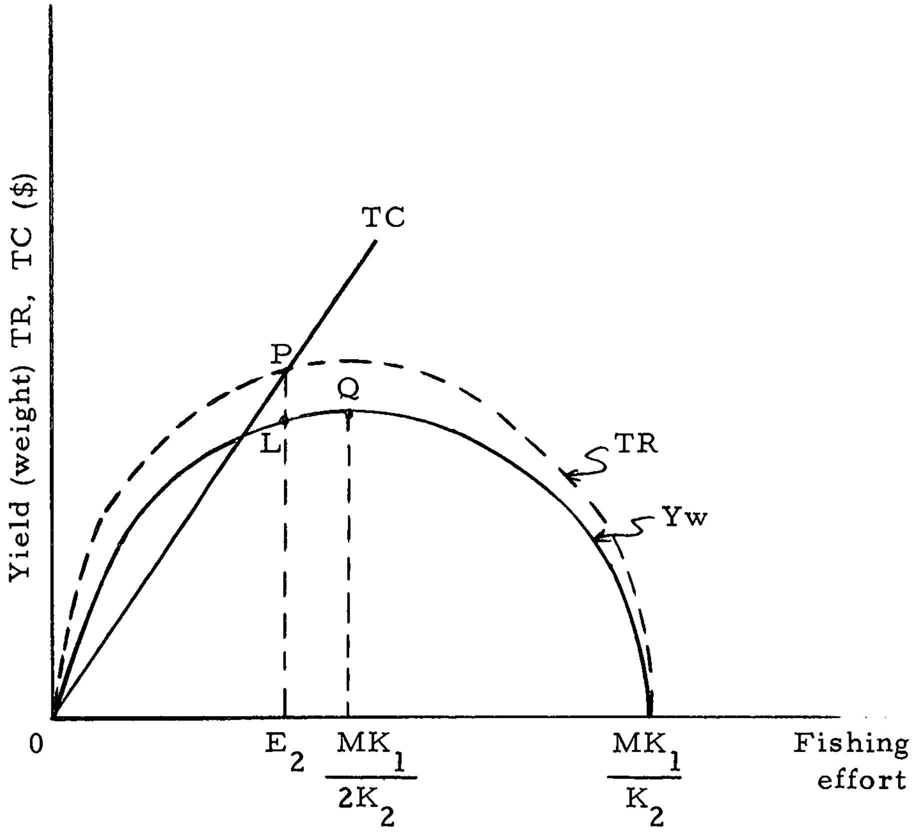

Figure 4. A bionomic model with low price-cost structure

for the mature fishery, the increase in fishing effort will result in a smaller yield and a decreased total and average return. A model of a typical mature fishery is shown in Figure 5.

Under conditions of free entry, it is apparent that fishing effort will be employed beyond the point of maximum yield (Q) in the mature fishery as indicated in Figure 5. An equilibrium is established at a level of fishing effort OE_1, where the average return is equal to average cost (AR = AC), and where the marginal return is negative. The yield is E_1S. On the other hand, if the open access resource were privately owned, the owner would exploit the fish stock to the point where the economic rent from the resource is maximized. Under private ownership, effort would be employed until the marginal cost of fishing is equal to the marginal revenue (MC = MR). Under such conditions, an equilibrium would be established at the level of fishing effort OE_2 where both AVP and MVP are positive, and at the yield E_2L, which is an economic optimal yield as explained below. At E_2L the economic rent (HH') is maximum.

Comparing the two cases, in the absence of ownership for a mature fishery, more fishing effort is applied and a smaller yield is harvested than in the case of private ownership. Thus economic "waste" of investment results because of excess capacity committed in the fishery under free entry. This excess investment could produce higher marginal revenue in other industries if reallocated. This

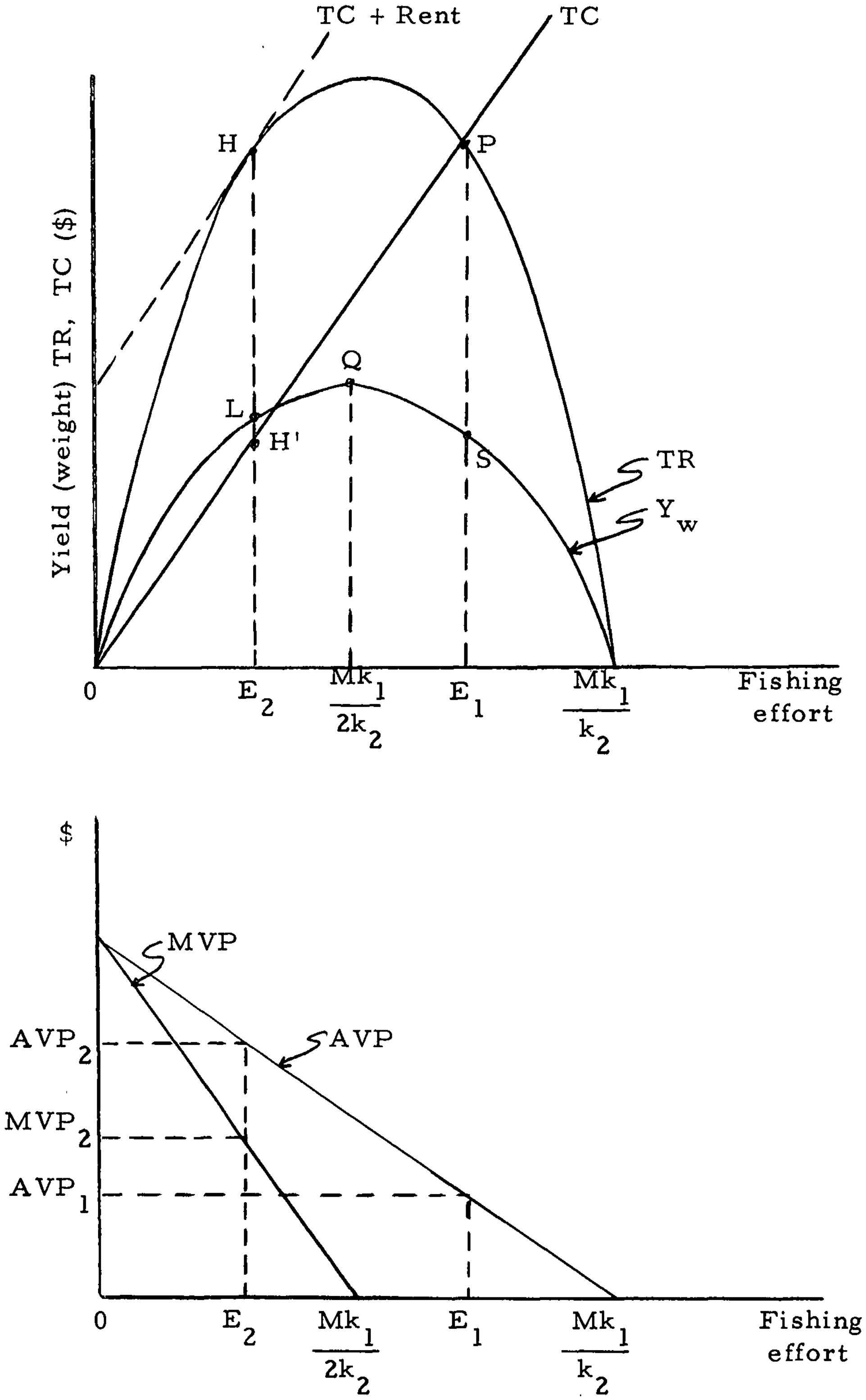

Figure 5. Bionomic model of a mature fishery

conclusion follows from the assumption that prices of both fish and fishing effort are determined by opportunity cost considerations

Under free entry, either a rise in prices due to increases in demand or improvement in fishing technology or both can lead to overfishing and may ultimately deplete the stock.

First, an increase in price will push the total revenue curve upward to TR_2 and shift AVP and MVP to the right, designated AVP_2 and MVP_2 in Figure 6. As a consequence, more fishing effort is attracted into the fishery but landings decrease: OE_1' vs OE_1, $E_1'S'$ vs E_1S. Continuous increases in price attract more and more factor inputs (fishing effort) into the fishery and result in continuous decreases in the stock. The stock may eventually be depleted.

Secondly, technological improvement in fishing pushes the yield function to the left and pushes APP and MPP in the direction shown in Figure 3. The new yield function maintains the same shape in a smaller domain with the same maximum yield. The APP and MPP shift to the left with higher intercept. As shown in Figure 7 with prices unchanged, the total revenue shifts from TR_1 to TR_2. The AVP and MVP shift to the left, corresponding to the shifts of Yw, APP and MPP. The economic equilibrium position is reached at p''. The amount of fishing effort decreases and, in this example, the yield falls: OE_1 to OE_1'' and E_1S to $E_1''S''$. The amount of fishing effort which leaves the fishery is E_1E_1'' ($=OE_1-OE_1''$).

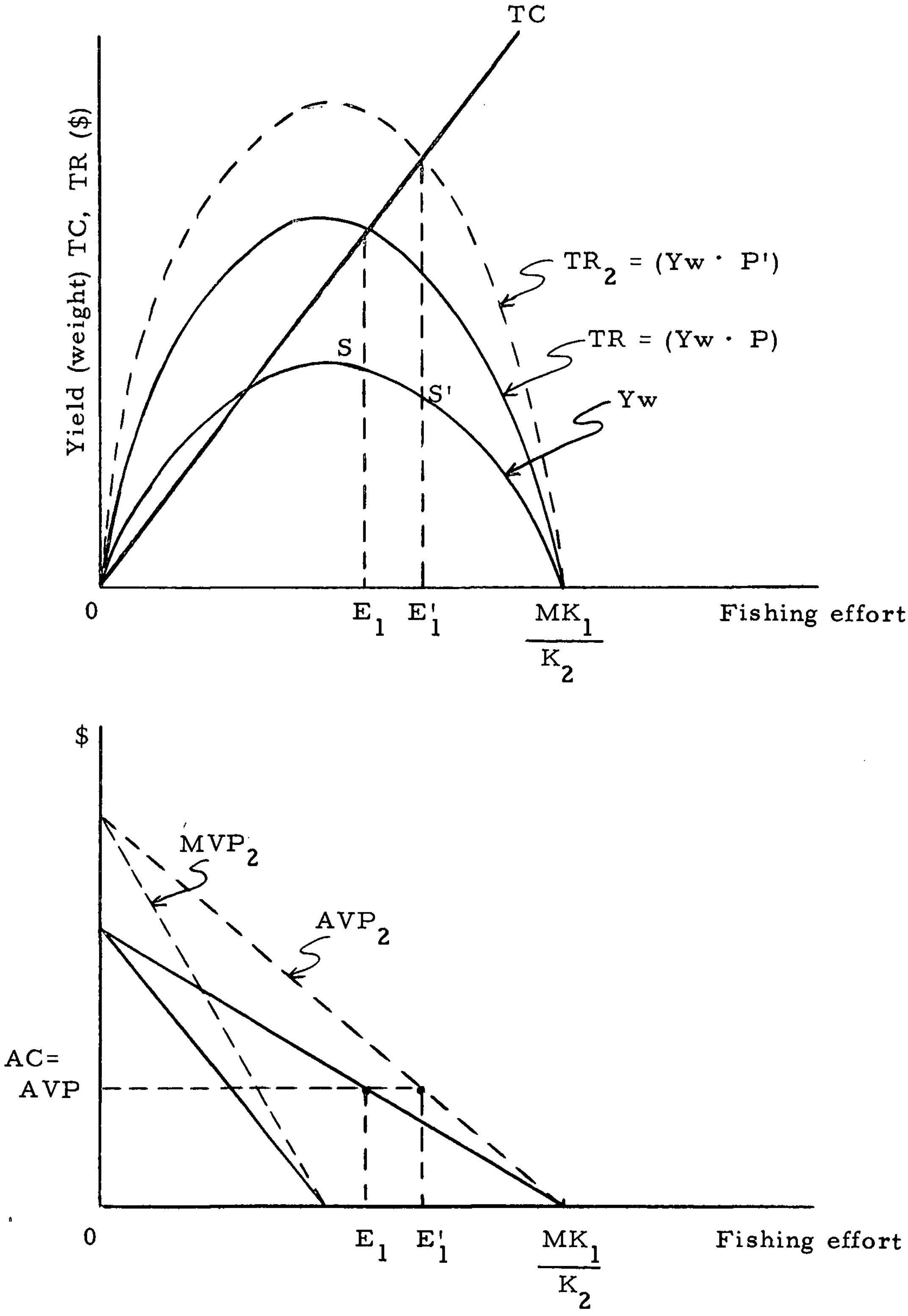

Figure 6. The shifts of TR, AVP and MVP due to an increase in fish prices (P'>P)

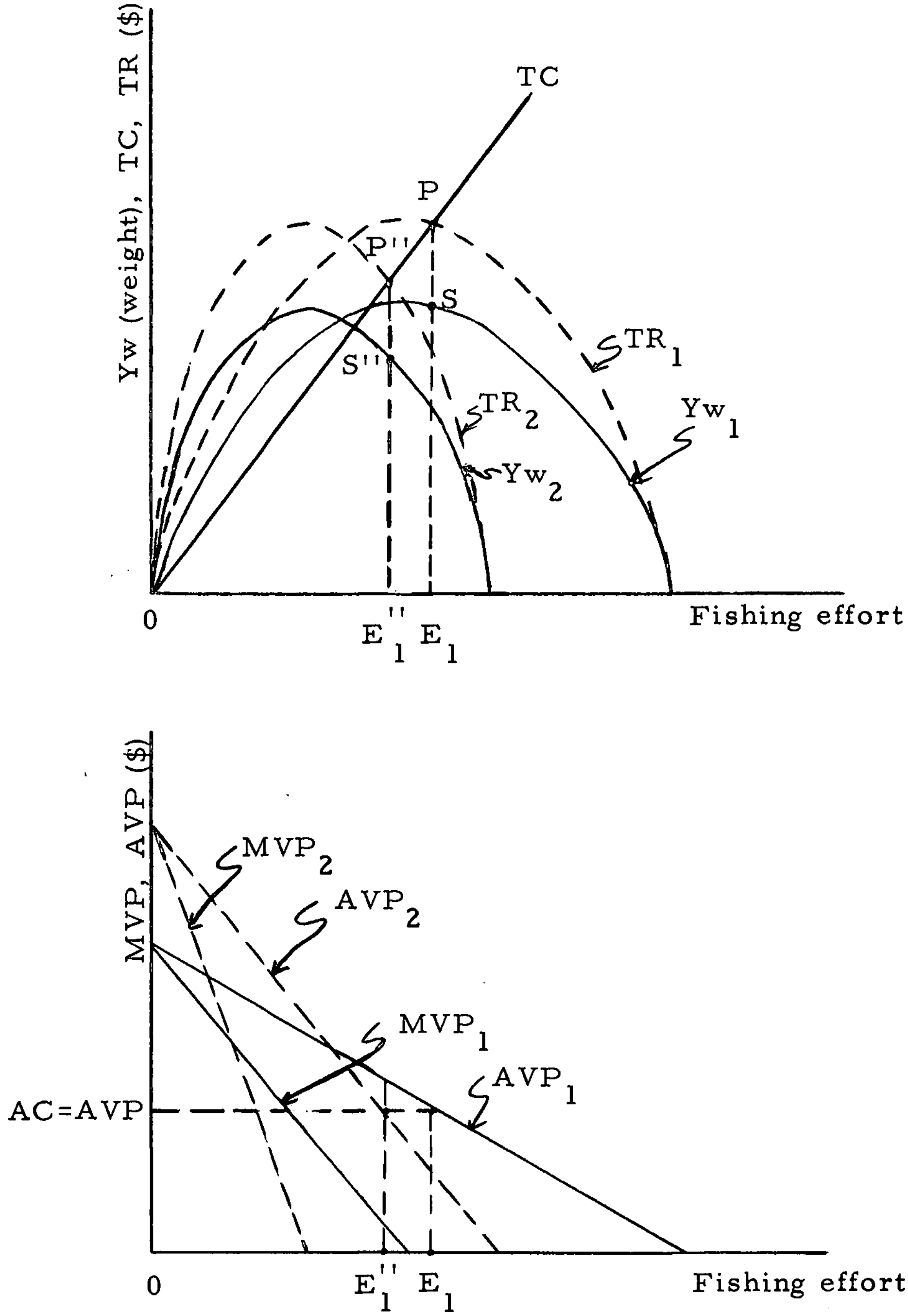

Figure 7. The shifts of TR, AVP and MVP due to technological improvement

Continuous improvement in fishing technology results in a continuous shift of TR, AVP and MVP to the left; a continuous pressure for some fishing effort to leave fishing; a continuous decline in harvest; and finally in the depletion of the fish stock.

The above economic analysis follows directly from the traditional exposition of the theory of the firm. As indicated above, for any resource which is not privately owned and where there are no barriers to entry, average rather than marginal return is received as a price paid to fishing effort. Economic rent which, under private ownership of the fishing resource, would accrue to these owners is dissipated among the resource users, and excess capacity is employed in the exploitation of the resource. Furthermore an increase in the price of fish results in: more economic rent being dissipated; more effort being attracted into the fishery, creating a greater overcapacity; and a greater pressure on the fish stock. Finally, continuous improvement in fishing technology leads to more economic rent being dissipated; more fishing effort leaving the fishery; and a constant pressure on the fish stock.

In the face of considerable chronic excess capacity, the industry becomes extremely vulnerable to any decline in the price of fish, the size of catch or both. With restricted factor mobility to leave the industry due to the isolated nature of many fishing communities, the pressure of excess capacity, plus a fall in price and/or an autonomous decline in catch can result in unstable and persistent low income. The bionomic model sketched above indicates equilibrium with the incomes of factors at opportunity levels. Economic waste occurs in the sense that other output is foregone as a result of excessive inputs which receive negative MR in the fishery.

Under these conditions, it is argued that public regulation of the fishery is appropriate (11, 14). The intense competition for a stable or shrinking supply of fish in the face of secularly rising demand and advancing fishing technology obviously make regulation difficult. Most regulations are designed to operate on the concept of maximum yield, subordinating issues related to economic efficiency.

The fish stock is an open access resource with the problems and characteristics discussed above. These problems and characteristics lure attention from different disciplinarians. Biologists are drawn into the analysis of commercial fishing by the governments and commercial interests seeking solutions to urgent problems of declining yields. Economists are attracted by the evidence of persistently low and unstable incomes and in some cases overwhelming economic waste in mature fisheries. Scientists from different disciplines perceive the problems in different ways and prescribe different solutions with different goals in mind. The fishery biologists, basing their analysis on the steady-state yield model, prescribe the rehabilitation of maximum sustainable yield (MSY) as the management objective while economists, using the bionomic model, emphasize maximization of economic rent (MER) as the objective. However, the objectives proposed by both biologists and economists are not the only objectives pursued. The following section will discuss Canadian salmon management programs and their designed objectives.

B) Canadian salmon fishery management programs and their objectives

Canada is one of four exploiters of Pacific salmon.[5/] Hoping to enhance the economic efficiency of utilization of its salmon resources, to avoid overfishing, to increase and stabilize the fisherman's income, Canada has launched many programs. These programs may be classified as conservation programs, limited entry programs, and salmon enhancement programs.[6/] The objectives of these programs are numerous but may be classified according to five sets of goals: (1) increased catch, (2) conservation of salmon, (3) contributions to the economy, (4) employment opportunity and (5) maintenance of the tradition of free fishing (12).[7/]

5/ Japan, the U.S. and the U.S.S.R. are the others.

6/ Canada's limited entry program may also be classified under conservation programs. However since it is a pioneer in the North Pacific salmon fisheries and has earned world-wide attention, the program will be discussed separately.

7/ The freedom to fish.

The following paragraphs discuss the programs and their objectives.

a) Conservation programs. Salmon conservation programs in Canada can be divided into three major categories: selectivity controls, controls of fishing capacity, and limitations on vessels and equipment.

a:1) Selectivity controls. Salmon are caught with purse seines, gillnets and troll lines. Selectivity controls affect the size and/or the age at which fish can be taken. Selectivity controls include two types: A minimum size for mesh in purse seines and gillnets, and a regulation on the size of troll-caught salmon.

Minimum mesh sizes for purse seines permit fish below a certain size to escape while retaining all individuals above that size. The minimum mesh sizes enable fishermen to take chum and pink salmon in areas where immature chinook and coho salmon are also concentrated, without much damage to the latter. Proper design and application of the mesh sizes may not only increase the total yield of salmon, but also conserve the salmon stocks.

The minimum mesh sizes for gillnets function to reject fish both smaller and larger than those in the allowable size range. The selectivity of the gillnets can be used to permit harvesting of one species while avoiding capture of others. The mesh sizes of the gillnets in the Skeena River have been designed to catch four-year-old and five-year-old fish at different rates. The regulations on mesh sizes for gillnets serve the goals of increased catch and conservation of the salmon stock.

The regulation on fish sizes of troll-caught salmon in coastal areas is designed to catch only certain sizes of fish, specifically those considered mature. Without this regulation, salmon could be caught before maturity and eventually, the total yield of salmon would be less than that were only mature salmon captured. This regulation may therefore increase the total catch of salmon. The selectivity controls, in general, achieve the goals of increased catch and the conservation of salmon.

a:2) Controls of fishing capacity. There are three methods to control the fishing capacity: one directly and two indirectly. The direct method is to control the number of fishing units (i.e., limited entry program) and will be discussed under a separate heading. The indirect methods are to control fishing time and to restrict fishing areas.

First, time closure is used to set the number of fishing days, depending on the number of fishing vessels participating in the fishery. The number of fishing days allowed in different areas also depends on the conditions of the areas. Before 1968, when a limit was placed on the amount of fishing gear in the fishery, the number of fishing days per week in Canada's salmon fisheries had gradually been reduced from five to three.

The main purpose of imposing a restriction on the number of fishing days is to assure enough escapees for spawning. It is a pure conservation measure.

Secondly, area closure rules are designed to remove some areas from fishing and to divide the fishing grounds into areas to permit different types of gear to fish separately. The biological characteristics of the Pacific salmon make them peculiarly vulnerable to excessive fishing effort in the estuaries of the spawning streams and in some areas of the Fraser River. Salmon frequently will not go up rivers when waters are low and clear. When fish wander around an estuary waiting for proper water conditions for upstreams, they are extremely vulnerable to fishing effort and can be fished to the point of extinction. In some areas of the Fraser River, fish which have escaped the Strait of George fishery turn back into open areas in association with certain wind and river conditions, and are again subject to capture. To protect certain runs of fish from overfishing, the mouths of the streams and some areas of the Fraser system have been closed from time to time.

Area closures are also designed to eliminate conflict between incompatible types of fishing gear. While trollers are permitted to fish for salmon in coastal areas, the gillnetters and seiners are allowed to fish in separate river areas. Area closures act to reduce the externalities arising from incompatibility among gear types.

Area controls are conservation measures and may achieve economic goals in the sense of eliminating external diseconomies and achieving equity, as perceived by decision makers. In another sense, area controls could reduce efficiency of gear use from an economic standpoint. Whether area closure rules serve the goal of "contribution to the economy" is questionable.

Controls of fishing capacity, through time regulation and area closure rules are conservation measures, though they may incidentally serve economic goals as well. Success in achieving economic goals by controls on fishing capacity is an open question.

a:3) Limitation on vessels and equipment. The limitations on vessels and equipment are deliberately designed to reduce technical efficiency of the individual operating units. These limitations include the elimination of traps, prohibiting the use of nylon nets, restrictions on the length and depth of nets, and preventing the use of electronic devices or aircraft in fish finding. Again, these constraints on equipment are designed for conservation purposes.

b) Limited entry program (8, 9, 42). The Fishery Service of the Environmental Department of Canada put a limitation on new entries and gradually eliminated some fishing units from the B.C. salmon fisheries in 1969. The existing salmon vessels under the program were divided into "A" and "B" categories. "A" vessels were those which had salmon landings valued in excess of $1, 250 for either 1967 or 1968. "B" bessels were those with less. "A" vessels can be retired and replaced by new vessels on the basis of ton-to-ton carrying capacity without losing licenses. "B" vessels cannot be replaced nor altered in any significant way. Their licenses will expire in 1979, and are not renewable.

After the first season, 1969, license fees, which had been nominal, were increased for "A" vessels to $100 for vessels under 15 tons and $200 for those over. "B" boats remained at $10. The "A" license fees were increased to $200 and $400 in 1971.

There was a fishing vessel buy-back program designed to accelerate and encourage the retirement of salmon vessels from the fishery. This buy-back program was introduced in December 1970 and was terminated in 1972. It was operated by a committee of representatives from the fishing industry. The owners of vessels who wished to leave the salmon fishery could approach the committee for an appraisal of their boats. The committee, after appraisal, determined the buy-back price. The owners had the choice of accepting or rejecting the offer. The boats would be withdrawn from the industry if the offer was accepted. The vessels purchased by the committee were auctioned off to the highest bidder but they could not be licensed for commercial fishing in B. C. henceforth.

This program was designed to achieve the following objectives:

(1) to reduce overcapitalization and excess labor, (2) to improve average fishermen's earnings, and (3) to facilitate the management of the resources. The first two objectives are relevant economic objectives while the third may be indirectly related to conservation measures. Over time, however, the elimination of fishing effort should reduce the pressure of fishing effort on a stock and should thereby enable the stock to build up, resulting in increasing yields from the stock. However, limited entry programs may actually place controls on only one factor of production, and thus, may lead to more intensive use of other factors.

c) Salmon enhancement programs. Canada has already instituted many programs designed to enhance its salmon fishery. Hatchery operations, artificial spawning grounds and fish ways, and the improvement of natural spawning grounds are examples. However, one program recently announced deserves special attention. The Canadian Fisheries Minister, Romeo Leblanc, announced on March 20, 1975, that a salmon enhancement program will be embarked upon after a two-year planning study (20). The program will involve province and federal cooperation. The planning study will last two years and was initiated in the spring of 1975. The implementation of the program will begin in 1977 upon Cabinet approval of detailed project proposals. The budget for this program is expected to range from \$250 to \$300 million. The details of the program have thus far not been available. Enhancement techniques to be employed in the program include artificial spawning channels, hatcheries and fishways. The objective of the program is to double the stocks of all species of Pacific salmon by the year 1990.

In conclusion, Canadian fisheries management programs are not designed to achieve one objective alone, but in most cases are designed to achieve multiple objectives. Among these objectives, those which are most frequently mentioned are increased catch, conservation of salmon, and increases and stabilization of earnings of fishermen.

C) The objectives and procedures of this study

One danger of fishery management programs is that decisions are made whose consequences are not foreseen. The objectives of this study are to help provide a better understanding of the salmon market and, in so doing, to estimate the total consequences of public and private policy actions. This study focuses on the impacts of the Canadian fishery management programs with respect to retail and wholesale prices of canned sockeye salmon, and on the returns to fishing effort in the sockeye fishery. The impacts of management programs particularly emphasized in this study are: the salmon enhancement programs; the limited entry program; and the time and area closure rules.

The salmon enhancement programs, as indicated by their name, are designed to increase the size of exploitable salmon stocks and thereby the amount of salmon landed. Therefore, the size of the sockeye salmon stocks and the quantity of sockeye landed are treated as variables which can be influenced by public policy, such as the enhancement programs described in this study.

The limited entry program, as mentioned above, is primarily designed to limit or to curtail the total fishing effort in the salmon fisheries. In this study, the amount of fishing effort is regarded as one policy variable directly associated with the limited entry program.

The time and area closure rules limit the period of fishing time and the fishing area available for the salmon fleet. The longer the period open for fishing and/or the more extensive the area available, the greater the number of fishing days a unit of fishing effort can be employed. Thus, the number of fishing days per unit of fishing effort is related to the time and area closure rules and is treated as another policy variable in this study.

To estimate the impacts of these programs on the prices of canned sockeye and the return to fishing effort, an econometric study of demand and supply dealing with quantity and price relationships is undertaken. This study divides the sockeye industry of Canada into four market levels with a supply-demand relationship at each level, these levels being delineated at the retail, wholesale, exvessel and fishing effort markets. An econometric model is constructed to include these market levels and, where possible, to treat the policy variables subject to the fishery management programs as exogenous variables. The impacts of changes in these exogenous variables are then estimated through the complete model. Conclusions are drawn and policy implications are discussed to complete the analysis.

D) Literature review

No study has been made of this kind, which is to delineate various levels for the Canadian salmon market and to develop an econometric model to provide meaningful estimates of the demand for and the supply of Canadian salmon products at these levels. Neither has one been made for the U.S. salmon industry. However, a similar study of the U.S. New England fishing industry is available (17, 18).

The study of the New England fishing industry focused on two fish species: haddock and ocean perch. This study examined the market levels from exvessel markets to retail markets, but ignored the markets for fishing-effort. It consisted of three major segments (the landings, wholesale-processors and retailer markets) and two subsidiary parts (the import and cold storage markets). The characteristics of each market level were depicted and an econometric model was built accordingly to include supply and demand at each level. Then the hypothesized relationships in the model were tested and estimated. The models for haddock and ocean perch proved to be only partially satisfactory representations of the markets for these fish at various levels. The models are particularly weak in the "middle market" area: the wholesale, cold storage holdings and import levels. The difficulties were said to have been associated with inaccuracies in the measurement of variables: net market movement, wholesale prices and cold storage holdings. However, reasonable results were obtained in the landings and retail market equations, and in several individual parameters in the middle-market area.

While no econometric studies including the various market levels have been undertaken for the U.S. or the Canadian salmon industries, there are numerous demand studies using single equation models for a particular market level; several for the U.S. salmon industry and one for the Canadian salmon industry.

In 1968, a study by Nash and Bell, using annual data from 1947 to 1965, assumed per capita consumption of canned salmon as a function of the price of canned salmon, U.S. personal income and the price of canned tuna (37). The function was estimated in logarithmic form. The estimated price and income elasticities were -0.006 and

-1.628, respectively. The interesting results of this study included the findings that the demand for canned salmon was highly price-inelastic, tuna and salmon were substitutes in consumption, and salmon may be an inferior good.

A study by Waugh and Norton in 1969 used annual data to examine consumption relationship between canned salmon and canned tuna (50). The results were similar to those of the Nash and Bell study: price-inelastic demand, a negative income coefficient and substitution between salmon and tuna in consumption.

Another study in 1969 by Nash, Sokoloski, and Cleary looked at demand factors for Alaskan fishing products and found that population and income did not have a significant effect on canned salmon prices (38). However the price elasticity of demand for each of the five species of salmon was found to be in excess of unity.

An unpublished thesis prepared by W. R. Wood in 1970 used annual data from 1947 to 1967 to estimate the wholesale demand equations for canned salmon taken together and for sockeye, pink, chum and coho taken separately (51). Under the specification that the price was treated as the dependent variable, the price elasticity, in all cases, exceeded unity and the income coefficient, in four out of five equations, was positive. When the equations were re-specified in such a way that quantity consumed became the dependent variable, then the price elasticity was substantially below unity (i.e., inelastic) and the coefficient for income was negative (i.e., inferior goods). These different results suggest that there exist specification difficulties.

In 1974, a study by Johnston and Wood used annual data from 1964 to 1974 to estimate the wholesale demand equation of canned sockeye (27). A linear relationship was specified among variables, a two-step procedure was used to estimate the parameters, and a ridge regression method was applied at the second step of the analysis. Under the first step, the wholesale prices in December were predicted. The predicted wholesale price was then used as an independent variable in the second step, where the per capita consumption of canned sockeye was treated as the dependent variable. The results of this analysis were that the demand was price-elastic, and that the income coefficient was positive. However the positive coefficient for income was inconclusive, due to the increased bias of the estimates associated with using ridge regression methods.

An unpublished thesis prepared by M. C. Onuorah in 1973 used Canadian annual data from 1947 to 1970 to estimate the exvessel demand equations for pink and sockeye salmon (39). The exvessel prices of pink and sockeye salmon were treated as dependent variables respectively and a linear relationship was specified in both equations. The analysis of the demand equation for pink salmon was not successful in uncovering statistical relationships. The analysis of the demand for sockeye salmon showed that the demand for sockeye at the landing market level was price inflexible (-0.0161) in Canada. However, the researcher ignored the fact that the exvessel price of sockeye salmon is determined by negotiations between fishermen and major packers before each fishing season. The resulting minimum price is not the market equilibrium price of sockeye, since the packers usually pay bonuses on the top of the minimum price at the end of the fishing seasons. Regardless of the magnitude of bonus payment, the price and quantity relationship was distorted in the study and therefore the results are questionable.

In summary, no econometric study at the various market levels of the Canadian salmon industry has been undertaken. Although some studies of single equation models have been made, the results are inconsistent and inconclusive. Therefore, it is hoped that the econometric study of the Canadian canned sockeye industry presented herein will provide such meaningful and useful information about the industry.

II. THE CANADIAN SOCKEYE INDUSTRY

Canada is the smallest in landings but the second largest in export sales among the four exploiters of Pacific salmon: Canada, Japan, USA and USSR. During 1968-70, the U.S. caught 41.3 percent of the total Pacific salmon landed, Japan 25 percent, the USSR 16.7 percent, and Canada 16.1 percent.[8/] In terms of export quantities, Japan exported 54.2 percent of the total world trade of Pacific salmon and salmon products during the same period, Canada 26.3 percent, USA 11.1 percent and USSR 8.4 percent.[9/]

The salmon industry is the dominant fishing industry in the province of British Columbia. Salmon, during 1968-72, accounted for 71 percent of the value of all fish landed in the province. The other species, including halibut, herring and many others, shared the rest of the 29 percent in value.

There are five species of Pacific salmon harvested in B.C. These are commonly referred to as: sockeye, chum, pink, coho and

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8/ These figures are calculated from data found in the yearbooks of the International North Pacific Fisheries Commission (25).

9/ These figures are calculated from data contained in Food and Agriculture Organization of the United Nations' Yearbook of Fisheries Statistics (52).

chinook. Among these species, sockeye ranks first in the value of landings and second in quantities landed (by weight). During the period 1951-72, sockeye accounted for 30 percent of the value of total salmon landed while it accounted for only 20 percent of the weight of salmon landed, as shown in Table 1.

Table 1. Share of Salmon Landings, 1951-72.

	Quantity	Value
Pink	33.0%	17.5%
Red (sockeye)	19.8	30.0
Chum	19.6	12.0
Coho	18.3	24.0
Chinook (King)	9.3	16.5
Total	100.0	100.0

Source: B.C. Catch Statistics, Fisheries Service, Vancouver, B.C.

A) Canadian Sockeye Resources

Canada's Pacific sockeye, whose scientific name is *Oncorhynchus nerka*, is called sockeye in both Canada and the U.S.,[10/] beni-masu in Japan, and krasnazu or nerka in the USSR (2).

Traditionally, sockeye has been the most highly prized salmon among the five species found in B.C. waters because it is very rich

[10/] Sockeye is also known as red salmon in Alaska, and blue-back in the Columbia River.

in oil and holds both color and flavor well under all conditions of storage. Sockeye is the fish on which the salmon canning industry of B. C. was built. It is the fish which is abundant in the Fraser River and which has given the River the reputation of being the world's most famous sockeye river.

Sockeye salmon, like other anadromous fish, begin their lives in fresh water and spend most of their remaining lives in the ocean. When they approach maturity, sockeye return to fresh water to spawn and die. One of the sockeye's obvious peculiarities is that it seldom ascends a stream without lakes. It spawns in small tributary streams above lakes, or where there is suitable gravel permeated by springs in the lakes themselves.

The young sockeye hatch from the eggs in the spring and drop back down to the lakes where they spend one, often two, and sometimes three years before migrating to the ocean during the months of March to July. Then they spend most of the rest of their lives in the ocean until reaching maturity. The mature sockeye weighs about 5 pounds, and may weigh up to 15 pounds. The length of the mature sockeye ranges from 2 feet to 2 feet 9 inches.

Four drainage areas support most of Canada's sockeye. These are the Fraser River, the Owikeno and Long Lakes (tributary to Rivers and Smith Inlets), the Skeena River and the Nass River (2). During 1951-63, the fisheries in the Fraser estuary and in the approaches to the Fraser River provided annual catches averaging 4.34 million sockeye, which was 67 percent of the total Canadian and Washington state sockeye catch. Catches bound for Rivers and Smith Inlets tributaries averaged 1.06 million sockeye, or 16 percent of the total, while catches in the vicinity of the Skeena averaged 8 percent of the total during the same period. The catch in the Nass area has averaged 205, 700 sockeye, 3 percent of the total. The remaining areas have provided in total an average catch of 358, 300 sockeye, only 6 percent of the total.

Sockeye are caught in substantial numbers from late June to the end of September with July being the peak month, as indicated in Figure 8. A second peak in late August reflects the dramatic appearance every four years of a very large run to the Shuswap Lake area of the Fraser River (2).

While in salt water, sockeye take a lure far less frequently than do the other species. Thus sockeye are primarily caught by nets and purse seines.

B) Sockeye fishing

There is a substantial number of fishermen in the B.C. fishing industry. Most are engaged in the B.C. salmon fisheries. Fishermen who fish for salmon must purchase a license each year from the Canadian federal government for a nominal fee. In addition to

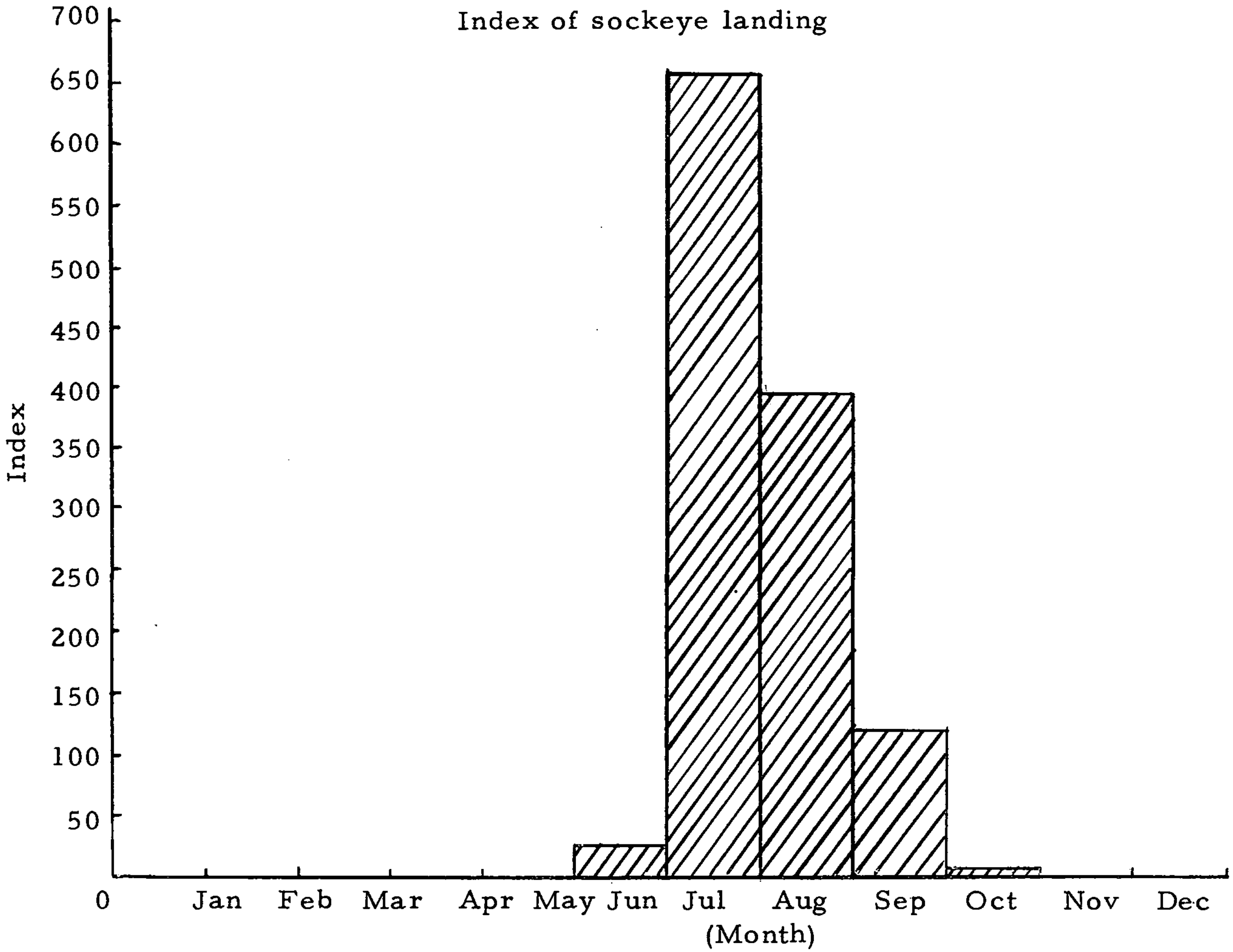

Figure 8. The seasonal variation of sockeye landing (1952-72)
Source: B.C. catch statistics (1952-72)

fishermen's personal licenses, gear licenses were required before 1966. Since 1966, gear licenses have been replaced by vessel licenses. The vessel license fees have increased substantially since 1969 when the limited entry program was implemented. The details of increases in the fees are presented on page 25.

Most fishermen belong to some labor organization. The major fishermen's organizations in the B. C. salmon fishery are The United Fishermen and Allied Workers' Union (UFAWU), the Native Brotherhood of B. C., The B. C. Gillnetters' Association, The Pacific Trollers' Association, and The Prince Rupert Fishermen's Cooperative.

Among these organizations, the UFAWU claims membership among different types of fishermen and plant workers along the B. C. coast. The UFAWU was formed in 1945 by merging the United Fishermen's Federal Union, British Columbia Fishermen's Protective Association, and United Fish Cannery and Reduction Plant Workers' Federal Union (16, 21). The Union, on behalf of its members, negotiates to achieve various agreements with either the Fisheries' Association of B. C., representing the major canning firms, or the Fishing Vessel Owners' Associations of B. C. The negotiations include the agreements on minimum prices of net-caught salmon, working conditions and division of seine catches, and working conditions and wages in fish processing plants. The Union declares and organizes strikes in cases of negotiation failure. In negotiating the minimum prices for net-caught salmon, the Union cooperates with the Native Brotherhood of B. C. in joint actions in most years.

The Native Brotherhood was formed in 1930. Its overall purpose is to obtain better living conditions for B. C. Indians. With respect to fisheries, it negotiates for its members with the Fisheries Association of B. C. These negotiations concern minimum prices and wage and working conditions. The negotiations are usually, though not always, undertaken jointly with the UFAWU.

The B. C. Gillnetters' Association was organized in the fall of 1952. Most members are from the upper Fraser River area. Although this association, on behalf of its members, negotiates separately with the Fisheries' Association with respect to minimum prices, the agreements usually follow the agreement reached by the UFAWU and the Fisheries' Association.

The Pacific Trollers' Association, as indicated by its name, is an organization of commercial trollers and was formed in the fall of 1956. The association is active in looking after the specific interests of the salmon trollers and, therefore, is particularly concerned with the management and conservation of chinook and coho salmon, the two species which dominate the troll fishery.

The Prince Rupert Fishermen's Cooperative is an agency type of marketing cooperative which contracts with each member to market fish produced by the members. The principal objective of the cooperative is to handle fish and fish products for its members as effectively and efficiently as possible.

Canadian salmon are harvested with three types of gear operated by fishermen on three separate types of vessels: troll lines on trollers, gillnets on gillnetters, and purse seines on seiners. In 1971, the gear fishing for salmon included 13, 903 gillnets, 466 purse seines, and 15, 359 troll lines. This gear was operated in 1971 by a fleet consisting of 3, 245 gillnetters, 377 purse seiners, and 2, 175 trollers (19).

Gillnetting, purse seining and trolling are the principal methods of commercial salmon fishing in B. C. Gillnetters, usually operated by one man, range upward from 28 feet in length, with large multipurpose boats reaching 38 feet. The net is hung from a cork line at the surface and weighted down by a lead line which runs along the bottom of the net. A buoy is attached to one end, and the net is set out by travelling at slow speed while the net is unwinding from a drum. The boat and net then drift with the tide or current until the net is hauled. Fish become entangled by their gills when they swim into the net.

Purse seiners range in length from 40 to 90 feet. A huge net is set out from a platform or table (on drum seiners, from a drum) at the stern and is maneuvered to encircle a school of fish. The seine is then drawn together at the bottom. Then the net containing the fish is loaded into the boat.

The salmon trollers, which vary in length from 30 to 40 feet, are marked by long poles which extend over the sides of the vessel while fishing. To these poles are attached weighted lines bearing lures which are trolled through the water at slow speed. The salmon are caught on the lures.

Most sockeye are caught in the net fisheries while troll-caught sockeye is a very insignificant part of the total. During the decade of 1963-72, gillnet-caught sockeye accounted for 72.9 percent of the sockeye landed in B.C. by weight; seine-caught sockeye was 22.6 percent, and troll-caught sockeye was 4.5 percent, as indicated in Table 2. The relative position of gillnetting has slightly decreased while those of seining and trolling, on the contrary, have shown gradual increases in importance in the later years of the period, as also revealed in Table 2. The trend in gillnetting has been a 2 percent decline per period while those in seining and trolling, on the contrary, have been upwards, at the rates of 1.26 percent and 0.77 percent, respectively.

Changes in the relative importance of gear types in sockeye fishing may be due to the factors underlying the efficiency of fishing units for this particular species. According to Argue (1), the

Table 2. Landing of Sockeye Salmon by Gear 1963-72 - 1000 pounds (round).

		GN		Seine		Troll		Total	
Year	Period (T)	1000 lbs.	% 1/	1000 lbs.	% 2/	1000 lbs.	% 3/	1000 lbs.	%
1963	1	9, 440	79.5	2, 290	19.3	140	1.2	11, 870	100
1964	2	20, 110	87.6	2, 650	11.5	190	0.9	22, 950	100
1965	3	14, 440	89.0	1, 660	10.2	120	0.8	16, 220	100
1966	4	18, 500	72.0	6, 860	26.7	350	1.3	25, 710	100
1967	5	24, 240	65.4	11, 110	30.0	1, 720	4.6	37, 070	100
1968	6	32, 690	79.0	7, 470	18.1	1, 220	2.9	41, 380	100
1969	7	19, 100	79.6	3, 960	16.5	920	3.9	23, 980	100
1970	8	15, 300	60.8	7, 230	28.9	2, 650	10.5	25, 180	100
1971	9	22, 129	57.9	11, 811	30.9	4, 263	11.2	38, 203	100
1972	10	16, 186	77.1	4, 540	21.6	256	1.3	20, 982	100
Total		192, 135	(72.9)	59, 851	(22.6)	11, 829	(4.5)	263, 545	100

Source: Catch Statistics of B.C. Fishery Service, Vancouver, B.C.

1/ GN (%) = 85.93 - 2.02 T; R^2 = .33
t-value (-2.00)

2/ Seine (%) = 14.45 + 1.26 T; R^2 = .26
t-value (1.65)

3/ Troll (%) = -0.39 + 0.77 T; R^2 = .36
t-value (2.11)

fishing efficiency of gillnetters relative to that of seiners can be measured in numbers of gillnetters per seiner according to their average catchability on the same fishing grounds. This relative efficiency varies from month to month and from area to area. On Juan de Fuca Strait, 4.3 gillnetters are equivalent to one seiner in August, and 4.9 gillnetters are equivalent to one seiner in September. However, the relative efficiency of gillnetters to seiners in the sockeye fisheries should be considered as 4.3 since most sockeye are caught in August.

Based on Argue's findings, a conversion to standardized fishing units can be established. In the Canadian sockeye fisheries, one seine boat can be considered to have the same catchability as 4.3 gillnetters. Thus a seiner is treated as 4.3 gillnetters in the measurement of standard fishing units, and one gillnetter is treated as one standard fishing unit.

With this conversion and the total number of seiners and gillnetters engaging in the salmon fisheries, the number of standard fishing units in the salmon-netting fleets is obtained. The average number of standard fishing units is 5,270 for the period 1967-71, as indicated in Table 3. The number of standard units exhibits a gradual decrease since 1967. This decrease may have resulted in part from the license control programs initiated in 1969.

Table 3. Numbers of Salmon-Netting Vessels in B.C. (1967-1971).

Year	Gillnetters (1)	Seiners (2)	Gillnetter equivalent of seiners (3)	Standard fishing unit # of gillnetters (1) + (3)
1967	3, 867	414	1, 780	5,647
1968	3, 828	398	1, 711	5, 539
1969	3, 426	369	1, 587	5, 013
1970	3, 520	410	1, 763	5, 283
1971	3, 245	377	1, 621	4, 866
Average	3, 577	394	1, 692	5, 270

Source: Fisheries Service, Vancouver, B. C.

As in many fisheries, the earnings of sockeye fishing units vary widely around a low average. The average gross return per standard fishing unit (i. e., gillnetter) in the B. C. sockeye fishery was $2, 291 during 1967-71. This average return varied widely from $1, 679 at its lowest in 1970 to $2, 896 at its highest in 1971, as indicated in Table 4.

C) The harvesting, marketing and pricing of sockeye

The sockeye catch is limited by the sizes of the runs. The management authorities regulate the fisheries to insure that enough fish spawn in order to provide future runs. Therefore what remains for harvesting is a residual. The catch is big when the run is big and small when the run is small. The the annual catch varies according to the availability and magnitude of sockeye runs. The

Table 4. Average Gross Return to a Standard Fishing Unit in B.C. Sockeye Fisheries (1967-71).

Year	Total value of net-caught sockeye, $000's (1)	Standard fishing units (2)	Average return, $
1967	13, 271	5, 647	2, 350
1968	15, 187	5, 539	2, 748
1969	8, 937	5, 013	1, 783
1970	8, 869	5, 283	1, 679
1971	14, 094	4, 866	2, 896
Average	12, 072	5, 270	2, 291

Source: (1) Fisheries Service, Vancouver, B. C.
(2) Table 3.

sockeye landings during 1960-72 fluctuated greatly around an average 235, 329 cwt. While the quantity of sockeye landed is mainly dependent on the size of the run, catch can also be forfeited as a result of labor disputes. Catch losses due to labor strikes are often high. For example, the loss of sockeye catches attributed to strikes was estimated to be sufficient enough to process 150, 000 cases in 1959 (29, p. 539). During the two decades of 1953-1972, strike years which are regarded as having caused some losses in sockeye catches were the years 1953, 1954, 1957, 1959, 1961, 1963, and 1971.

The price of net-caught sockeye, like other net-caught species, is determined by negotiation between the two delegates representing fishermen and major packers, respectively. A minimum price is agreed upon before net fishing actually begins. This agreed upon price is just a minimum price.

This minimum price, by no means, stands for the true cost of input to canners, since packers in general pay bonuses on top of the minimum prices at the end of the fishing seasons. Data on the amount of the bonuses are not available; some believe the bonuses are approximately 10 percent of landed values, while others believe they may be as high as 15 percent or 25 percent. The bonuses vary from year to year and from one type of gear to another, and even from one fisherman to another.

While the price of net-caught sockeye is determined by negotiations, the price of troll-caught sockeye is decided by demand and supply forces in markets. However, the number of transactions taking place under the latter is a mere trifle, since the portion of sockeye caught with troll lines is small.

The price of troll-caught sockeye in the dressed form is always higher than the price of net-caught sockeye in the round form. Troll-caught sockeye command a higher price since they have been dressed. Prices for both net and troll-caught salmon increased steadily during the period 1960-72, but at different rates. The price of net-caught sockeye increased 20 percent from 35.25¢ a pound to 42.77¢, while the price of troll-caught sockeye increased 58 percent from 34.54¢ to 54.50¢, as shown in Table 5.

Table 5. Average Exvessel Price of Sockeye by Gear Types (1960-72).

Year	Net-caught sockeye (round) ¢/lb.	Troll-caught sockeye (dressed) ¢/lb.
1960	35.25	34.54
1961	33.29	36.79
1962	33.45	36.90
1963	34.00	36.84
1964	36.00	39.20
1965	37.11	39.30
1966	37.10	40.76
1967	37.54	41.01
1968	37.81	42.64
1969	38.75	44.28
1970	39.35	48.42
1971	41.53	50.11
1972	42.77	54.50

Source: Economic Branch, Department of Environment Pacific Region.

D) <u>The sockeye processing industry</u>

The first salmon cannery in B.C. was erected at Annieville in 1870 (15). The salmon canning industry in B.C. has geographically expanded from the south to the north and has also extended from high-valued sockeye to low-valued species resulting from the increase in demand for salmon products.

The canneries are dispersed along the entire B.C. coast and five species of salmon are utilized in processing. In 1967, there were nine canneries located in the south district along the Fraser River, seven canneries situated at the far north of the province in the Skeena and Nass district, three canneries in the central B.C. coast and three on off-coast islands, of which two were on Vancouver Island in the south and one on the Queen Charlotte Islands in the north (29, p. 617). In the same year, the total salmon production was 1, 465, 708 standard cases[11/] of which 558, 892 cases were sockeye, 146, 677 cases were coho, 650, 142 cases were pink, 94, 022 cases were chum and 15, 975 cases were spring (chinook) and steelhead.

Seasonal variations in the sockeye runs due to biological factors result in an industry with excess capacity during some periods. Salmon runs vary in abundance by seasons and so does the production of canned sockeye. This seasonal variation in production creates excess capacity in the canning industry on a yearly basis. The capacity in the industry, estimated in 1968 as approximately 40, 000 forty-eight pound cases per eight-hour day, has been sufficient to process peak season landings (30). During the off-seasons, the canning facilities are idle. Excess capacity may also exist in the production seasons when salmon runs are poor.

The biological factors not only determine the seasonal

11/ A standard case is a 48-pound case, a common unit used to measure the total pack consisting of different can sizes.

availability of salmon but also the abundance of fish for particular years. Heavy runs cause problems and poor runs do also. In years of extremely heavy landings, canners are forced to impose limits on catches to alleviate glut conditions. The pink fisheries in 1962 and 1965 are examples. The excess escapement due to the limited catches may create problems for management authorities. A poor year may result in not enough escapement and this may concern management authorities. Also a poor run leaves the processing industry with much excess capacity.

When a poor run prevails, it tends to leave some canning facilities idle or to leave the industry operating at less than full capacity. Thus packers, in order to utilize their full capacity, compete vigorously with each other for the raw fish in poor seasons. This competition for raw fish exists in three forms. First, packers vertically integrate backward to the fishing industry by acquiring fishing units so as to secure the raw fish. In 1968, canners owned 43 percent of the seiners and 15 percent of the gillnetters, as shown in Table 6.

Secondly, canners, in order to assure enough raw fish for processing, contract with fishermen on the first refusal basis[12/]

[12/] The fisherman under financial obligation to a company agrees to offer his whole catch to the company at its nearest buying station at the prevailing price and to deliver the catch to the station or to the company's tenders.

Table 6. B.C. Salmon Net Fishing Vessels Owned by Major Fishing Companies, 1968.

Types	Number of vessels	Vessels owned by canners	Percentage owned by canners
Seiners	398	172	43
Gillnetters	3,828	587	15

Source: (30, p. 20)

when the fishermen approach the canners for financing. The number of fishermen having financial commitments to processors is considered substantial.

> "While there are no accurate records of the number of fishermen subject to such financial commitments, Mr. Homer Stevens (UFAWU), in his evidence, estimated that 90 percent of the gillnetters had such commitments and Mr. L. K. Carr (Pacific Trollers Assn.) estimated that 85 percent of the trolling fleet was financed in this manner." (16, p. 38)

The number of seiners under this type of contract is not available but is also expected to constitute a substantial number.

Thirdly, the companies charter independent seiners (i.e., non-company owned seiners) to assure the delivery of seiners' catches. Chartered seiners account for about half of the seiner fleet in the salmon fishery.

> ". . . in 1957, B.C. Packers owned 45 (seiners) and there were 42 independently owned delivering salmon to it. Of the latter, Mr. Harrison (B.C. Packers) stated that with the very odd exception these vessels would be chartered by the company. . . . Canfisco

owned approximately 45 salmon seine vessels and about 40 were chartered." (16, p. 93-94)

The processing industry is characterized by a small number of firms and high concentration in both buying and selling markets. During the period of 1960-72, the number of processing companies varied from 17 to 9 with a tendency toward steady decline, as indicated in Table 7. There existed only nine companies in 1972.

Table 7. Numbers of Canneries and Companies in the Canadian Salmon Industry 1960-72.

	Canned salmon		Canned sockeye	
Year	Canneries	Companies	Canneries	Companies
1960	21	17	20	16
1961	22	16	22	16
1962	21	16	21	16
1963	23	17	23	17
1964	21	15	21	16
1965	22	16	22	17
1966	23	17	23	17
1967	21	15	20	14
1968	20	15	20	15
1969	13	10	13	10
1970	16	11	15	11
1971	12	10	11	9
1972	12	9	12	9

Source: Fisheries Service, Department of Environment, Canada.

Although exact concentration figures are not available, the buying market (i.e., exvessel market) for the processing industry is believed to be highly concentrated. Concentration in the buying markets may be directly reflected in the concentration of production.

Production concentration was stable at a relatively high level during the decade of 1963-72. The salmon processing industry had a little higher concentration in canned salmon as a whole than in canned sockeye as an individual species during the decade; the largest two and largest four companies in the salmon canning industry respectively accounted for 68 percent and 82 percent of the total production of canned salmon, while the figures were 66 percent and 80 percent for the canned sockeye production, as indicated in Table 8.

The small number of existing companies dominating the processing segment may lead to a concentration of power in the overall sockeye market. The largest two firms are the major suppliers of canned salmon in the domestic market whereas they are minor participants in export sales. "The two majors appear to control between them as much as 95 percent of the domestic market" (41, p. 69).

Another characteristic of the salmon processing industry is that a well-organized association has been formed by the major packers. This association now entitled the Fisheries Association of B. C., was formerly the Salmon Canners Operating Committee

Table 8. Percentages of the Packs of Sockeye and Total Salmon Produced by the Top Two and Top Four Processing Companies (1963-72).

Year	Sockeye		Total salmon	
	Top 2	Top 4	Top 2	Top 4
1963	59.6	74.9	60.9	75.7
1964	66.7	85.1	67.4	84.0
1965	48.6	62.3	58.2	81.2
1966	68.4	82.8	69.4	84.2
1967	70.4	83.3	71.9	83.9
1968	65.9	81.1	63.2	75.9
1969	72.1	84.2	73.3	85.0
1970	77.0	84.3	74.9	82.8
1971	69.6	79.0	73.0	81.8
1972	63.8	84.5	67.1	86.1
Average	66.2	80.2	67.9	82.1

Source: Fisheries Service.

Note: Top 2 = B.C. Packers + Canfisco + Nelson Brothers + J. H. Todd and Son; B. C. Packers has owned Nelson Brothers since 1960 and it with Canfisco has jointly owned J. H. Todd and Son since 1955-60. Prior to 1960, B. C. Packers had partial interest in Nelson Brothers.

in 1951 (16, p. 26). The Fisheries Association negotiates with the UFAWU and the B.C. Brotherhood about minimum prices for net-caught salmon as well as wage agreements. The objectives, as outlined by the Association, are (a) to foster and promote the development, conservation, and protection of the fishing industry and the fisheries resources; (b) to engage, encourage, and assist research in any field which may relate to such development, conservation, and protection, and (c) to provide and assist in regulations of relations between fishery employers and employees (41, p. 36-37). This association has been allowed to form an export cartel since 1962 by the Canadian federal government. It announces the export price of Canadian canned salmon and negotiates export contracts with foreign buyers.

E) The production, marketing and pricing of canned sockeye

Sockeye, regardless of catch source, is mainly processed in canned form. The amount of sockeye utilized in forms other than canned is relatively insignificant. During the period of 1966-70, canned sockeye, on the average, accounted for 98 percent of Canadian sockeye landings while the other forms of sockeye products shared the remaining portion (2%). The actual distribution for this period is revealed in Table 9 below.

Table 9. Utilization of the Canadian Sockeye Catch (1966-70).

Year	Canning (%)	Others (%)
1966	92.9	7.1
1967	99.5	0.5
1968	99.7	0.3
1969	99.2	0.8
1970	99.5	0.5

Source: Fisheries Statistics of B. C., Department of Environment, Canada, 1966-70.

As indicated above, most sockeye caught in B.C. is processed through canning. For this reason, canned sockeye will be singled out for discussion.

The quantities of canned sockeye produced are mainly determined by the quantities of sockeye landed. The sockeye pack and sockeye landings tend to fluctuate together, as revealed in Figure 9 and Table 10. During 1951-72, the highest sockeye pack occurred in 1958 with 1, 074, 305 standard cases and the low was in 1963 with only 158, 375 standard cases. Likewise the highest and the lowest landings levels occurred in the same respective years.

The production of canned sockeye is diversified according to can sizes: one-pound, half-pound and quarter-pound cans. The mix of can sizes may vary from year to year, but the half-pound can has been the most popular. Despite differences in the mix of can sizes between years, the input-output rate is considered fairly stable. For example, the input-output ratio in 1972 was estimated as 68 to 1, indicating that 68 pounds of raw sockeye produced one 48-pound case of canned sockeye regardless of can sizes (personal communication with Mr. Joe D'Andrea of the Economic Branch of Fisheries Service in summer 1973).

The production of canned sockeye is highly seasonal with most sockeye being canned between July and November. This seasonal characteristic of sockeye packing is coincidental with the seasonal

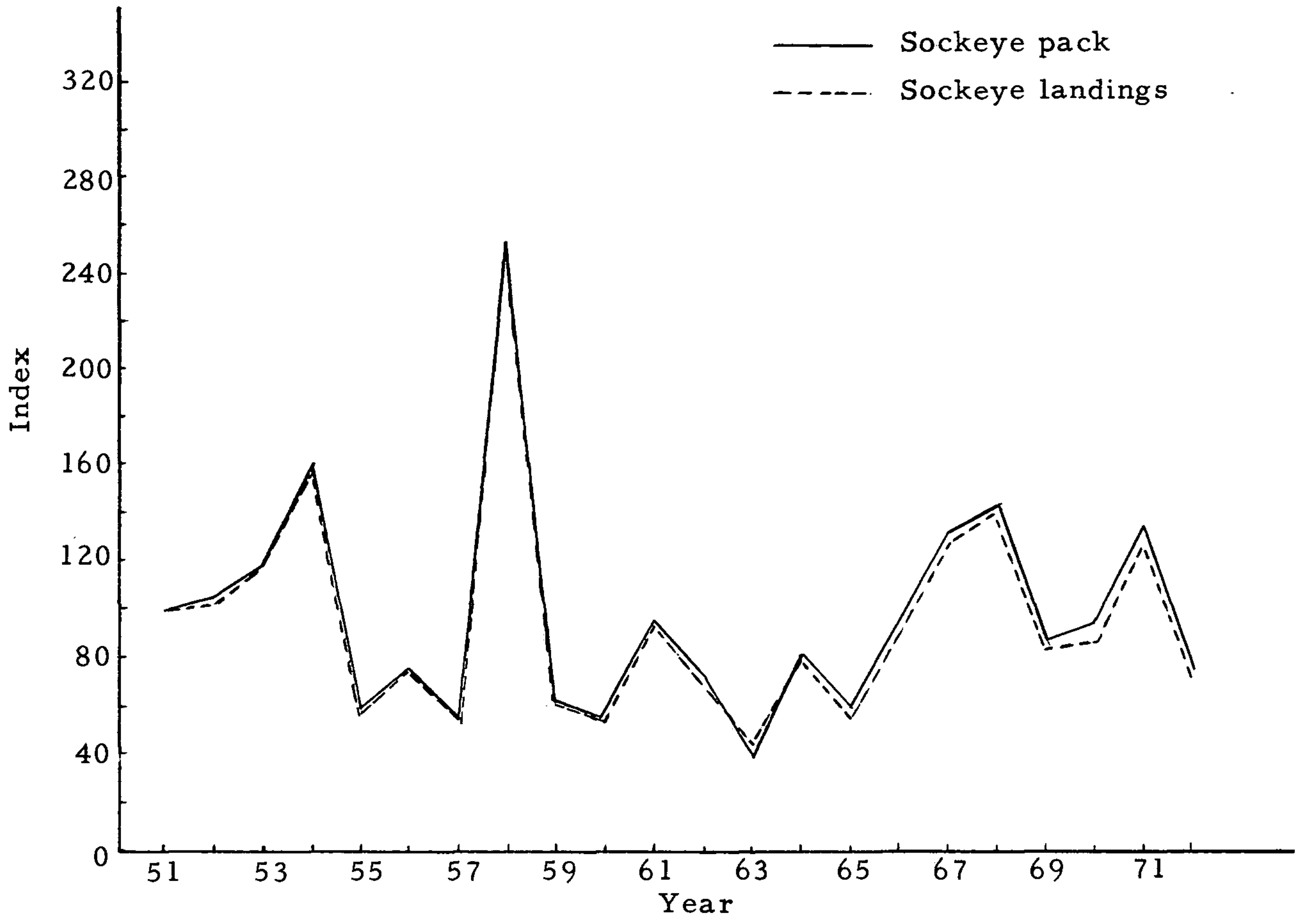

Figure 9. Index of sockeye landing and pack, 1951-72

Table 10. Sockeye Landings and Sockeye Pack in B.C. (1951-1972).

Year	Landing weight (round) CWT[1/]	Landing weight (round) Index (1951=100	Sockeye pack Cases[2/]	Sockeye pack Index (1951=100)
1951	298, 240	100	428, 217	100
1952	308, 684	104	449, 174	105
1953	353, 419	119	410, 100	119
1954	470, 266	158	680, 930	159
1955	166, 498	56	244, 821	57
1956	214, 992	72	320, 096	75
1957	157, 312	53	228, 452	53
1958	741, 147	249	1, 074, 305	251
1959	180, 596	61	256, 170	60
1960	154, 797	52	226, 912	53
1961	266, 219	89	398, 236	93
1962	201, 049	67	297, 717	70
1963	118, 730	40	158, 375	37
1964	229, 506	77	343, 359	80
1965	162, 210	54	245, 798	57
1966	257, 053	86	407, 949	95
1967	370, 722	124	558, 892	131
1968	413, 898	139	611, 011	143
1969	241, 384	81	359, 608	84
1970	251, 861	84	395, 606	92
1971	382, 025	128	568, 756	133
1972	209, 820	70	312, 308	73

Source:

1/ B.C. catch statistics 1951-1972, Fisheries Service, Department of Environment.

2/ British Columbia Canned Salmon Pack Bulletin, 1951-1972, Fisheries Service, Department of Environment.

variation in sockeye runs, except the packing period extends to December. This seasonal property not only under-utilizes canning capacity, but also creates marketing problems for canners since the demand for canned sockeye is considered stable throughout the calendar year. Thus while production in the first half of the year is next to zero, consumption is year-round. As a consequence canners, who are also wholesalers in the industry, hold inventories for the non-production seasons in an attempt to even out the supply. This inventory holding increases costs to canners.

Canners as wholesalers in marketing channels market their products through foreign markets as well as through domestic retailers. The marketing of canned sockeye through both markets is discussed in the following paragraphs.

The marketing of Canadian canned sockeye depends heavily upon export markets due to Canada's relatively small population. During the period July 1962 to June 1972, industry data reveal that total export sales were 1, 765, 855 cases, accounting for 44 percent of the total sales for the industry. However the quantity of Canadian canned sockeye exported fluctuates greatly. During the period described above, the average export consisted of 176, 586 cases, as indicated in Table 11. That table reveals that, on the average, the percentage of total sales exported increases as total sales increase.

Table 11. The Export and Domestic Sales of Canadian Canned Sockeye, 1963-72.

Year ending June	Export sales		Domestic sales		Total sales	
	Cases	%	Cases	%	Cases	%
1963	82,873	28.8	204,623	71.2	287,496	100
1964	62,498	27.2	167,021	72.8	229,519	100
1965	171,686	48.6	181,818	51.4	353,504	100
1966	64,842	24.9	195,963	75.1	260,805	100
1967	132,200	37.9	216,651	62.1	348,851	100
1968	314,158	55.0	256,776	45.0	570,934	100
1969	286,419	50.8	277,916	49.2	564,336	100
1970	239,429	54.6	199,400	45.4	438,829	100
1971	110,160	28.5	276,605	71.5	386,765	100
1972	301,590	52.8	270,082	47.2	571,672	100
Total	1,765,855	44.0	2,246,855	56.0	4,012,710	100
Avg.	176,586		224,686		401,271	

Source: Fisheries Association of B.C.

The export markets for Canadian canned sockeye are numerous with a high concentration in the UK, which absorbed 89.4 percent of the Canadian canned sockeye exported from July 1962 to June 1972, as shown in Table 12. Other minor markets are Australia, Belgium, South Africa, and Ireland.

The Canadian exporters face keen competition from Japanese suppliers in the U.K. market. Japanese sockeye runs are earlier than Canadian runs and, therefore, so are Japanese sockeye packs. The U.K. importers have tended to buy from Japan first, then Alaska and Canada last. U.K. buyers and Japanese suppliers, in

Table 12. The U.K. Shares of Canada's Canned Sockeye Exported, 1963-1972.

Year ending June	U.K. shares		Total export	
	Cases	%	Cases	%
1963	73, 586	88.8	82, 873	100
1964	44, 788	71.7	62, 498	100
1965	156, 772	91.3	171, 686	100
1966	54, 261	83.7	64.842	100
1967	125, 252	94.7	132, 200	100
1968	283, 068	90.1	314, 158	100
1969	276, 850	96.7	286, 419	100
1970	217, 201	90.7	239, 429	100
1971	74, 235	67.4	110, 160	100
1972	272, 362	90.3	301, 590	100
Total	1, 578, 375	89.4	1, 765, 855	100

Source: Fisheries Association of B.C.

negotiating export prices, may take Canadian and U.S. supplies into consideration. Regardless, Canadian exporters generally have accepted the prices set by U.K. and Japanese traders (personal communication with Mr. P. A. Todd of B.C. Packers, Ltd.). It is therefore implied that though the Canadian sockeye run, among many factors, has an impact upon world price, the Canadian exporters can be assumed to take the world price as given.

With regard to export markets, the small canners have relied heavily upon these markets for their entire output while the two big canners treat export markets as secondary markets. On the other hand, the small canners seldom compete with the top two canners in the domestic market and thus the domestic markets have become the important outlet for the two major canners (41). The reasons that the small canners have concentrated on the export markets without competing in the domestic are: (a) their individual pack of sockeye is too small to assure the domestic supply throughout the entire year, (b) difficulties in acquiring financing does not permit them to carry inventories during the non-production seasons, and, (c) the small canners may be barred from domestic markets by the big suppliers' market manipulations (i.e., marketing strategy). This will be explained in later pages.

September is a crucial month in the marketing of canned sockeye. By September, the sockeye landings are known from which the total pack of sockeye is determined. The export market by September is also ascertained in terms of export quantities and prices. Even though deliveries may take place during the year, most of the export sales are contracted under September prices: one knowledgeable source indicates that this is true of 95 percent of total export sales. Thus the B.C. canned sockeye exporters make their commitments, not totally but largely, to the export market by September, and distribute the remainder of their pack through the domestic market. The domestic sales during 1963-72 were 2,246,855 cases in total as shown in Table 11 on page 60. Domestic sales varied each year with an average of 224,686 cases.

The domestic wholesale market is characterized by a high concentration in the selling side and price leadership in marketing.

> "British Columbia Packers, Ltd., and Canadian Fishing Company, Ltd., which produce 90 percent of the salmon output, set the level of wholesale prices for the industry. Although the two major firms are in open competition, it is generally thought that their price decisions are similarly based. The two majors appear to control between them as much as 95 percent of the domestic market." (41, p. 69)

The major canners establish the domestic selling price at a level in order to maintain certain price differences between the foreign and domestic markets. In general, the domestic wholesale prices are higher than the export price, as shown in Figure 10. The higher domestic price may reflect two things: a) that there exists a product differential; and b) that there is market manipulation by the major firms. With respect to the former, the big firms' brands are more popular than those of the small firms. For instance, the "Clover Leaf" (B.C. Packers) and "Gold Seal" (Canfisco) are two popular brands of canned sockeye which command higher domestic prices at retail. These popular brands are perhaps regarded as being of higher quality by consumers. Secondly, the higher domestic price may be due to the high percent of the market controlled by the major firms. This situation may enable the majors to price domestically marketed sockeye at higher levels.

This price-difference strategy is employed by major suppliers in such a way that small suppliers are excluded from the domestic

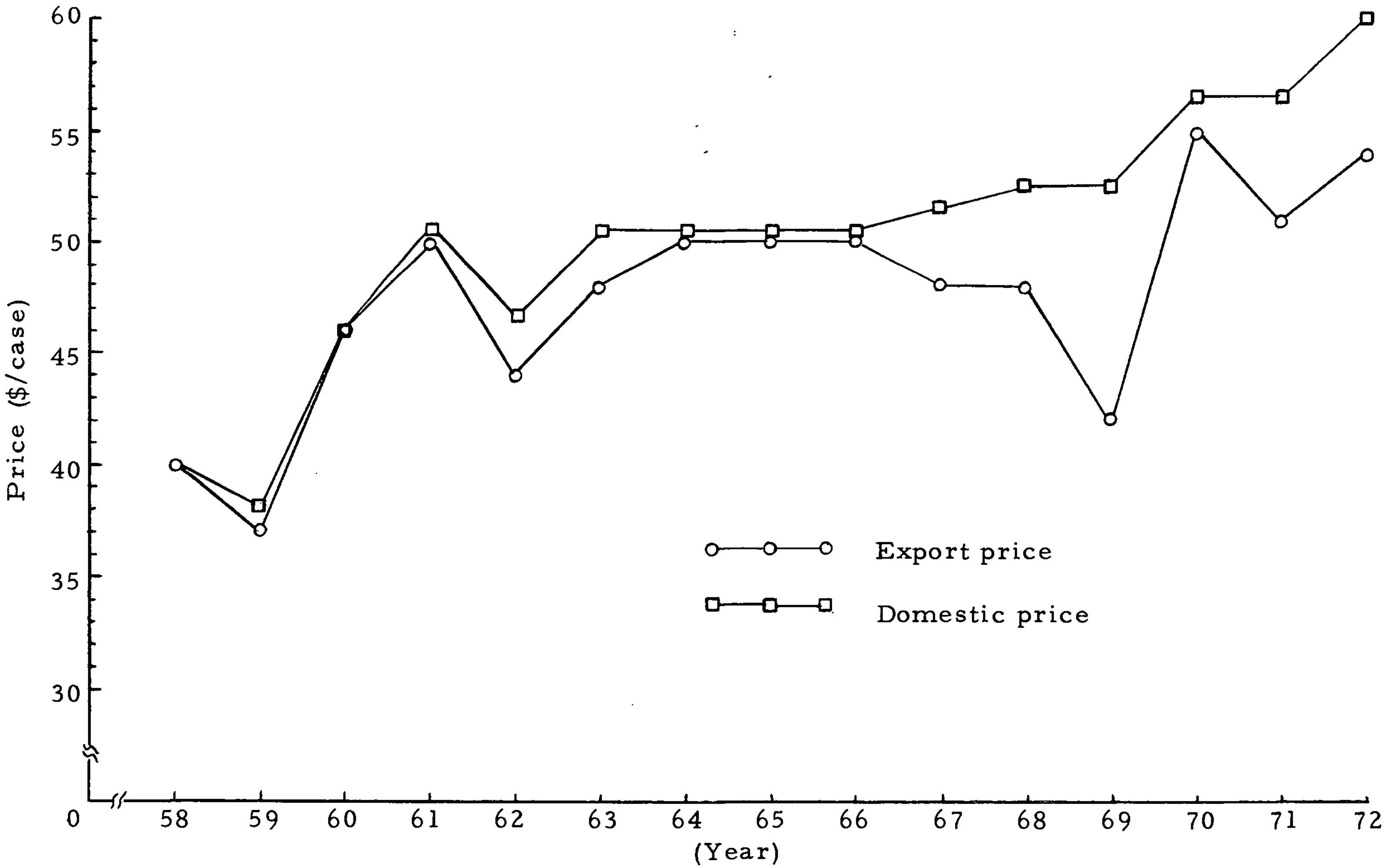

Figure 10. Wholesale prices of canned sockeye salmon in export and domestic markets, 1958-72
Source: Fisheries Association of B.C. Note: FOB Vancouver plant

market and consequently the major suppliers reap the higher revenues from domestic sales.

Firms in the canning industry have promoted their individual brands since 1954, but expenditures on promotion do not appear to be great (30). However combined efforts by the Fisheries Association of British Columbia on behalf of the major canners to increase the demand for canned sockeye are substantial. "In 1968 the major processors jointly spent over $300, 000 in one of the industry's largest advertising promotion campaigns." (30) The major theme under these coordinated efforts is non-price in nature.

This non-price promotion is known as the "package deal" in the industry. The major domestic suppliers pool two percent of their domestic sales revenues as promoting funds. With these funds, the B. C. Fisheries Association on behalf of the major canners helps to finance salmon retailers for approved advertising programs or pays for special display space for canned sockeye in the retail stores. Promotion of this type is said to be very effective. (Mr. P. A. Todd, Vice-President of B. C. Packers, Ltd.)

Non-price promotional activity is said to be accentuated when landings are heavy and the foreign market price slumps. (Mr. Todd, Vice-President, B. C. Packers, Ltd.) Under the strategy, domestic promotion of canned sockeye should have been particularly heavy in years ending June 1958, 1967, 1968, 1969, and 1972, because these were the years between 1958 and 1972 when sockeye landings were above average, and export prices were below average. Indeed, this prediction is borne out, to a great extent by the analysis of marketing activities in salmon markets as revealed in the yearbooks of the Pacific Fishermen.[13/]

The movement of canned sockeye to consumers occurs through three channels:

First, canners - retailers - consumers: B.C. Packers, Ltd. maintains sales offices in marketing centers to distribute canned salmon to retail chains directly. The retailers then offer the canned salmon to consumers.

Second, canners - brokers - retailers - consumers: Canfisco and Nelson Brothers contract with brokers to market their canned salmon. Brokers serve as middlemen in this marketing channel, earning commissions but never actually possess any canned salmon. The usual commission is two to three percent of sales revenues. In terms of invoices, this channel is the same as the first one, since the invoices are issued to retailers in both channels.

Third, canners - independent wholesalers - retailers - consumers: Independent wholesalers order salmon products directly from canners, taking possession at the point where the

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13/ A similar analysis is not available for recent years.

processors release the product. Independent wholesalers then resell the products to retailers or restaurants, which in turn offer the canned sockeye for final consumption.

The first and second channels are the most important. The first two channels have provided the most canned sockeye to consumers and have become more significant, as retail chains become a more important market force. Unlike the first two channels, the third channel has become decreasingly important over the past years. From 1958 to 1972 the first two channels accounted for approximately 70 percent of domestic sales while the third channel accounted for the remaining 30 percent (Mr. Todd).

The wholesale price of domestically marketed sockeye displays a seasonal fluctuation. This seasonal variation in the domestic wholesale price is attributed to the seasonal nature of sockeye runs. The major sockeye runs begin in late June and end in September. Canned sockeye production follows the same pattern except that the production season extends later, into November. By September, the total volume of sockeye available for canning is definitely known. Market conditions which exist in late June may be changed by July due to new information on the size of the run and these new forces continue to work up till the following June. Thus wholesale prices of canned sockeye tend to fluctuate through July-August, becoming established at new levels by September or October, leveling off until

June of the following year. This pattern is as shown in Figure 11. The seasonal price fluctuation suggests that the marketing year be viewed as running from July 1 to June 30 instead of the conventional calendar year. Indeed this is the marketing year prevailing in the sockeye industry, and important data are reported for the marketing year.

It is believed that retailers carry no inventory for the purpose of price speculation, although they might hold some inventories as a safeguard against a stockout. Since data on inventories held by retailers are not available for purposes of the present study, the retailers are assumed to pass along what they have acquired from the wholesalers. Thus the quantities sold by canners to the domestic markets during the marketing year are assumed to be the same quantities purchased and sold by the retailers and also the same quantities consumed by Canadian consumers during that period. This implicitly assumes that the retailers' supply of canned sockeye is perfectly price inelastic.

The per capita consumption of canned sockeye is revealed in Table 13. The average per capita consumption during 1958-1972 was 0.58 pounds with the highest per capita consumption being 0.85 pounds in 1959 and the lowest per capita consumption being 0.42 pounds in 1964.

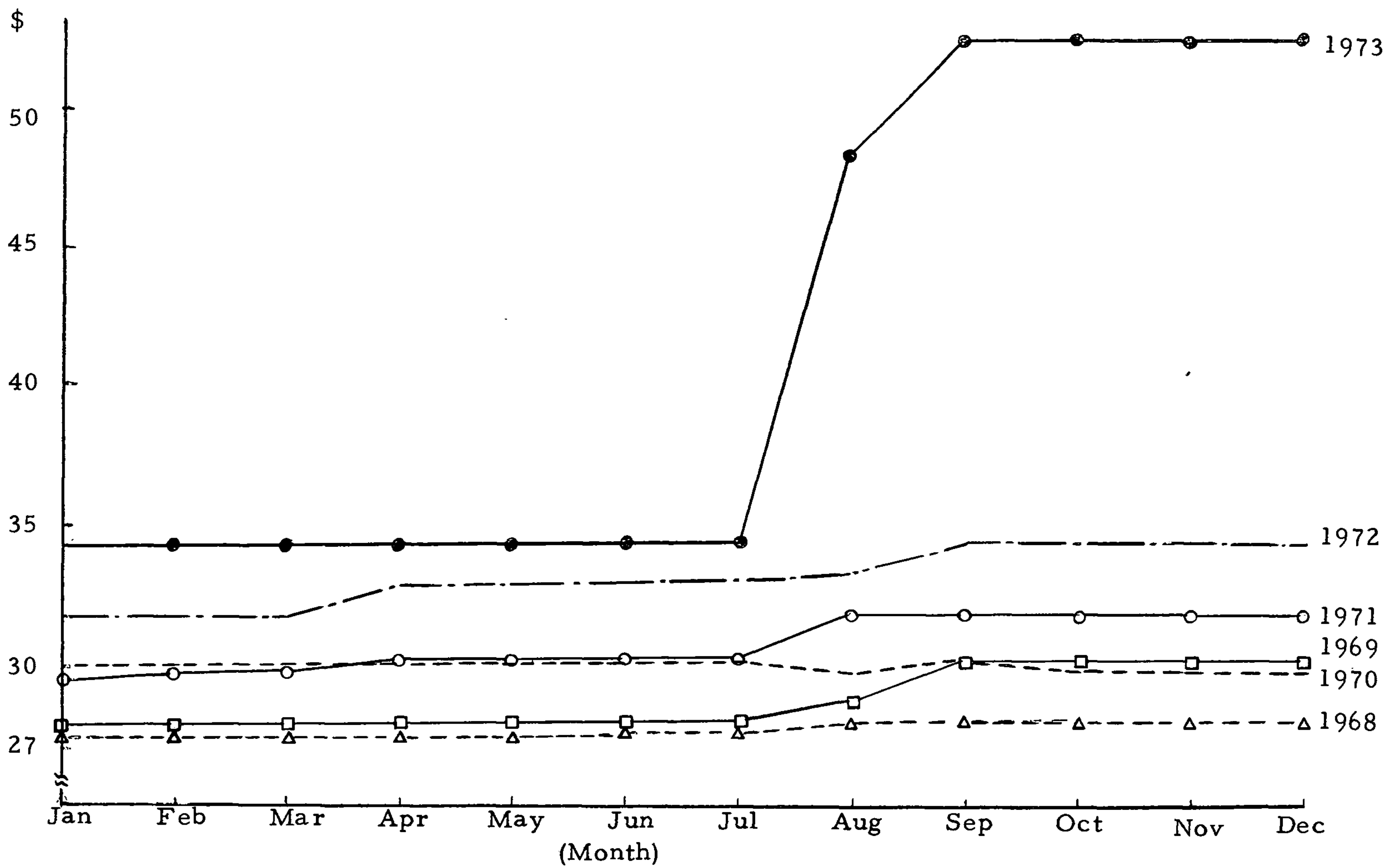

Figure 11. Monthly domestic wholesale price of canned sockeye (1968-1973), $/case at the beginning of the month

Source: Monthly Review of Canada Fisheries, Statistics Canada

Table 13. Per Capita Consumption and Deflated Retail Prices of Canned Sockeye Salmon in Canada, 1958-1972.

Year ending June	Consumption per capita lbs. 1/	Index of consumption per capita	Deflated retail prices $/tin 2/	Index of deflated price
1958	0.75484	129	0.40663	92
1959	0.83165	142	0.40414	91
1960	0.65479	112	0.44069	99
1961	0.58783	101	0.48720	110
1962	0.63745	109	0.48111	108
1963	0.52364	90	0.48143	109
1964	0.41950	72	0.48474	109
1965	0.44831	77	0.48064	108
1966	0.87434	81	0.46813	108
1967	0.51489	88	0.46717	105
1968	0.60006	103	0.44386	100
1969	0.63978	110	0.43470	98
1970	0.45256	78	0.41269	93
1971	0.61947	106	0.37766	85
1972	0.59755	102	0.38309	86
Avg.	0.58377	100	0.44359	100

1/ $= \dfrac{\text{Domestic Sales}}{\text{Population}}$

2/ $= \dfrac{\text{Retail Price per 8-ounce tin}}{\text{Consumers' Price Index (1949=100)}}$

Retail markups for canned sockeye are higher in rural areas than in urban areas. Up until 1969, the retail markup in the rural areas was about 20 percent of wholesale prices on the average and in the urban areas was approximately 15 percent (Mr. Todd). Markups in the retail price of canned sockeye over the period 1958-72 are shown for Montreal in Table 14. For Montreal the average markup over 1958-69 is 14.75 percent and for 1970-72 declines drastically to 5.04 percent. This substantial decrease in the retail markup after 1970 is due to a change in the retail marketing of canned sockeye. To boost sales, retail stores select certain products, known as image items, out of several thousand products, to promote total sales of the stores.[14/] The retailers, in order to attract more customers and thereby increase sales, cut the price of these image items. Canned sockeye was not chosen as an image item until 1970. The inclusion of canned sockeye in the list of image items after 1970 is responsible for the reduction in retail markup since that time.

The retail prices of canned sockeye have been reported for five cities in Canada up to 1967: Montreal, Toronto, Winnipeg, Vancouver, and Halifax. However, the index of retail prices based on 1961 figures has been reported for Montreal and Toronto alone

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[14/] Dominion Store, a large retail chain, is the biggest retailer of canned sockeye in eastern Canada.

Table 14. Average Wholesale and Retail Prices at Montreal and Retail Markups for Eight-ounce Tins of Canned Sockeye Salmon, 1958-72.

Year ending June	Wholesale price ¢/8-oz tin	Retail price ¢/8-oz tin	Retail markup %	Average markup %
1958	46.46	50.30	8.27	
1959	45.90	50.80	10.68	
1960	51.92	56.10	8.05	
1961	56.56	62.80	11.03	
1962	52.69	62.40	18.43	
1963	54.73	63.50	16.02	14.75
1964	55.71	65.10	16.86	
1965	56.02	65.80	17.46	
1966	56.96	66.10	16.05	
1967	57.75	68.30	18.27	
1968	57.35	67.60	17.87	
1969	58.38	68.90	18.02	
1970	61.52	68.30	11.02	
1971	62.56	63.90	2.14	5.04
1972	66.21	67.50	1.95	

Source: Monthly Review of Canadian Fisheries, Statistics Canada.

since 1968. These retail prices are reported for eight-ounce grade A cans at the beginning of each month. The Montreal retail prices deflated by the consumer price index (1949=100) are shown in Table 13 and Figure 12.

The relationship between the index of per capita consumption and deflated retail prices is demonstrated in Figure 12. It is shown that, between 1958 and 1972, the changes in prices and in quantities consumed in general were negatively related: the prices increased (decreased) as the quantities decreased (increased).

In concluding this chapter, it can be said that the sockeye industry of Canada, for the purpose of econometric analysis can be summarized into four market levels with a supply-demand relationship at each level: retail, wholesale, exvessel, and fishing-effort markets. The relationships among these levels are illustrated in Figure 13.

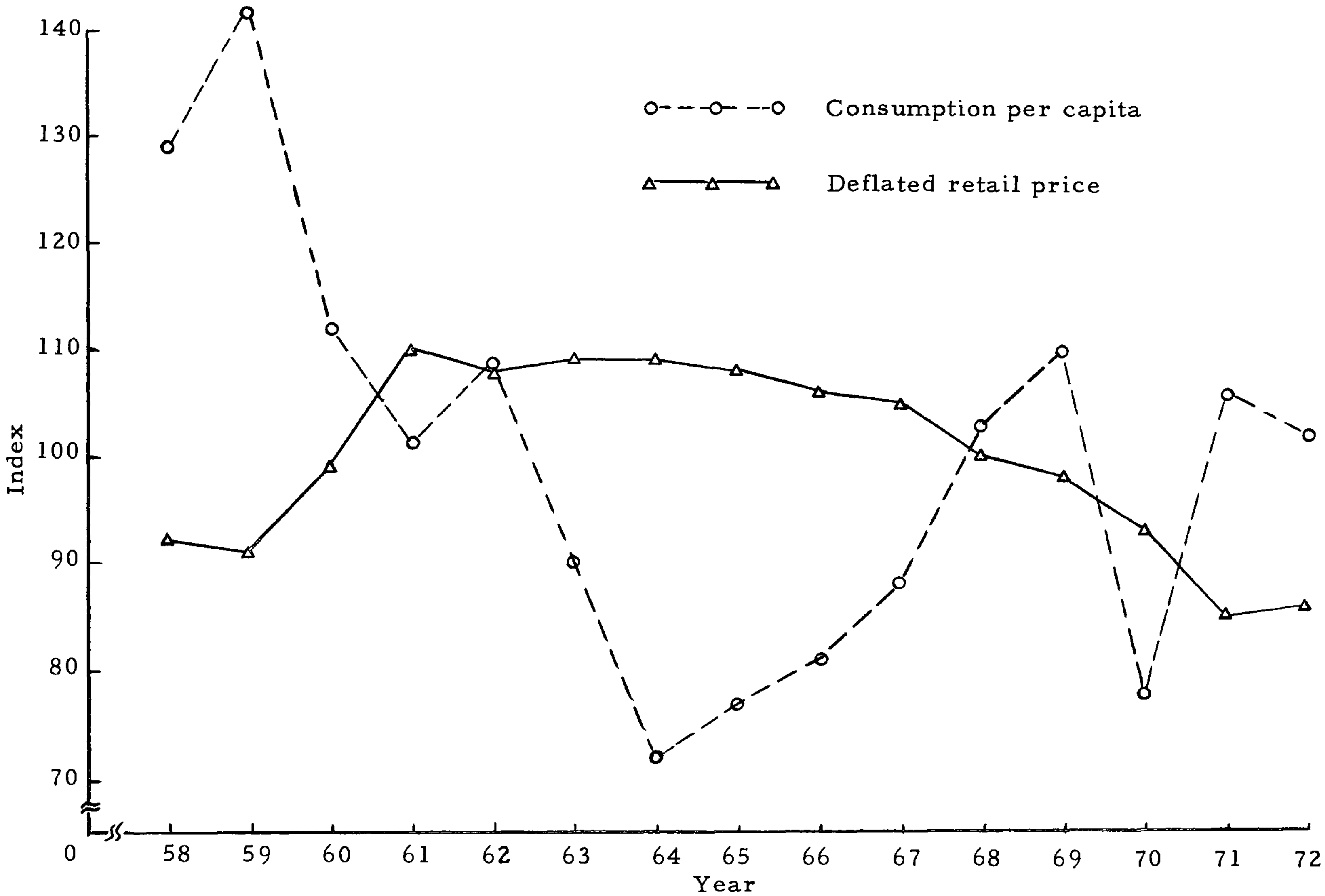
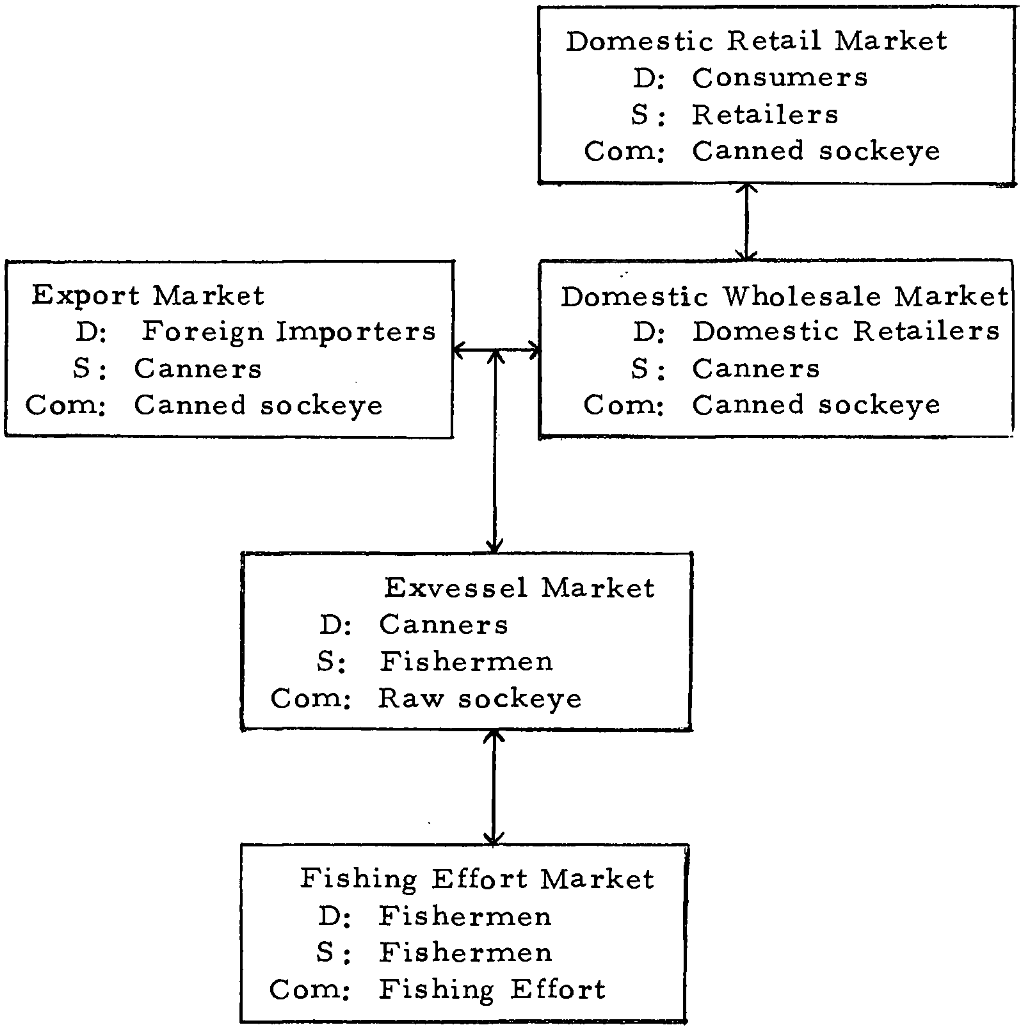


Figure 12. Index of per capita consumption in Canada and deflated retail prices in Montreal, canned sockeye salmon



Note: D: Demander
S: Supplier
Com: Commodity

Fishing Effort: Number of gillnetter equivalents.

Figure 13. Market structure of the sockeye industry.

III. AN ECONOMETRIC MODEL OF THE CANADIAN SOCKEYE INDUSTRY

As mentioned in A and B of Chapter I, the implementation of the Canadian salmon fishery management programs should result in increases in sockeye landings and the return to fishing effort. Increases in sockeye landings resulting from the management programs have an immediate effect on the market price at the exvessel level, and eventually increase the total pack of canned sockeye. An increase in sockeye packs should affect the quantities of canned sockeye supplied to both foreign and domestic markets, and consequently the equilibrium prices in these markets. Changes in prices and quantities of canned sockeye at the domestic wholesale level will affect the equilibrium retail prices and quantities through their effect on the retail market. The effects on prices and quantities at the different market levels will also affect the sales revenues at the different market levels, depending on the price elasticity of demand for canned sockeye at those levels. Finally the average return to fishing effort is directly affected by changes in the total catch of sockeye, its exvessel price, and the level of effort employed in fishing.

In order to estimate the parameters of the supply and demand functions at various market levels, an econometric model of the Canadian sockeye industry is constructed, and described below.

A) The domestic retail market

a) The retail supply

It is believed that the retailers of canned sockeye, in the absence of holding inventories for price speculation, simply pass along all quantities obtained from canners. Therefore the annual supply of canned sockeye at the retail level is assumed to be independent of the prices of canned sockeye, and any other market influences in a given marketing year. Mathematically this can be expressed as:

$$\frac{Q}{N} = K_{1t} \quad ------ \qquad (3\text{-}1)$$

where

$\frac{Q}{N}$ = sockeye supply per capita in year t.

K_{1t} = quantities obtained from canners on a per capita basis in year t.

b) The consumer demand

Conventionally, the theory of demand shows that the quantity of a commodity demanded is a function of its own price, the price of related goods and consumers' income. For the individual consumer, it may be assumed that the quantity demanded is an endogenous variable, and that the commodity's own price, the prices of related goods, and income are exogenous variables. However, for markets with several buyers and sellers it may not be reasonable to treat quantity demanded as a dependent variable and the commodity's own price as one of the independent variables. Instead, the commodity's own price may be treated as a dependent variable and the quantity demanded as an independent variable. Essentially this is the case in the canned sockeye market of Canada, where the quantity supplied at the retail level is thought to be independent of changes in current retail prices. As a consequence the quantity supplied is an independent variable, rather than a dependent variable. Thus the consumption price of canned sockeye is hypothesized to be a function of the quantity demanded, the retail price of canned pink salmon, and income. Furthermore non-price promotion in the domestic market is considered to have a noticeable impact on the demand for canned sockeye. Thus a dummy variable is introduced to account for the effect of non-price promotion on the final demand for canned sockeye.

In all, then, the retail price of canned sockeye is to be treated as a dependent variable and is specified to be a linear function of the quantity of canned sockeye consumed, consumer's income, the retail price of the canned pink salmon, and a dummy variable for non-price promotion, as indicated in Equation 3-2. The signs of the independent variables, indicating the hypothesized relationship between the dependent variable and each independent variable, are shown in the equation. The question mark sign for income (INC) signifies the indeterminate relationship between income and the amount of canned sockeye consumed. If canned sockeye is a normal good, the estimated coefficient on this variable is expected to be positive.

$$P_r^r = f(-\frac{Q}{N}, \ ?\ INC, \ + P_r^p, \ + D) \text{ - - - - - } \qquad (3\text{-}2)$$

where

P_r^r = retail price of canned sockeye at Montreal deflated by CPI (1949=100); \$/8-oz. tin, grade A.

$\frac{Q}{N}$ = per capita consumption of canned sockeye in pounds.

INC = per capita disposable income deflated by CPI; dollars.

P_r^p = retail price of canned pink salmon at Montreal deflated by CPI; \$/8-oz. tin, grade A.

D = promotion dummy: 1 for promotion years, 0 for other years.

B) The wholesale markets

There are two segments of markets at wholesale levels: domestic wholesale markets and foreign markets. They are described as follows:

a) The domestic wholesale market

The domestic wholesale market is characterized by high concentration on the selling side with a small number (perhaps two) major suppliers controlling 95 percent of this market (41). The price is established through a price leadership tactic; that is, the major firms set the wholesale price for the industry. The domestic wholesale price is set by September or October after the export quantity and price are determined.

In this study, canners are treated as wholesalers in the domestic market, distributing their product directly to retailers. Thus at the domestic wholesale market level canners are the suppliers and retailers are the demanders. The demand-supply relationship at the domestic wholesale market level are presented below in more detail.

a:1) The domestic wholesale supply

Under a marketing strategy to keep the small canners from domestic operations, the major firms facing the domestic and foreign outlets market their canned sockeye in such a way as to maintain a certain price difference between domestic and export markets. The major canners, as soon as the export markets are assured in terms of price and quantity in late August or early September, announce the wholesale price for domestic trades according to the situations in the foreign and domestic markets. The domestic wholesale price is usually set at a higher level than the export price. If the domestic price is set too high, the major canners can receive competition from smaller canners in the domestic market and, as a result, end up exporting more canned sockeye than they prefer. With a moderately high price relative to the export price, the major canners are better able to price out the small competitors since the smaller canners experience higher costs in domestic operations in contrast to the major canners, due to diseconomies of small size.

By adopting the strategy described above, the major canners supply the entire domestic market at the established price. Thus the domestic supply is assumed to be perfectly price elastic at each set price level. This is demonstrated in Figure 14.

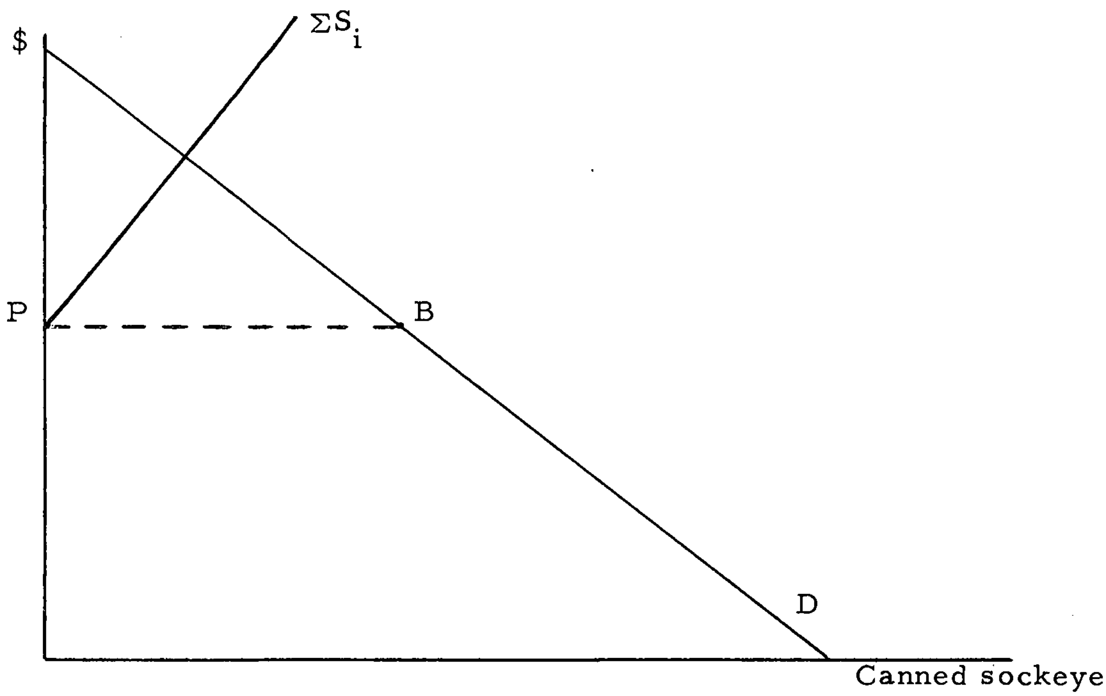


Figure 14. Price setting by major firms

The demand curve (D) is the industry demand faced by both small and major canners. The curve labeled as ΣS_i is the aggregate domestic supply curve consisting of the output from the small canners. The objective of price setting is indeed to bar the small canners from the domestic market. The major canners will set the domestic price as high as possible but sufficiently low so there is no entry by the small canners. Under this strategy, the maximum price that can be set is OP.

The range of prices that can be set is determined by the shifts of ΣS_i. The upward (downward) shift of the ΣS_i would allow the maximum price to rise (fall). For instance, if the ΣS_i shifts upward as $\Sigma S_i'$, the major firms would be able to raise the maximum price to OP_1 and still eliminate competition from the small canners. In the case of a downward shift to $\Sigma S_i''$, the highest price to be set is that at OP_2. This situation is shown below in Figure 15.

Changes in the magnitude of two variables are believed to be responsible for the major shifts in ΣS_i: (a) the export price of canned sockeye; and (b) the exvessel price of raw sockeye. The influence of these variables on ΣS_i is as follows:

First, the export price may be treated as an exogenous variable which is determined by UK and Japanese traders. The Canadian exporters usually follow the Japanese export prices. Since the small canners depend on the export market in distributing their output, the

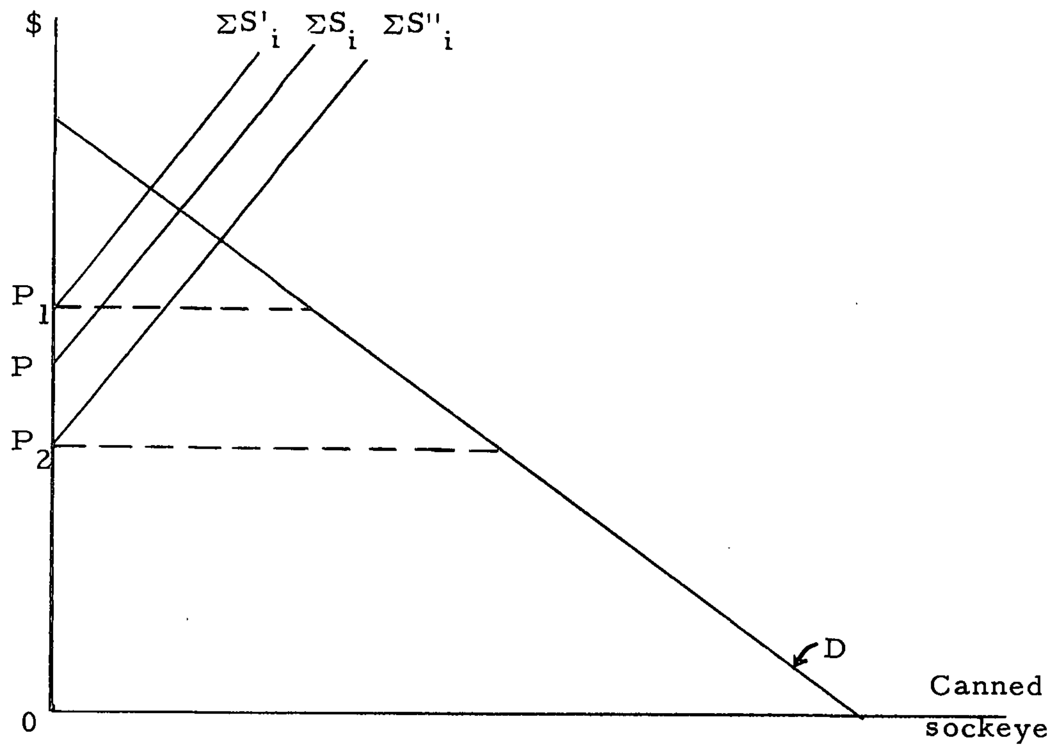


Figure 15. Price setting under shifts of ΣS_i

export price has to be considered an alternative cost for these small canners if they supply the domestic market. The higher (lower) the export price, the higher (lower) is the opportunity cost experienced by the small canners when they distribute their product through the domestic market. Therefore the higher (lower) the export price, the smaller (larger) the quantity supplied to the domestic market at each price level. This means that the ΣS_i shifts up and down as the export price rises and falls, and therefore the maximum domestic price tends to be set with reference to the high and low levels of ΣSi. Thus, the domestic price is set at a level positively related to the export price level.

Secondly, the ex-vessel price of raw sockeye is a major factor input cost. Changes in exvessel price directly affect the marginal cost (MC) and, therefore, the supply curve. An increase (decrease) in this input price shifts the MC and, consequently, the ΣS_i curve to the left (right), allowing the maximum domestic price to increase (decrease). An increase in input price also raises costs for the majors. Thus, the established domestic price is positively related to the exvessel price of raw sockeye.

The major canners in order to keep potential entrants out may not set the domestic price at the maximum level. Any price below the maximum should be sufficiently low to eliminate the competition completely. How far the price is set below the maximum is determined by numerous other factors. Among these factors, the amount of canned sockeye available for the domestic consumption is hypothesized to be important and to be inversely related to the established price. Because the major canners announce the domestic price after the export sales are contracted, the export price and quantity are known. Therefore the quantity remaining for the domestic market is relevant in price setting. If the quantity available is great, the price tends to be set at low levels so as to move the product through the market. This prevents an end-of-season accumulation of inventories. If the quantity available is small, the price tends to be set at higher levels to discourage demand.

In summary, the industry supply at this level is perfectly elastic at the set domestic price. This analysis could be expanded to include the set-up cost of small suppliers, small suppliers' expectations regarding future opportunities in the domestic market, and the possibility that the major firms may permit the small firms to sell domestically if it were in the major firms own interest. The marginal revenue facing the major firms is discontinuous at B (Figure 14). Therefore, for some levels of marginal costs, the net-return maximizing price may be set higher than OP. However, consultations with industry representatives suggest that the marketing strategy followed is that of setting the domestic price in accordance with the "potential entrant" considerations. Accordingly, the domestic supply curve at wholesale is treated as if it were perfectly price-elastic. Thus domestic price is hypothesized to be a linear function of the export price, the exvessel price, and the quantity available for the domestic sales. The functional relationship indicating the hypothesized relationships, is denoted in Equation 3-3.

$$P_w^r = f(+P_e^r, + P^{ev}, - Q_a) \quad (3\text{-}3)$$

where

P_w^r = October domestic wholesale price of canned sockeye at Vancouver deflated at Wholesale Price Index (WPI)(1935-39=100); $48 lb. case (1/2 lb. cans).

P_e^r = opening export price of canned sockeye deflated by WPI (1935-39=100); \$/48 lb. case (1/2 lb. cans).

P^{ev} = exvessel price of raw sockeye deflated by WPI (1935-39=100); ¢/lb.

Q_a = quantity available for domestic consumption (Pack + Beginning Inventory - Export); standard cases.

a:2) The domestic wholesale demand

At this level, the bigger retailers of canned salmon such as Safeway and Dominion stores seek their supply of canned sockeye directly from canners' sales offices and brokers. Small customers such as restaurants and small groceries obtain their supply through independent wholesalers. As the retail chains have increased in size, the purchases of canned sockeye from canners' sales offices and brokers have increased steadily. Meanwhile the demand for canned sockeye by small customers has gradually declined. However the demand at this level must necessarily reflect all components of retail demand.

Since most of the purchases are by the big retailers, it is reasonable to assume that these retailers are the demanders of canned sockeye at the wholesale level. Furthermore, because these purchases are transacted through canners' sales offices and brokers, and since these sales offices are branches of canners' operations and the brokers receive a fixed commission, it is also reasonable to assume that the canners are suppliers of canned sockeye at this level.

The demand of retailers for canned sockeye is a derived demand faced by canners, being derived directly from the consumption demand. The demand at this wholesale level is contingent upon: (a) the price the retailers must pay; (5) the price they expect to receive; (3) the price of other inputs at the retail level (i.e., the wage of retail workers); and (d) the price of substitute goods (e.g., the wholesale price of canned pink salmon).

The demand at wholesale is specified as a linear function of the retail price, the wholesale price, the wage rate paid by retailers and the wholesale price of canned pink salmon. The relationships between the dependent variable and each independent variable are shown in Equation 3-4.

$$Q^r_{dd} = f(+ P^r_r, -P^r_w, -w^r, + P^p_w) \text{ - - - - - } \qquad (3\text{-}4)$$

where

Q^r_{dd} = quantity sold at wholesale; standard cases.

P^r_r = retail price of canned sockeye deflated by WPI (1935-39=100); \$/8-oz. tin, grade A, Montreal market.

P^r_w = October wholesale price of canned sockeye at Vancouver deflated by WPI (1935-39-100) \$/48-1/2 lb. case.

W^r = wage rates paid by retailers deflated by WPI (1935-39=100) \$/week.

P^p_w = October wholesale price of canned pink salmon at Vancouver deflated by WPI (1935-39=100) \$/48-1/2 lb. case.

b) The export market

In the world trade of canned sockeye, the UK is the major international market. Japan and Canada are the major suppliers, competing with each other vigorously for dominance in this market. The UK market purchases approximately 90 percent of the Canadian canned sockeye that is exported.

The world price for canned sockeye is announced by UK and Japanese traders in late August or early September when the Pacific sockeye runs, including those of Japan, Alaska, and Canada, are known. The price is set in view of timing of the Japanese, U.S. and Canadian runs as discussed in Chapter II. Canadian traders usually follow the price set by UK and Japanese traders.

b:1) The export supply

A supply curve shows the quantity-price relationship (other factors being held constant) indicating the quantities which suppliers are willing to sell at different market prices. The supply curve is postulated to have a positive slope, that is, the quantity supplied is expected to increase with an increase in the product price.

The export supply of canned sockeye is assumed to be positively related to export prices. Since Canadian traders follow the Japanese price in world trade, they should be considered price followers instead of price makers. The export price must be regarded as an exogenous variable in Canada's export supply. Thus Canadian traders supply the quantity they are willing to supply at the set price. The higher the set price, the greater the quantity the Canadian traders tend to supply.

The export supply curve may shift due to: (a) changes in input prices; (b) changes in the availability of the product; and (3) changes in opportunity costs (i.e., the domestic wholesale prices of canned sockeye. However, changes in the opportunity costs are not relevant to the Canadian export supply due to the time lag discussed above. Therefore the domestic wholesale price does not influence the export supply, although expectations about that price may be important.

The price of raw sockeye is an input price. Changes in the price of raw sockeye cause the marginal cost curve and the supply curve of canned sockeye to shift. The price of raw sockeye is expected to be negatively associated with the quantity of canned sockeye exported.

The availability of canned sockeye in a marketing period is determined by two factors: the total pack of canned sockeye during the period, which is a function of quantity of sockeye landed, and inventories held by canners at the beginning of the period.

The export supply of canned sockeye is directly determined by the availability of canned sockeye, which in turn, is related to sockeye landings. The greater the landings, the greater the availability of canned sockeye and the larger the quantity supplied for export.

The variable representing sockeye landings is a policy variable, and can be affected by management programs. The quantity of landings influences the availability of output to be marketed and the supply and prices of canned sockeye at the different market levels.

The availability of canned sockeye is also determined by the inventories at the beginning of a period. The larger the inventories at the beginning of a period, the more canned sockeye available for the period, and the greater the supply of canned sockeye to the export market.

To summarize, the quantity of canned sockeye supplied to the export market is specified as a function of the export price, the price of raw sockeye, the landings of sockeye, and the beginning inventory of canned sockeye held by canners. The functional relationship is hypothesized to be linear with the expected signs as shown in Equation 3-5.

$$Q^r_{es} = f(+P^r_e, \ -P^{ev}, \ + BI, \ + L) \text{ - - - - - } \qquad (3\text{-}5)$$

where

Q^r_{es} = total export sales of canned sockeye to all export markets in standard case.

P^r_e = opening export price of canned sockeye deflated by WPI (1935-39=100); \$/48 lb. case (1/2 lb. cans).

P^{ev} = exvessel price of raw sockeye deflated by WPI (1935-39=100); ¢/lb.

BI = beginning inventory of canned sockeye held by canners (in standard cases).

L = landings of raw sockeye in cwt.

b:2) The export demand

The UK is the major importer of the Pacific sockeye and approximately 90 percent of the Canadian canned sockeye that is exported goes to U. K. markets. In the world trade of canned sockeye each year the UK traders contract their first purchases with Japanese exporters and set the export price for other purchases. Then the UK traders move to contract with the US traders and finally contract with Canadian exporters. In the UK-Canada trade, the Japanese export prices are followed even though the Canadian exporters announce an opening export price. Thus, the opening export price is essentially predetermined for the Canadian exporters. As a result, the demand for canned sockeye from all export markets faced by Canadian exporters may be treated as being perfectly elastic at the predetermined export price. [15/]

$$P_e^r = K_{2t} \quad \text{- - - - -} \qquad (3\text{-}6)$$

where

P_e^r = opening export price of canned sockeye facing Canadian exporters.

K_{2t} = opening price level of export canned sockeye in year t, as determined by Japanese and UK negotiations.

C) The exvessel Market

a) The supply of raw sockeye

Sockeye landings, including troll-caught and net-caught, are mainly dependent on the sizes of the sockeye runs. The sizes of sockeye runs are in turn determined by biological factors rather than economic variables. Thus the seasonal supply of raw sockeye at this level is assumed to be predetermined. For this reason, the supply curve for raw sockeye is postulated to be perfectly inelastic with respect to prices higher than a certain level, with no quantities being supplied at prices lower than that level. The supply curve is

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15/ The preceding discussion is concerned with the demand from all export markets taken as a whole. Since the export demand has many components, estimation of total export demand would require a tremendous amount of data. However this researcher feels that while he does not have all the required data, some data are available to estimate the UK demand faced by Canadian exporters. Using available data, he estimates the UK residual demand faced by Canada and presents it in Appendix II.

discontinued at OP, as shown in Figure 16 (a). If the price is too low to cover the average variable cost of production, no sockeye is expected to be supplied since fishermen would not be willing to fish. If the price of sockeye, on the other hand, is higher than OP, the fishermen would supply and exploit the sockeye stock to the extent which the biological factors allow. Therefore, the relevant supply curve is the portion of curve which is inelastic with respect to the prices higher than OP. That is the portion labeled as SB in Figure 16 (a).

b) The demand for raw sockeye

The price of net-caught sockeye, like other net-caught species is determined by negotiations between the two delegations representing fishermen and major packers respectively. The resulting minimum price is not the market equilibrium price of raw sockeye, since packers usually pay bonuses on top of the minimum price at the end of the fishing seasons. However, data on the amount of the bonuses are not available, as mentioned earlier. These unknown bonuses obscure the true market equilibrium price. The discussion in this section explains why the demand at this market level cannot be specified due to the role of bonuses on the market.

The price negotiations over net-caught sockeye can be characterized as monoplistic on the selling side and monopsonistic on the buying side. Disputes over the price at which sockeye is traded

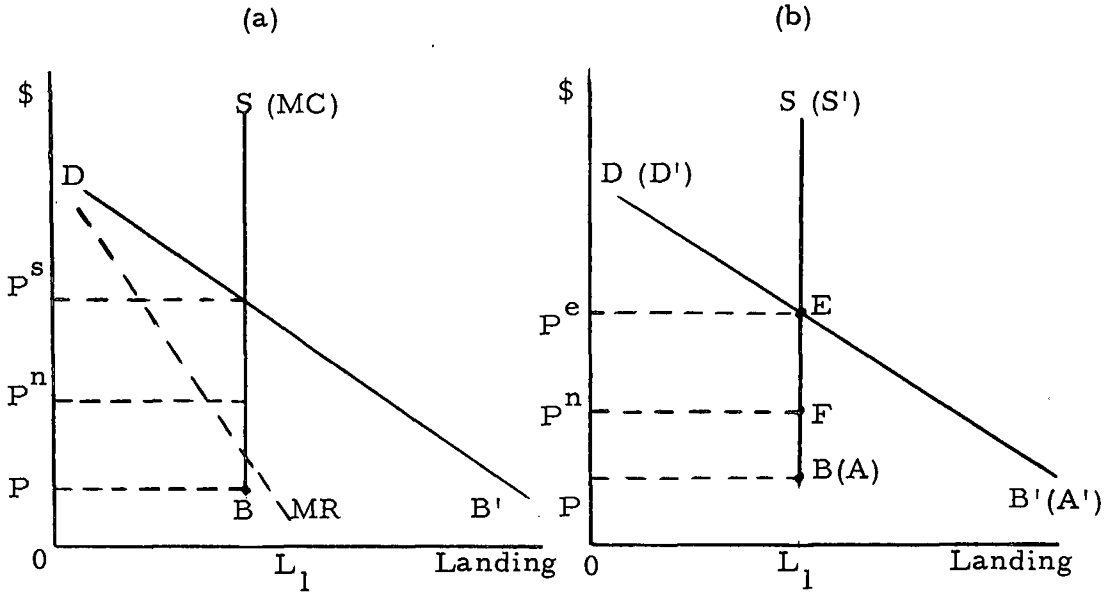


Figure 16. Price negotiation model (I)

have always existed. Thus a price negotiation between delegates from both a canners' association and the fishermen's unions must be held before each fishing season. While anticipating demand for and supply of raw sockeye before each season, each side tries to exploit the other in order to maximize its own net returns. The anticipated prices which the monopolist wants to charge and which the monopsonist is willing to pay are not consistent. Thus a price dispute results each season and a minimum price deviating from the true price is generally reached through the negotiation.

The above points can be shown in Figure 16 (a). The anticipated demand and the anticipated supply are labeled as DB' and SB, respectively. Marginal revenue to DB' and marginal unit cost to SB are labeled as MR and MC separately in Figure 16 (a). For profit maximization, the monopolist equating MR with SB (MR=SB) asks for the price OP^s, while the monopsonist equating MC with DB' ($MC=DB'$) maximizes his profits at the lowest possible price, equal to OP. There is inconsistency in exvessel prices. A dispute range is the range between OP^s and OP since the price above the OP^s would be refused by the buyer and the price below OP would be unacceptable to the seller.

This negotiated price may be reached at different price levels depending on the relative market power of two parties. The more bargaining power the monopsomist has related to that of the monopolist the more likely the negotiated price will be reached at a level near the lower limit (OP). If the monopsonist has little market power relative to the monopolist, the negotiated price will be reached at a level near the upper limit (OP^s). A negotiated price is always reached for a season, say OP^n in Figure 16 (a). As soon as the exvessel price has been agreed upon, individuals of both groups (i.e., canners and fishermen) go back to their business operations as if they were in competition, and canners have always paid fishermen bonuses to attract the future delivery of fish for their future operations.

This payment of bonuses indicates that there is a price discrepancy between the agreed price and the actual equilibrium price for a given landing. The following are explanations of the role of bonuses in the market. Of particular interest is their effect on the specification of economic models to be used in estimating demand parameters.

As a season goes on, both anticipated demand and supply may be devised when new market information comes in. Assume for a moment that the anticipated demand and supply before the season are indeed the actual demand and supply depicted in Figure 16 (b). Through the competition among demanders and suppliers within their own groups during the season, the equilibrium price and quantity may be reached, with the equilibrium price OP^e, contrary to the negotiated price (OP^n). Thus the discrepancy between the actual equilibrium price and the negotiated price is EF ($=OP^e-OP^n$), which is paid as a bonus to fishermen. Since this amount of the bonus (EF) is not observable, the point observed in the market, instead of the equilibrium point E, is F, which is not an actual equilibrium point in terms of price. This inability to observe the actual equilibrium consequently prevents the researcher from knowing the true relationship between exvessel prices and quantities after the season and, therefore, from estimating the demand parameters at this level.

If the anticipated demand and supply are revised after the season begins (i.e., either DB' or SB shifts, or both shift), the same arguments are still valid: without knowing the actual magnitude of the bonus payment, this researcher has no way to observe the actual prices after the seasons and has no way to estimate the demand parameters accurately.

Figure 17 (a), (b) and (c) show three cases in which the final position of both demand and supply ($D'A'$ and $S'A$) after a season are located to the right of the anticipated ones (DB' and SB), and the unknown bonus payment under the same agreed-upon price OP^n is EF ($=OP^e - OP^n$). The size of the bonus depends on the relative shift of these two curves to the right. The bigger the shift of $D'A'$ relative to that of $S'A$, the higher the expected bonus.

Figure 18 (a) and (b) depict cases in which $D'A'$ stays the same as DB' but $S'A$ shifts to the right and to the left, respectively. The unknown bonus payment under the same negotiated price (OP^n) is expected to be EF ($=OP^e - OP^n$). As shown in the figures, the bigger the shift to $S'A$ to the right of SB, the smaller the expected bonus; the larger the shift of $S'A$ to the left of SB, the bigger the expected bonus.

Figure 19 (a) and (b) depict the case in which $S'A$ stays the same as SB but the $D'A'$ is shifted to the right and to the left of DB' respectively. The unknown bonus payment under the same negotiated price is EF. The size of this unknown bonus payment is positively relative to the shift of $D'A'$ to the right of DB' and is

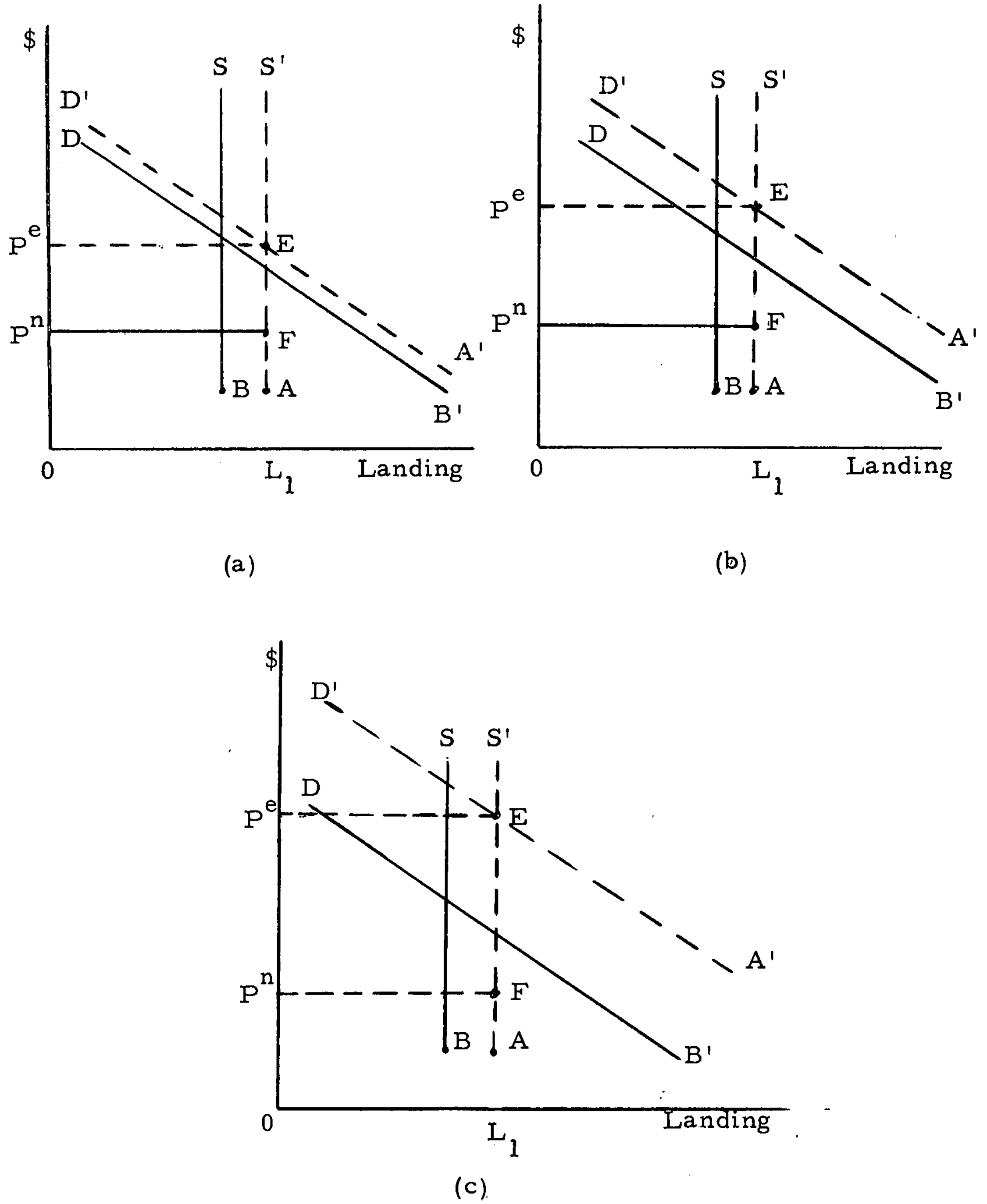


Figure 17. Price negotiation model (II)

negatively relative to the shift of D'A' to the left of DB', as indicated in the figures.

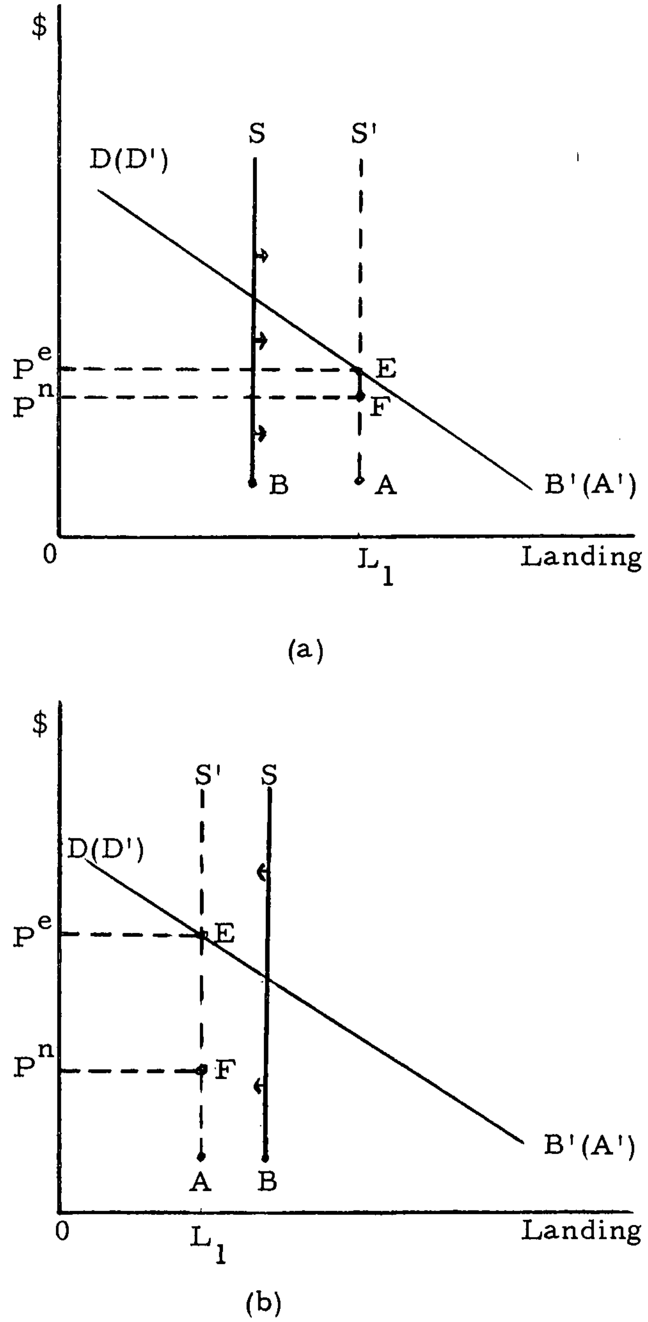


Figure 18. Price negotiation model (III)

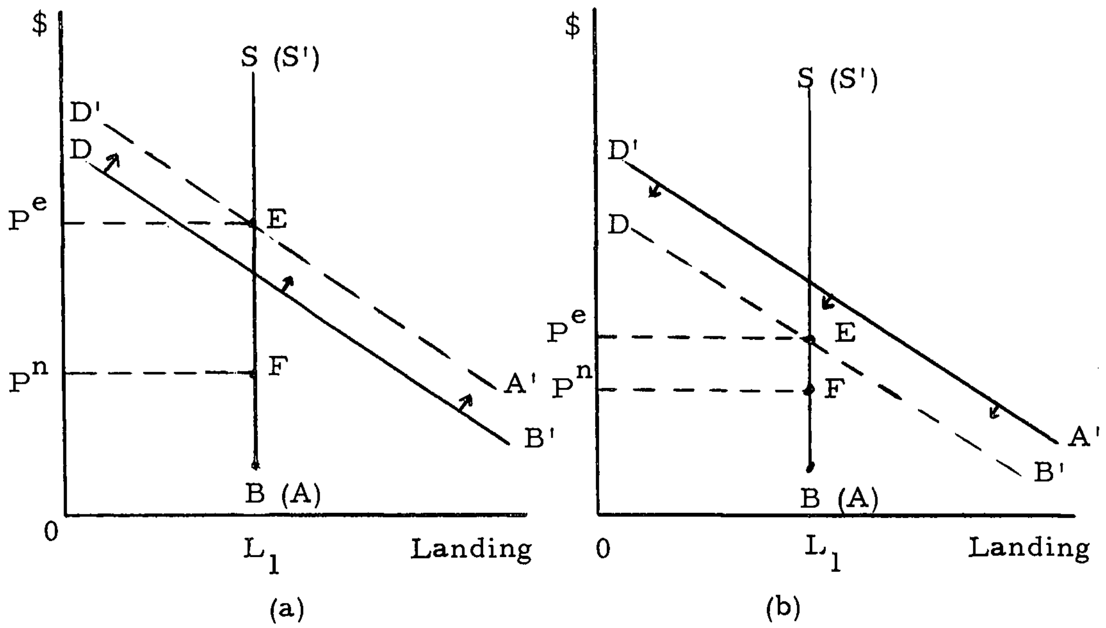
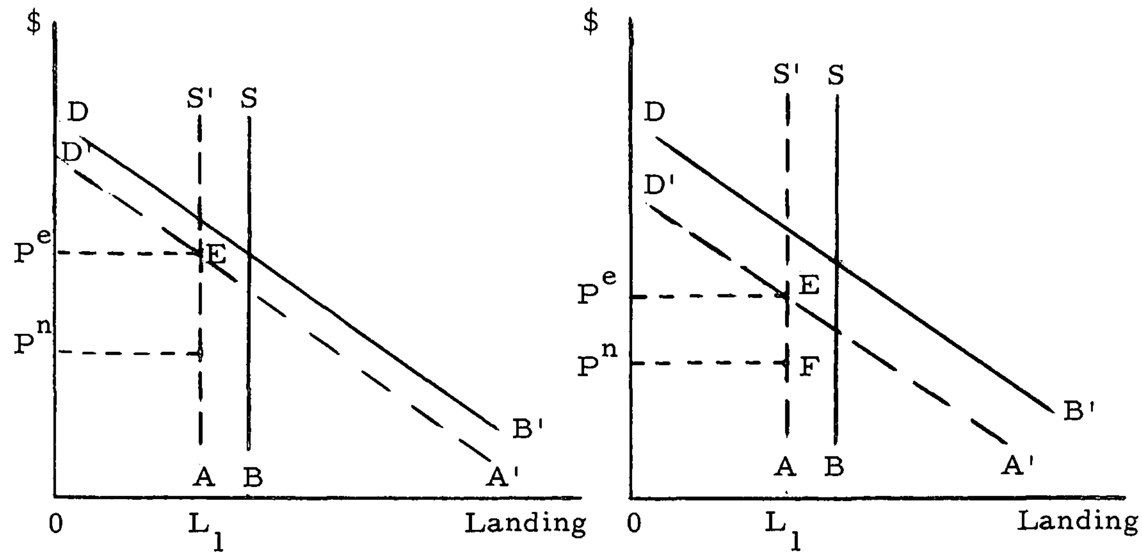


Figure 19. Price negotiation model (IV)

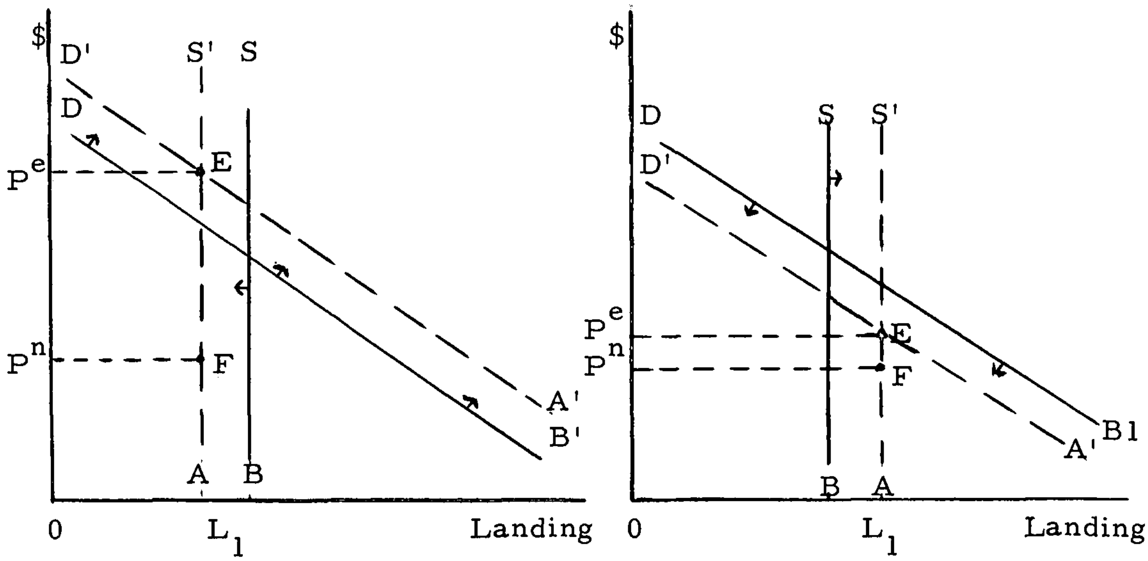
Figure 20 (a) and (b) depict cases in which the final positions of both D'A' and S'A are to the left of the anticipated ones (DB' and SB), and the unknown bonus payment under the same OP^n is EF ($=OP^e-OP^n$). The size of this bonus depends on the relative shift of these two curves to the left. The larger the leftward shift of D'A' relative to that of S'A, the smaller the expected bonus.

Figure 21 (a) shows a case in which D'A' is to the right of DB' whereas S'A is to the left of SB. The effects of the shifts in S'A and D'A' on the bonus offset each other. The unknown bonus payment is EF.



(a) (b)

Figure 20. Price negotiation Model (V)



(a) (b)

Figure 21. Price negotiation model (VI)

Figure 21 (b) shows a case in which the final position of $D'A'$ is at the left of DB' and that of $S'A$ is at the right of SB. These two forces reinforce each other to reduce the unknown bonus payment.

The final positions of $S'A$ and $D'A'$, relative to the position of SB and DB', and the level of the negotiated price determine the size of the unknown bonus. Other things being equal, the farther the final position of $D'A'$ is to the right (left) of DB', the larger (smaller) the unknown bonus may be; the farther the final position of $S'A$ to the right (left) of SB is, the smaller (larger) the unknown bonus that may be paid. The bonus can be negative as well. A negative bonus occurs when the equilibrium price which the demanders are willing to pay is less than the pre-season agreed-upon price at a given level of landings. This is the case in which the amount supplied exceeds the amount demanded at the agreed-upon price. Generally one would expect the market mechanism to push down both prices and quantities. However, the demanders are restricted to pay the agreed upon price according to the agreement. Prices cannot be adjusted. The market clearance mechanism can only work through the quantity adjustment. The demanders will only take smaller quantities than what the suppliers want to supply at the agreed-upon price and, thus, put a limit on fish deliveries. This phenomenon was seen in 1962 and 1965 in Canada's pink salmon fisheries (p. 49).

At any rate, the market equilibrium point E at the close of the season is not observable due to a lack of information on the magnitude of the bonus payment. Thus the estimation of demand parameters at this level becomes impossible.

D) The fishing effort market

Fishing effort per unit of time is defined as fishing units composed of a fishing vessel with necessary fishing gear and fishing laborers. In the sockeye fishery, gillnetters are the major harvesting units: during 1963-1972, gillnetters landed 73 percent of the total sockeye catch. In this study an average gillnetter in the B.C. salmon fisheries is treated as a standard fishing unit. Other fishing units such as purse seiners are converted to standard fishing units. For purse seiners, one purse seiner = 4.3 gillnetters = 4.3 units of fishing effort (p. 44). This means that one seiner has the same catchability as 4.3 units of gillnetters. The total number of standard fishing units is to be treated as the total amount of fishing effort available in the B.C. sockeye fishery. This fishing effort, in addition to the naturally occurring sockeye stocks, is one of the major inputs in the "production" of sockeye salmon.

Like the other inputs, this fishing effort has its own market, with demand-supply forces to determine its equilibrium prices and quantities. Unlike the other inputs, fishing effort does not have distinguishable demanders and suppliers within its market. This situation will be elaborated below.

In reality, the fishing effort market can be perceived in two ways: First, boat owners with their boats are the demanders of fishing effort in the sense that they initiate the recruitment of fishermen and acquire fishing gear to form units of fishing effort to be employed in fishing. These boat owners are also the suppliers of fishing effort who provide their own boats, their acquired gear, their own labor and their recruited laborers (i. e., crewmen) to supply units of fishing effort. These boat owners then are both the demanders and suppliers of fishing effort. Secondly, fishermen employing their own labor, from another viewpoint possibly can be considered as demanders who take initial action to rent boats, to acquire gear, and to organize units of fishing effort for fishing. These fishermen can again be thought of as suppliers of fishing effort who supply their own labor, their acquired gear and their rented boats in forming units of fishing effort. Thus these fishermen can also be considered as both the demanders and suppliers in the fishing effort market. This follows from the "open access" nature of the fishery, as discussed in Chapter I, in which no one "owns" the fishery resource. Were there an "owner," this individual would be the demander of boat services, labor services, etc. (fishing effort) while fishermen would be the suppliers. In either case, the boat owners or the fishermen are both the demanders and suppliers of the same economic services. In order to clarify the notion of the demand-supply relationship at this market level, brokers acting between identical agents may be artificially created to serve as intermediaries for purposes of analysis in an economic model.

The brokers are artificial constructs who receive no commission in their roles but who act as middlemen in the fishing effort market. Assume the boat owners are the demanders and suppliers in the market. The roles of these brokers can be viewed as follows: the boat owners as demanders demand fishing effort from dummy brokers and these corresponding dummy brokers revert to the same boat owners for supply. Since the brokers receive no commission in this construction, the prices of fishing effort paid and received separately by the demanders and the suppliers are the same. These prices are equivalent to the average returns to fishing effort per season to be discussed in the next paragraph.

The reason for taking average returns as the price of fishing effort is related to the characteristics of common property. A sockeye stock is a common property resource with open access characteristics yielding no return to its "owners." Thus fishing effort as an input combines with a zero-cost input (i.e., the sockeye stock) in sockeye production and is paid the average returns rather than the marginal returns as the "price" of fishing effort.

The supply of fishing effort is considered a predetermined variable each season due to the fact that applications for fishing licenses, including licenses for gear, fishermen and fishing boats, have to be submitted and approved some time before the seasons actually start; and the fact that, without adequate preparations beforehand, it is impossible to enter the salmon fishery in the middle of a season. Also, entrance into sockeye fishing is responsive to the earning conditions in the salmon fisheries as a whole, but is probably not responsive to the expected earnings from sockeye fishing alone. Therefore the number of fishing units involved in sockeye fishing may be regarded as predetermined and so may the supply of fishing effort in the sockeye fishing industry.

$$FE = K_{3t} \text{ - - - - -} \qquad (3\text{-}7)$$

where

FE = fishing effort per season in gillnetter equivalents.

K_{3t} = the amount of fishing effort in t.

The demand for fishing effort is a derived demand for an input, as shown in Figure 22. The demanders equate the price of fishing effort with the average return to fishing effort. The demand price of fishing effort, which is the average return to fishing effort (AR), is hypothesized to be a function of the average productivity of fishing effort, the exvessel price of sockeye (p^{ev}), and the amount of fishing effort. The average productivity (APP) of fishing effort is in turn

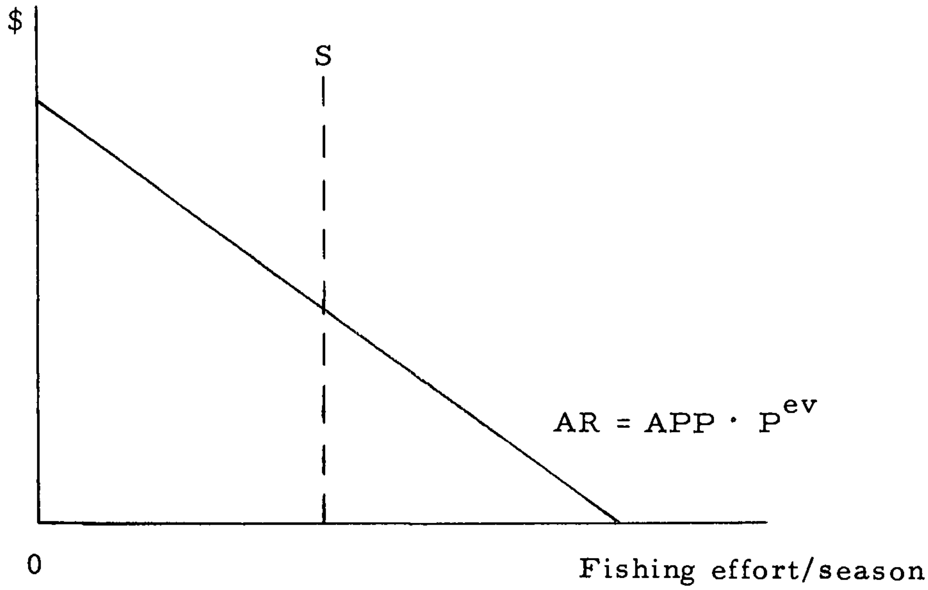


Figure 22. Derived demand for fishing effort

related to the size of the sockeye runs, technological improvements in fishing, and the length of particular fishing seasons. Also, the derived demand for fishing effort might be influenced by the introduction of the limited entry program in the salmon fisheries in 1969. A dummy variable (D_2) is designated to account for this influence. Therefore, the average return to fishing effort is specified as a function of the amount of fishing effort, the exvessel price of raw sockeye, the length of fishing seasons, the size of the sockeye runs, technological improvements represented by percent diesel vessels to total in fishing, and the dummy variable. The hypothesized relationship between average return and the explanatory variable is shown in Equation 3-8. [16/]

$$AR = f(-FE, + P^{ev}, + LS, + ST, + TECH, + D_2) \quad \text{- - (3-8)}$$

where

AR	= average return to fishing effort involved in sockeye fishing deflated by WPI (1935-39=100) \$/FE.
FE	= amount of fishing effort in gillnetter equivalents.
P^{ev}	= exvessel price of raw sockeye deflated by WPI (1935-39=100); ¢/lb.
LS	= length of fishing season in days.
ST	= size of stock (catch + escapement) in thousand fish.
TECH	= percentage of diesel vessels to total vessels.
D_2	= dummy, 0 for 1961-68, 1 for 1969-72.

This demand equation can be used to estimate the effect of public policy on the average return to fishing effort. First the amount of fishing effort (FE) is influenced by the limited entry program, which is one of the governmental fishery management

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16/ The coefficient of the variable representing technical improvements (TECH) is hypothesized to be positive. This hypothesis is superficially contradictory to the discussion in Chapter I of the impacts of technical improvements on the fishery. However this specification is based on a short run analysis, whereas the discussion of Chapter I is a long run analysis. One would expect the immediate impact of a technological improvement to be an increase in the average return to fishing effort, even though the longer run impacts could reduce those returns.

programs under study. The impact of the limited entry program on the average return to fishing effort in the sockeye fishery can therefore be estimated through the effect of the changes in FE and D_2 on the average return.

Secondly, the size of the sockeye stock (ST) heading for spawning grounds, which is the available size of stock for fishing, is subject to changes in many management programs. Among these programs, the enhancement program is the most prominent. Therefore the size of the sockeye stock and the impact on the average return to fishing is related to, among other factors, the enhancement program.

Thirdly, the length of fishing seasons (LS) again represents government policies implemented through the area and time closure rules.[17/] Thus the impact of this variable (LS) on the return to fishing effort is regarded as the impact of the area and time closure rules.

E) Summary of the model and discussion of estimation methods

The model is summarized as follows:

[17/] To a lesser extent, season length is influenced by the occurrence of fishermen's strikes.

a) The domestic retail market

Supply: $Q/N = K_{1t}$ - - - - - - - - - - - (3-1)

Demand: $P^r_r = f(-Q/N, +P^p_r, \ ?INC, \ + D_1)$ - - (3-2)

b) The wholesale markets

b:1) The domestic wholesale market

Supply: $P^r_w = f(+P^r_e, + P^{ev}, \ -Q_a)$ - - - - (3-3)

Demand: $Q^r_{dd} = f(+P^r_r, \ -P^r_w, + P^p_w, \ -W^r$ - -- (3-4)

b:2) The export market

Supply: $Q^r_{es} = F(+P^r_e, \ -P^{ev}, \ + BI, \ + L)$ - (3-5)

Demand: $P^r_e = K_{2t}$ - - - - - - - - - - - (3-6)

c) The exvessel market

Due to the inability to observe the true market equilibrium prices, the estimation of the supply and demand at this level becomes impossible and is omitted.

d) The fishing effort market

Supply: $FE = K_{3t}$ - - - - - - - - - - (3-7)

Demand: $AR = f(-FE, \ + P^{ev}, \ + LS, \ + ST,$

$+ TECH, \ + D_2)$ - - - - - (3-8)

The endogenous variables in this model are P^r_r, P^p_r, Q, Q^r_{dd}, P^r_w, Q^r_{es} and AR, and the exogenous variables are the remaining variables in the model. In this model Equations 3-2 and 3-4 are simultaneously determined and all other equations are determined individually.

The estimation of simultaneous equations must be undertaken with special care. Bias and inconsistent estimates result from the application of ordinary least square estimators (OLS) to a structural equation of a simultaneous system.

> "If OLS is applied to an equation in a model there will usually be more than one current endogenous variable in the relation and whichever variable one selects as the 'dependent' variable the remaining endogenous variable(s) will generally be correlated with the disturbance in the equation so that OLS estimates will be biased and inconsistent." (26, p. 376)

To obtain unbiased and consistent estimates for the coefficients of a structural equation, there are alternative estimators available: indirect ordinary least square estimators (ILS), two-stage least square estimators (2 SLS), limited information estimators (LIE), three-stage least square estimators (3 SLS) and full-information maximum likelihood estimators (FIML). The first three estimators are single-equation methods of estimation designed to estimate a single structural equation with only limited reference to the rest of the system. The latter two estimators are system methods of estimation by which all equations are estimated simultaneously. These estimators are discussed next.

The ILS estimator essentially applies OLS to reduced form equations rather than structural equations to obtain estimates indirectly. However, the application of ILS to reduced form equations results in unbiased and consistent estimates only under the restricted condition that structural equations are exactly identified. If this condition is not met, the estimates are either not unique or indeterminate. Estimates obtained for overidentified equations are not unique while estimates are indeterminate in the case of under-identified equations. Thus for reduced form equations, the ILS estimator provides unbiased and consistent estimates under the restricted condition of exact identification.

For an overidentified equation, the 2SLS estimator is the most popular single-equation method. In the first stage, the endogenous variables shown as explanatory variables in the equation are regressed on all predetermined variables of the system, and the predicted values are obtained for these endogenous variables. In the second stage, the predicted endogenous variables are treated as predetermined variables of the structural equation, OLS is applied to the structural equation.

The 2SLS estimator is unbiased and consistent, but lacks asymptotic efficiency since it does not take into consideration the correlation of the structural disturbances across the equations. However this estimator does not require full information for the whole system but only the predetermined variables and their sample values. This is an advantage in computation. If the structural equations of the system are exactly identified, the 2SLS estimator generates the same results as the ILS estimator.

The LIE is another single equation estimation method. Initially under LIE, a likelihood function is established by limiting those endogenous variables appearing in the equation under estimation and by disregarding the identifying of the restrictions on the remaining structural equations. Then the function is maximized with respect to the unknown parameters and finally their estimates are obtained. Secondly, a variance ratio is set up under the same considerations as in the likelihood function. Then the ratio is minimized with respect to the unknown parameters and their estimates finally are solved. For the details of these approaches, the interested readers may check textbooks on econometrics or statistics (e.g., 23, 26, 28).

Likewise the 2SLS estimator, the LIE is unbiased and consistent but not asymptotically efficient in general. The reasons are given above in the discussion of the 2SLS. The LIE has one characteristic distinguishing it from the 2SLS.

> ". . . the limited information maximum likelihood estimator is invariant with respect to the choice of the endogenous variable whose structural coefficient is to be equal to one, whereas the two-stage least squares estimator is not invariant in this respect." (28, p. 571)

The 3SLS and the FIML are extensions of 2SLS and LIE, respectively, except that they take into account the correlation of the disturbance across equations. These estimators are unbiased, consistent and asymptotically efficient. However, they are very complicated estimators. Their application consumes much computer time and expenses. In the case of exact identification, they achieve no gain over the 2SLS and LIE estimators. Furthermore, "a specification error in one equation will be carried into the estimates of the other equations if the 3SLS is used; the 2SLS will be free of this problem." (26) Again interested readers may consult the textbooks of econometrics and statistics for details.

In summary, all equations of this model are overidentified. The ordinary least squares method is selected as an estimator for each equation except the equations 3-2 and 3-4. Since these two equations require a simultaneous solution, their estimation must be given special attention. Although several estimators are available to deal with the estimation of simultaneous equations, this researcher chooses the two-stage least squares method to estimate the parameters of equations 3-2 and 3-4 in this study. This is because the 2SLS is unbiased and consistent, and because he has access to a computer program for this estimation procedure.

IV. THE EMPIRICAL ANALYSIS AND IMPLICATIONS OF THE STATISTICAL RESULTS

This analysis, except that portion dealing with the fishing effort market, is based on time series data covering the period July 1958 to June 1972. The data are organized into 15 marketing periods, with each period extending from July 1 to the following June 30. The analysis of the fishing effort market is based on annual data from 1961 to 1971. The analytical results and their implications are presented and discussed below.

A) The domestic retail market

The retail supply of canned sockeye is specified as an identity in Equation 3-1. No estimation is necessary for the identity. The consumption demand for canned sockeye is specified as Equation 3-2. The empirical result is shown as Equation 4-1.

$$P_r^r = 81 \times 10^{-2} - 36 \underset{(9.75)^a}{\frac{\hat{Q}}{N}} \times 10^{-2} + 82 \underset{(2.93)^a}{\hat{P}_r^p} \times 10^{-2} - 31 \underset{(-8.18)^a}{INC}$$

$$\times 10^{-5} + 47 \underset{(5.20)^a}{D_1} \times 10^{-3} \qquad \text{- - - - - - - - - -} \qquad (4\text{-}1)$$

$R^2 = 0.94$
$d = 1.66$

a - significant at the 1% level.

The coefficient of determination (R^2) is 0.94, indicating that 94 percent of the variation in the retail price of canned sockeye is associated with the variations in the per capita amount demanded ($\frac{Q}{N}$), the retail price of canned pink salmon (P^p_r), per capita disposable personal income (INC), and non-price promotion (D). The functional relationships confirm prior expectation except the relationship between retail price and income. The t-statistics are listed in parentheses directly below the individual coefficients. [18/]

The "d" stands for the Durbin-Watson statistic. The calculated d-value is 1.66, which is in the "inconclusive" range at the five percent level in the Durbin-Watson test for autocorrelation. Thus, one can neither reject nor accept the hypothesis that autocorrelation is not present in the residuals.

The ^ symbol appearing above a variable denotes predicted values of that variable. Two-stage least squares procedures were used to estimate coefficients.

The negative relationship between P^r_r and $\frac{\hat{Q}}{N}$ reveals the following demand behavior: the more the quantity of canned sockeye available to consumers, the lower the retail price of canned sockeye the consumers are willing to pay, *ceteris paribus*. The

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[18/] Statistical tests of this chapter are based on one-tail tests.

price flexibility calculated at mean values of P_r^r and $\hat{Q}/N$ indicating that an increase in per capita supply of canned sockeye at the retail level by one percent away from the average value for the 1958-1972 period would result in a drop of the retail price by 0.467 percent. The reciprocal of the estimated price flexibility, an estimate of the price elasticity, is -2.141. The elastic demand with respect to its own price implies that an increase (a decrease) in quantities supplied away from the average value would result in an increase (a decrease) in sales revenues to suppliers. Thus Canadian retailers would experience an increase in canned sockeye sales revenues if they increased the average quantities supplied at retail, ceteris paribus.

The positive relationship between P_r^r and $\hat{P}_r^p$ signifies that canned sockeye and canned pink salmon are substituted for each other in consumption in Canada. Other things being constant, the demand for canned sockeye tends to increase as the retail price of canned pink salmon rises. The cross price flexibility is 0.511, implying that a one percent rise (fall) in the retail price of canned pink salmon away from its mean value for the 1958-1972 period would lead to a .511 percent rise (fall) in the retail price of canned sockeye.

The relationship between P_r^r and INC is negative which is inconsistent with the findings of previous studies done in the U.S., as discussed in Chapter I. This negative coefficient for INC implies that canned sockeye is an inferior good; that is, the higher the disposable per capita income, the lower the quantity of canned sockeye consumed, and the lower the demand price. This result appears not only contradictory to the result of a survey of U.S. fish purchases in 1969, but also contradictory to the belief of people in the industry.

First, the survey undertaken in 1969 showed that the U.S. per capita consumption of canned sockeye salmon increased as per capita income increased; the per capita consumption for the income classes less than $1,000 was 0.299 pounds and the consumption for the income classes over $3,500 jumped to 0.885 pounds, as shown in Table 15. This may imply that canned sockeye salmon is a normal good rather than an inferior good.

Table 15. U.S. Per Capita Consumption of Canned Sockeye (Red) Salmon by Income Classes in 1969.

Income per capita ($)	Consumption per capita (lbs.)
Under 1,000	0.299
1,000-1,999	0.395
2,000-2,499	0.391
2,500-2,999	0.609
3,000-3,499	0.466
Over 3,500	0.885

Source: (6)

Secondly, some individuals involved in the sockeye industry believe that the old generations, born before the great depression, have developed a taste for salmon, but that the younger generations born after the depression have not developed this taste. Over time, the older generations with these tastes are passing away and are being gradually replaced by the young generations without these tastes. Therefore, fewer and fewer consumers having these tastes comprise the consumer demand, and the per capita consumption of canned sockeye has gradually decreased over time. While the demand has decreased over time, income per capita has increased steadily. Thus the "change in tastes" phenomenon conceivably has dominated and distorted the positive income effort. A test designed to delineate the separate effects of income and changes in tastes on the consumption of canned sockeye is undertaken, and presented in Appendix I. The results show a significant decrease in demand due to changes in tastes, but fail to reverse the measured negative income effect. The results about the effect of changes in tastes on demand for canned sockeye are consistent with the same survey in 1969. According to that survey, U.S. per capita consumption of canned sockeye increases as the age of household heads increases. This is shown in Table 16. The survey result may imply that the older generations in the U.S. have stronger "tastes" for canned sockeye than have the younger

Table 16. U.S. Per Capita Consumption of Canned Sockeye (Red) Salmon by Age Classes of Household Heads in 1969.

	Per capita consumption (lbs.)			
Age	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Under 25	0.032	0.009	--	--
25-34	0.051	0.031	0.032	0.041
35-44	0.073	0.070	0.059	0.051
45-54	0.190	0.137	0.112	0.132
Over 55	0.316	0.230	0.226	0.188

Source: (33, 34, 35, 36).

generations, and may suggest that, over time, preferences of the U.S. population have shifted away from canned sockeye salmon.

The coefficient on the non-price promotion variable is positive and significant at the one percent level. This result is consistent with prior expectations and confirms the canners' claims. The B.C. canners claim that the non-price promotion is very effective in shifting the demand curve outward, enabling the canners to move large quantities at a given price. If, on the other hand, no promotion had been undertaken, the retail price would have dropped in those years that promotion was undertaken with the canners distributing the same quantities to the market.

B) The wholesale market

a) The domestic wholesale market

The domestic wholesale supply equation is a price-setting equation and is hypothesized to be perfectly price-elastic with respect to quantities supplied, as specified in Equation 3-3. The empirical supply equation is shown as Equation 4-2.

$$P_w^r = 14 \times 10^{-1} + \underset{(1.20)^b}{17\, P_e^r \times 10^{-2}} + \underset{(4.08)^a}{50\, P^{ev} \times 10^{-2}}$$

$$- \underset{(0.11)}{11\, Q_a \times 10^{-8}} \qquad \text{- - - - - -} \qquad (4\text{-}2)$$

$R^2 = 0.79$
$d = 1.47$

a - significant at 1% level.
b - significant at 20% level.

The coefficient of determination (R^2) is equal to 0.79, meaning that the three explanatory variables, including the opening export price of canned sockeye (P_e^r), the average exvessel price of raw sockeye (P^{ev}) and the quantity available for domestic sale (Q_a), account for 79 percent of the variation in the dependent variable, which is October wholesale price set at the canners' plants in Vancouver, B.C. The Durbin-Watson, d, statistic (1.47) is in the "indeterminant" range at the five percent level, indicating that one can neither accept nor reject the hypothesis that autocorrelation is not present in the residuals. The values in parentheses are t-statistics for individual coefficients. Though the t-test does not reveal significance for all coefficients, the coefficients have the expected signs.

The positive coefficient for P_e^r confirms the argument that the higher the export price, the higher the domestic price set by the major canners. Other things being constant, an increase (de-crease in the export price (P_e^r) by $1.00 per standard case would bring an increase (decrease) in the October price set at the Vancouver canners' plants (P_w^r) by $0.17.

The positive relationship between P_W^r and P^{ev} is consistant with the prior rationale that the higher the cost of the salmon input, the higher the domestic wholesale price the major canners will attempt to establish. A one-cent increase in the price of raw sock-eye would result in a $0.50 increase per standard case in the Oct-ober wholesale price set at Vancouver, ceteris paribus. (The price of raw sockeye does not include the bonuses.)

The coefficient for quantity available in the domestic market (Q_a) is not significantly different from zero. However, its sign is as expected and indicates that the increase in availability of canned sockeye for the domestic market would reduce the price set by the major canners.

The implications of these results are detailed in the following paragraphs.

The management programs, especially the salmon enhancement programs could affect wholesale price setting in two ways: (1) through their impacts on the world price of canned sockeye, and (2) their effect on the product availability for domestic trades. First, the increase in Canadian sockeye runs could reduce the world price set by the UK and Japanese traders since these traders take into consideration the Canadian sockeye runs in their price negotiation. The reduction in the world price, as discussed above, would affect the Canadian major canners in their domestic price setting. Under these circumstances they would tend to set the domestic wholesale price at a lower level. Secondly, an increase in sockeye landings due to the enhancement programs would increase the amount of canned sockeye available for the domestic trade (Q_a). An increase in domestic availability of canned sockeye should lead to a decrease in the wholesale price at the domestic market, according to the results obtained.

The impacts of the management programs on sales revenues at the wholesale level are discussed next under the analysis of demand for canned sockeye at the wholesale level.

The demand for canned sockeye at the domestic wholesale level is a derived demand of the retailers faced by the canners treated in this study as both canners and wholesalers). The demand is specified as Equation 3-4. Again the two-stage least squares estimator is employed, and the resulting empirical equation is shown as Equation 4-3.

$$Q^r_{dd} = 76 \times 10^3 - 96\ \hat{P}^r_r \times 10^4 - 35\ P^r_w \times 10^3 + 25\ P^p_w \times 10^3$$

$$\qquad\qquad (-1.03) \qquad (-1.18)^a \qquad (0.78)^b$$

$$-36\ W^r \times 10^2 \quad - - - - - \qquad (4\text{-}3)$$

$$(-0.50)$$

$$R^2 = 0.58$$
$$d = 1.81$$

a - significant at the 20% level.
b - significant at the 25% level.

The coefficient determination ($R^2 = 0.58$) is low but significant at the five percent level. The d-statistic is 1.81, which is in the "inconclusive" range at the five percent level in the Durbin-Watson test for autocorrelation. Thus, again, one can neither accept nor reject the hypothesis that autocorrelation is not present in the residuals. The coefficients have the expected signs, except for that of the predicted retail price of canned sockeye ($\hat{P}^r_r$). The t-statistics are shown in parentheses right below the individual coefficients.

The sign of the coefficient for $\hat{P}^r_r$ is unexpected. The negative sign could be attributed to its high correlation with the October wholesale price of canned sockeye (P_w^r) and, thus, $\hat{P}_r^r$ may have picked up some of the effect of P_w^r.

The October wholesale price (P_w^r) of canned sockeye has its expected sign. The negative sign confirms the demand relationship that the higher the wholesale price, the lower the quantity that retailers are willing to purchase, ceteris paribus. The price elasticity measured at the mean values of the variables is -1.472 at this level. Other things being constant, a one percent increase (decrease) in the wholesale price away from the average of the 1958-1972 values would result in a 1.472 percent decrease (increase) in the quantity sold and correspondingly would result in a decrease (increase) in sales revenues. Therefore the impacts of the management programs (i.e., the enhancement programs) on the sale revenues should be estimable given the estimated price elasticity. As mentioned on page 123, the enhancement programs should lead to a decrease in the wholesale price. Assuming no change in other variables, including the retail price, this fall in the wholesale price should lead to higher sales revenues for the wholesalers since the price elasticity of demand in the wholesale market is greater than unity. Because of the high correlation between $\hat{P}_r^r$ and P_w^r, the estimated price elasticity may understate the "true" figure.

The coefficients of the variables representing the wholesale price of canned pink salmon (P^p_w) and the wage paid to retail workers (W^r) have the expected signs.

b) The export market

The quantity exported to the world market is specified to be linear function of the export price of canned sockeye (P^r_e), the ex-vessel price of raw sockeye (P^{ev}), the beginning inventory of canned sockeye held by wholesalers (BI) and the landings of sockeye (L) as indicated in Equation 3-5. Since the explanatory variables of this equation are predetermined, the application of the ordinary least squares estimator to estimate the equation is appropriate. The empirical result is shown as Equation 4-4.

$$Q^r_{es} = 91 \times 10^3 + \underset{(-1.29)^b}{37\, P^r_e \times 10^3} \underset{(-0.96)^c}{- 25\, P^{ev} \times 10^3} + \underset{(1.19)^b}{48\, BI \times 10^{-2}}$$

$$+ \underset{(6.96)^a}{10\, L \times 10^{-1}} \qquad \text{------} \qquad (4\text{-}4)$$

$$R^2 = 0.90$$
$$d = 2.13$$

a - significant at the 1% level.
b - significant at the 15% level.
c - significant at the 20% level.

The coefficient of determination (R^2) is 0.90, indicating that 90 percent of the variation in the quantity exported is associated with the variations in the export price, the exvessel price, beginning inventory and the sockeye landings. For this equation, the magnitude of the Durbin-Watson statistic (d=2.13) suggests that one can reject the hypothesis, at the five percent level, that autocorrelation is present in the residuals. The coefficients of the explanatory variables have the hypothesized signs, and are significant at various probability levels as indicated in Equation 4-4.

The positive coefficient for the export price indicates expected supply behavior, i.e., the higher the export price the larger the quantity exported, _ceteris paribus_. Other things being held constant, an increase in the export price by one dollar per standard case would result in an increase in the quantity exported by 37,000 standard cases.

The negative coefficient of the exvessel price implies that the higher the cost of the raw salmon input, the smaller the quantity exported. This is consistent with expectations. As a result, the quantity supplied at different price levels tends to fall as the exvessel price increases.

The beginning inventory (BI) is part of the product available for marketing through both export and domestic markets. The positive coefficient for BI means that an increase (a decrease) in product availability would lead to an increase (a decrease) in quantities exported, _ceteris paribus._ The magnitude of the coefficient

(0.48) indicates that an increase (a decrease) in the beginning inventory by one standard case would cause an increase (a decrease) in the quantity exported by 0.48 standard case. The remainder (0.52 = 1-0.48 standard cases) would be accounted for by the increase (decrease) in the availability of product for the domestic market.

The coefficient for sockeye landings is positive, as expected. The quantity of canned sockeye available for marketing is directly related to the quantity of sockeye landed. Most of the raw sockeye is canned, regardless of the source of catch, and the input-output conversion is fairly stable at 68 pounds of raw sockeye to one standard case of canned sockeye. A high (low) level of landing is associated with a high (low) pack and therefore a high (low) product availability. Again the increase (decrease) in product availability would lead to an increase (decrease) in quantities exported, _ceteris paribus_. The magnitude of the coefficient (1.00) is reasonable, as explained in the next paragraph.

Landings are measured in 100 pound units. The equation indicates that an increase in sockeye landings of 100 pounds would result in an increase in canned sockeye exported by one standard case. However, this 100 pound increase in landings can produce 1.47 standard cases of canned sockeye, which is large enough to cover one standard case increase in export and leave 0.47 standard cases for domestic sales. This increase of 0.47 standard cases in product available for domestic sales (Q_a), as indicated in Equation 4-2, would reduce the domestic wholesale price set by the major canners and increase the sales revenues, as indicated on page 125.

In summary then, an increase in sockeye landings resulting from any of the salmon enhancement programs will increase the availability of canned sockeye for both export and domestic consumption. This increase will correspondingly increase the export supply, and reduce domestic prices which, assuming no change in the other variables, including the retail price, will, in turn, increase sales revenues from both markets separately, since the domestic wholesale demand is price-elastic ($\epsilon_p = -2.141$) and the export demand is perfectly price-elastic, by assumption.

It is assumed that the demand in export markets as a whole faced by Canada's traders is perfectly elastic at the world price set by the UK and Japanese traders. The demand price is assumed to be predetermined, as shown in Equation 3-6. Therefore no estimation is necessary. Thus, the UK market demand faced by Canadian traders is hypothesized to be a residual demand. Owing to data limitations, this hypothesis is not tested here. However the nature of the UK residual demand is illustrated and estimates of its parameters are made in Appendix II. The preliminary results are (1) that the own price elasticity of demand is relatively high (ϵ_p = -7.3585); (2) that the cross price elasticity with respect to the world price of canned pink salmon is relatively high (ϵ_s = 4.7798); (3) that the income elasticity is indeterminate; and (4) that the effect of Japanese sockeye landing on the UK residual demand for Canadian canned sockeye is significant whereas that of the U.S. is insignificant. For the details of the results, readers must consult Appendix II.

C) The exvessel market

Due to the inability to observe the market equilibrium prices, no attempt is made to estimate the supply and demand parameters of this level.

D) The fishing effort market

The supply of fishing effort is exogenous to the sockeye fishery model and is treated as a predetermined variable in the model. Thus no estimation of this supply is required.

The demand for fishing effort in the sockeye fishery stands for the average return to fishing effort involved in sockeye fishing and is specified as follows: the average return to fishing effort in the sockeye fishery (AR) is a linear function of: (1) the amount of fishing effort (FE); (2) the exvessel price of raw sockeye (P^{ev}); (3) the length of the fishing season (LS); (4) the size of the sockeye stock (ST); (5) technological improvements (TECH); and (6) the limited entry dummy variable (D_2), as indicated in Equation 3-8. The empirical relationship is shown in Equation 4-5.

$$AR = -36 \times 10^{2} + 17\ ST \times 10^{-2} + 22\ P^{ev} \times 10 + 21\ TECH \times 10^{-1} + 15\ D_2 \times 10 - 37\ FE \times 10^{-3} + 18\ LS \quad (4\text{-}5)$$

$$R^2 = 0.98$$
$$d = 3.43$$

The coefficient of determination (R^2) is 0.98, indicating that 98 percent of the variation in the average return to fishing effort is explained by variations in the explanatory variables (ST, P^{ev}, TECH, D_2, FE, LS). The explanatory variables have their hypothesized directional relationships with respect to the average return. The Durbin-Watson test shows that there exists negative first-order autocorrelation in the error terms.

The disturbances are autoregressive. The least squares estimators of the regression coefficients are still unbiased and consistent, but they are no longer efficient (27). The statistical tests are not valid in the case of autocorrelation, since the variances of the estimates are biasedly estimated. There are several methods available for coping with autocorrelation problems: the Cochrane-Orcutt iterative process and the Durbin-Watson method (26, 28) are examples. However, these methods were designed for the condition that the explanatory variables are fixed values, and the application of these methods involves a reduction in sample size. The condition of fixed values of the explanatory variables is generally not met in economic studies. This study carries no exception. Furthermore, the samples used in this study are small samples with sample sizes of 15 and 11 for the two separate sets of data. These small sample sizes do not leave much room for correcting autocorrelation. Nonetheless, it is of some interest to discuss the implications of the estimated results, recognizing that such results are highly tentative.

The variable representing average return (AR) is measured in dollars per unit of fishing effort per season; the variable of sockeye stock (ST) is measured in thousands of fish and is the summation of the sockeye runs, including the Skeena sockeye, the Rivers and Smith sockeye and half of the Fraser sockeye runs; technological improvement (TECH) is a relative measure and is the ratio of diesel fishing vessels to the total number of fishing vessels expressed as a percentage; fishing effort (FE), measured in gillnetter equivalents is obtained by treating one seiner as being equal to 4.3 gillnetters and one gillnetter as being equal to one unit of fishing effort; length of season (LS), measured in fishing days per gillnetter equivalent per season, is obtained by treating one seiner day as being equal to 4.3 gillnetter days and summing up the total days in gillnetter day equivalents for the months of July and August, and then dividing the total gillnetter day equivalents by total gillnetter equivalents to obtain the length of season; the limited entry dummy variable takes zero values in years 1961-1968 and is equal to one in years 1969-1971.

The positive sign for the coefficient of ST indicates a positive relationship between the average return and the size of the sockeye stock; the average return increases (decreases) with increases (decreases) in the size of the sockeye runs. The magnitude of the coefficient (0.17) implies that an increase in 1,000 fish would increase average return per gillnetter equivalent per season by \$0.17, *ceteris paribus*.

The expected impact of the salmon enhancement programs on the average return can be calculated by multiplying \$0.17 by the increase in sockeye (in thousand of fish) returning from spawning. For instance, if the programs result in an increase of one million fish (1000 thousands) returning for spawning the average return, other things being constant, would increase by \$170 per gillnetter equivalent per season in real terms. However, other things will probably not be constant. Such an increase in sockeye stocks would, eventually, be expected to reduce the exvessel price.

The coefficient on the exvessel price (P^{ev}) has its expected positive sign. The magnitude (220) indicates that an increase in the exvessel price by one cent in real terms would result in an increase of the average return by $220 per gillnetter equivalent per season, *ceteris paribus*.

The variable representing technological improvements has the hypothesized sign. This implies that technological improvements have played a role in determining the average return. As discussed earlier, tests of the statistical significance of the estimated coefficients in the equation are not possible. Nonetheless, it should be mentioned that the estimated standard error on this coefficient is high, suggesting that the true coefficient may be zero. This could reflect the fact that technological improvements have been discouraged in salmon fishing through management regulations. This may also show that the long-run effects of technical improvements have offset their short-run effects on the average return.

The positive coefficient for the limited entry dummy variable suggests that the limited entry program imposed in 1969 has had impacts on the derived demand for fishing effort and has significantly shifted the derived demand upward.

The coefficient on the fishing effort variable is negative, as expected. The negative sign indicates that the average return equation is a demand equation; a decrease (an increase) in fishing effort in the sockeye fisheries would correspond with an increase (decrease) in the average return. The magnitude of the coefficient

(0.037) indicates a decrease (an increase) in one gillnetter equivalent would result in an increase (a decrease) of $0.037 in the average return per gillnetter equivalent _ceteris paribus_. Presumably the total impact of the limited entry program of 1969 on the average return to fishing effort in sockeye fishing can be determined by multiplying $0.037 by the amount of gillnetter equivalents phased out under the license control programs. However this inference should be made cautiously since there are discrepancies between the assumptions of this study and the realities of the industry. This study implicitly assumes that gillnetters and seiners are, taken separately, homogenous in their own respective categories, and that therefore it is possible to employ a fixed conversion between them in order to calculate standard units of fishing effort. This study also assumes that a fishing vessel, as long as it reported a catch in a season, provided fishing effort in that season no matter how long it engaged in sockeye fishing, or the amount that it landed in that season. Contrary to these assumptions, gillnetters and seiners are not homogenous in their own groups, and a substantial number of fishing vessels exist which fish for only a few days out of the season, and/or land only a relatively few sockeye in a season. The amount of fishing effort phased out under the license control program imposed in 1969 consists of these small operators. Therefore, the impact of this program on the average return could be in reality somewhat different than that predicted by this model.

The coefficient of the length of seasons (LS) variable has a positive sign, as expected. The magnitude of the coefficient (18.0) indicates that an increase of one day fishing per gillnetter equivalent would produce an increase in the average return of $18 in real terms, _ceteris paribus._ This implies that if the authorities manage the sockeye fisheries during July and August in such a way as to allow every gillnetter equivalent one more day of fishing, the average return to the gillnetter equivalents would increase $18 per gillnetter equivalent per season. But this assumes no effect on the exvessel price and that there would be fish to catch during that extra day.

V. SUMMARY AND CONCLUSIONS

Traditionally, salmon stocks have been treated as "common property"; that is whoever feels it is profitable to utilize the salmon stocks can do so, without restriction and compete with others in the exploitation of these stocks. Prior to 1968, there was free entry into all the Canadian salmon fisheries. The results of this unrestricted competition for salmon were twofold: first, there was the ever increasing threat of depleting the salmon stocks; secondly, severe overcapitalization in the fisheries had led to low and unstable returns to fishing effort.

The poor performance of the fisheries, attributable to the above mentioned situation, provided the rationale for government intervention. Canada now not only controls the fishing grounds, fishing seasons, and fishing equipment, but also has initiated limited entry and expanded salmon enhancement programs.

All Canadian salmon fishery programs are designed to: (1) prevent the salmon stocks from being depleted; (2) increase the stock and catch; and (3) increase and stabilize the earning of fishermen. One danger of these fishery programs is that decisions are made whose consequences are not foreseen. The objectives of this study are to help provide a better understanding of the markets for sockeye salmon, and, in so doing, to estimate the total consequences of public and private fishery policy actions. The study focuses on the impacts of these fishery programs on the market prices of sockeye products and on the returns to fishing effort employed in the sockeye fishery.

The sockeye fishery is chosen since it is the most important Canadian salmon fishery, serving as the keystone for the development of the Canadian salmon industry. Furthermore the fishery has a long standing recorded history providing the data required for the analysis herein.

The Canadian sockeye industry is discussed in length with some distinctive characteristics being singled out in Chapter II. An econometric model of the multi-level Canadian sockeye market is constructed with consideration of these characteristics in Chapter III. The econometric model is specified in such a way as to treat the sockeye stocks, sockeye landings, the amount of fishing effort and the length of seasons as exogenous variables subject to the influence of the fishery programs. The following are the conclusions of this study.

At the consumption level, the demand for canned sockeye is price-inflexible (-0.47), implying a high price-elasticity (ϵ_p = -2.144 = 1/-0.47). The cross price flexibility with respect to the price of canned pink salmon is relatively low (0.511). Income flexibility is negative, indicating that canned sockeye may be an inferior good. The non-price promotion sponsored by canners in cooperation with the retailers of canned sockeye is very effective in shifting the consumption demand outward. The changes in tastes of the sockeye consuming public, represented by a time trend variable, have significantly reduced the demand for canned sockeye, and generated downward pressure on the retail price of canned sockeye.

The domestic wholesale price set by canners at wholesale levels is positively related to the export price of canned sockeye and the exvessel price of raw sockeye. These two prices also have a significant influence on the domestic wholesale price of canned Canadian sockeye. The supply price appears to be negatively related to the quantity available for domestic sales.

The demand for canned sockeye at the domestic wholesale level is relatively price-elastic ($\epsilon_p = -1.472$). This implies that, other things being constant, the wholesale supplier would experience an increase in sales revenues due to increases in the quantities sold at reduced wholesale prices. (This refers to derivations from the average levels of the variables for the 1958-1972 period.)

With respect to the export supply, the results indicate that, *ceteris paribus*, a one-dollar-per-standard-case increase in the export price would raise the export supply by 37,000 standard sockeye cases. Also increases in the amount of canned sockeye available from inventories and sockeye landings would increase export supply, but this increase is less than the increase in the amount of canned sockeye available. Hence, some increase in the canned sockeye available would lead to increases in the quantities of canned sockeye available for domestic sales as well. For example, an increase in sockeye landings of 100 pounds would yield an additional 1.47 standard cases of canned sockeye. This would result in an increased export of approximately one standard case and an increase in canned sockeye available for domestic consumption of 0.47 standard cases.

The export demand facing Canadian exporters is assumed to be perfectly elastic. However the residual demand of the UK market for Canadian canned sockeye is assumed to have a downward slope. An analysis of the UK residual demand for the Canadian canned sockeye, using sparse data, suggests that this demand is: (1) price elastic ($\epsilon_{p^r} = 7.3585$) and (2) cross price elastic ($\epsilon_{p^p} = 4.7798$) with respect to changes in the world price of canned pink salmon. However, (3) income elasticity is indeterminate and (4) the effect of Japanese sockeye runs on the UK demand for the Canadian canned sockeye is significant whereas that of the U.S. sockeye runs is not significant. Both the perfect price elasticity of world demand by assumption and the high price elasticity of the UK residual demand by estimation faced by Canadian canned sockeye exporters, imply that the export sales revenues accruing to Canadian exporters from both these markets would increase were the Canadian export sales in these markets to increase.

In short, canners facing a price-elastic demand in both foreign and domestic markets at the wholesale level should experience an increase in sales revenues from both export and domestic markets, if the enhancement programs lead to increases in the availability of canned sockeye.

An analysis of the exvessel market is not performed, since the unknown end-of-season bonus payment to fishing effort obscures the market equilibrium price. The parameters of the exvessel demand could be estimated if the magnitude of the bonuses were known. However, attempts to acquire information on bonus payments met with failure, which suggests an area for future study.

The supply of fishing effort is considered to be predetermined. The demand for fishing effort is expressed in terms of the average return to fishing effort. The determinants of the average return are the amount of fishing effort, the exvessel price of raw sockeye, the length of fishing seasons, the size of the sockeye runs, technological advancements in fishing, and a limited entry dummy variable. Each of these determinants, except that representing technological improvements, affects the average return significantly. The impact of these determinants on the average return is reasoned as follows: If, due to management programs, there were an annual increase in the number of sockeye returning to spawn, there should, correspondingly, be an increase in the average return to each gillnetter equivalent of fishing effort, _ceteris paribus_. An increase in the exvessel price in real terms would also increase the average return to each unit of fishing effort, _ceteris paribus_.

The limited entry program imposed in 1969 has shifted the derived demand for fishing effort and accordingly the average return to fishing effort upward. A decrease in fishing effort would result in an increase in the average return. Specifically, a decrease in gillnetter equivalents by one would increase the average return to fishing effort by $0.037, _ceteris paribus_. Finally with respect to fishery policies, if management authorities were to allow one more day of sockeye fishing during July and August the annual average return to each gillnetter equivalent of effort would increase in real terms by $18.00, _ceteris paribus_.

In concluding this study, this researcher should point out that after trying several alternative specifications for the industry model he has found this specification to be more suitable than the other. However, areas in need of further study are apparent, especially those dealing with the export and exvessel markets for Canadian sockeye salmon.

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APPENDICES

APPENDIX I

To estimate the effect of changes in tastes and to separate this effect from the income effect on the consumption of canned sockeye, a time-trend variable (T) from 1 to 15 is created to account for the effect of changes in tastes, and is included in the consumption demand equation. The sign for this time-trend variable is expected to be negative. For the purpose of comparison, Equation 4-1 is reproduced here as Equation I-1. The newly hypothesized equation incorporating the time-trend variable is presented as Equation I-2.

$$P_r^r = 0.80994 - \underset{(0.03645)^*}{0.35502}\,\frac{Q}{N} + \underset{(0.28008)^*}{0.82027}\,P_r^p - \underset{(0.000038)^*}{0.003}\,INC$$

(s. e.)

$$+ \underset{(0.00906)^*}{0.04706}\,D_1 \quad ------ \qquad \text{(I-1)}$$

$$R^2 = 0.94$$

$$P_r^r = 0.70706 - \underset{(0.09664)^*}{0.38826}\,\frac{Q}{N} + \underset{(0.53454)^*}{0.09764}\,P_r^p - \underset{(0.000232)}{0.00022}\,INC$$

(s. e.)

$$+ \underset{(0.01282)^*}{0.05029}\,D_1 - \underset{(0.01240)}{0.00464}\,T \quad ----- \qquad \text{(I-2)}$$

$$R^2 = 0.94$$

* - significant at 1% level.

As indicated in Equation I-2, the estimated coefficient on the income variable has not reversed its sign but has become insignificant. However the time-trend variable is not significant either. The change in significance for the income variable make this result suspicious. When the correlation matrix is examined, there is high correlation between INC and T (r=0.981). This high correlation between independent variables may result in multicollinearity problems which lead to imprecise estimates and t-tests. A comparison of Equations I-1 and II-2, shows that the standard error of estimates of II-2 in parentheses increases greatly from those of II-1, and the estimated coefficients change their values as well. These changes in results may confirm the existence of the multicollinearity problems; the high correlation between INC and T may increase the diagonal elements of the variance-covariance matrix so that the estimates change and their standard deviations increase.

To cope with this multicollinearity problem, a principal component analysis is applied to generate a new variable representing INC and T. The first principal component generated from the first eigenvector is shown as I-3. This first principal component accounts for 99.1 percent [(1.98135 x 100)/(1.98135 + 0.01865)] of the total variations of INC and T. The first principal component is then used in place of INC and T in the analysis. The results are shown in I-4.

$$FC = 0.707\ INC + 0.707\ T \quad - - - - - \qquad (I\text{-}3)$$

$$P_r^r = 0.80329 - 0.35719\ \frac{Q}{N} + 0.83140\ P_r^p + 0.04728\ D_1$$

$$\begin{array}{llll} (s.e.) & (0.0364)^* & (0.28088)^* & (0.00907)^* \end{array}$$

$$-0.00043\ FC \quad - - - - - - \qquad (I\text{-}4)$$

$$(0.00005)^*$$

$$R^2 = 0.94$$

* - significant at 1% level.

Comparing I-1, I-2, and I-4, it is noted that the results of I-4 are close to those of I-1 in terms of the magnitudes of coefficients and their standard deviations. Although the results obtained from I-4 provide the information needed to estimate the effect of taste changes on the consumption of canned sockeye, the results still indicate the negative income effect.

APPENDIX II

As mentioned on page 60, the UK traders in conjunction with Japanese traders set the world price for canned sockeye trades. UK traders buy from the Japanese first, then from the U.S. sellers and finally from the Canadian exporters. The Canadian exporters, in effect, supply the residual to the UK market. This implies that the demand faced by Canada is a residual demand. This residual demand is the demand to be estimated and is illustrated in Figure 23.

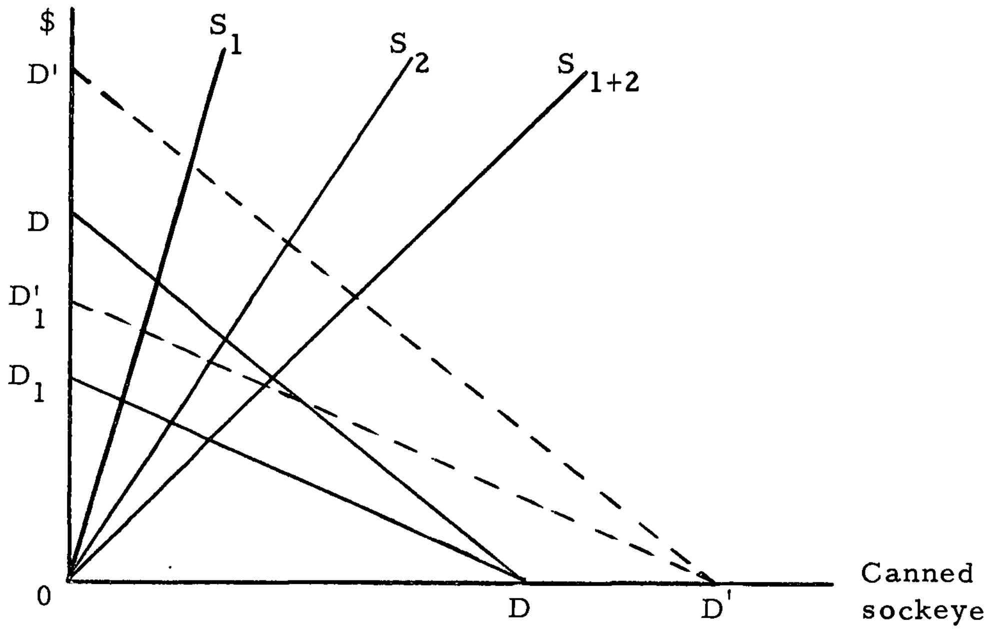

Figure 23. The UK residual demand faced by Canada (A)

The line labeled as DD is the UK demand, the demand for canned sockeye faced by Japan, the U.S. and Canada. The positive sloped curves indicated as S_1 and S_2 are the U.S. and Japanese supply curves of canned sockeye to the UK market respectively. The horizontal summation of S_1 and S_2 (S_{1+2}) is the total supply from the U.S. and Japan. The demand left for Canada is the residual demand (D_1D) which is derived by subtracting S_{1+2} from DD. This residual demand is the demand of interest.

The residual demand could shift, corresponding to shifts in DD, S_1 and S_2. For instance, the outward shift of DD to right due to the increase in world prices of canned pink salmon (i.e., the substitute good) would lead to the outward shift of the residual demand from D_1D to D'_1D, as shown in Figure 23. The shifters of DD are considered numerous: the world price of canned pink salmon, the UK population, the UK wholesale price of canned sockeye, etc. The UK wholesale price of canned sockeye in turn is a function of variables affecting consumption of canned sockeye at retail levels. Unfortunately, not all of these data are available to this researcher. However, some of these variables, except for the world price of canned pink salmon, the UK income and the UK population could be assumed to be irrelevant and insignificant. Thus, the world price of canned pink salmon, the UK income and the UK population are hypothesized to be shifters of DD and are

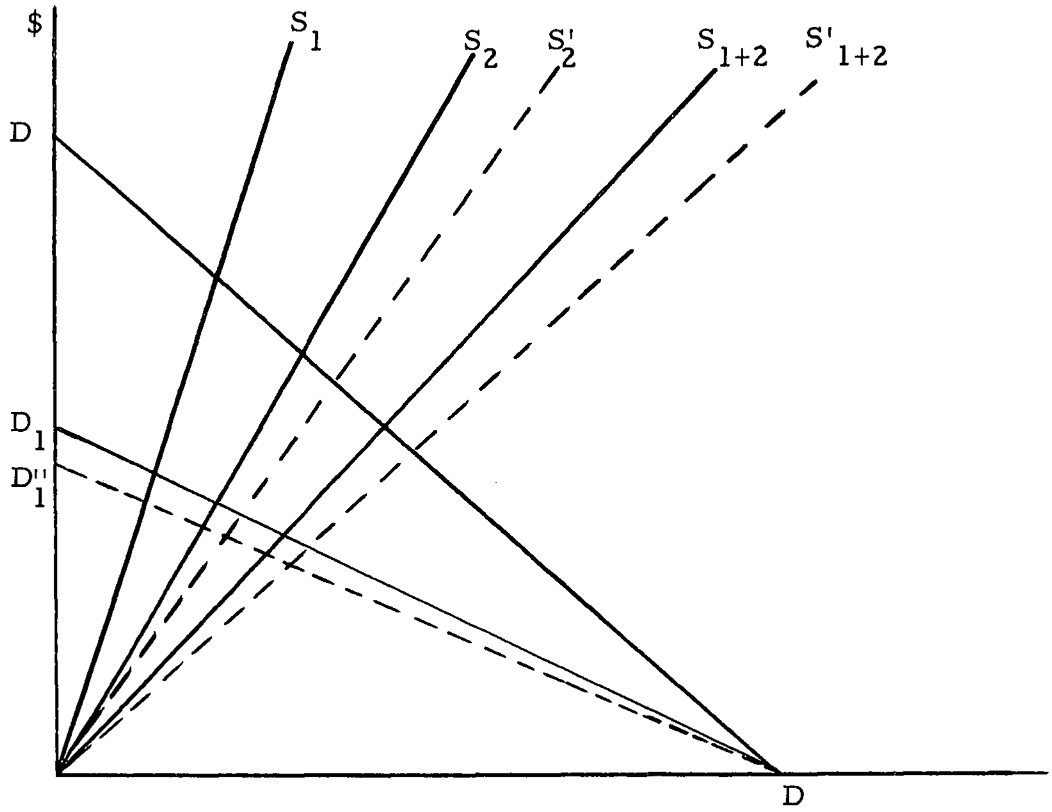

Figure 24. The UK residual demand faced by Canada (B)

treated as explanatory variables in the residual demand (D_1D).

A shift of either S_1 or S_2 or both will cause a shift in the residual demand. If, for example, the Japanese supply to the UK (S_2) is shifted outward to S_2' due to an increase in Japanese sockeye landings, then the total supply of the U.S. and Japan would shift accordingly to S_{1+2}', and finally the D_1D shifts inward to $D_1''D$ as shown in Figure 24. The shifters of S_1 and S_2 are variables related to the Japanese and U.S. sockeye and sockeye related product markets. Again the variables representing these shifters are numerous and data on these variables, except sockeye landings of these two countries, are not available. Therefore the Japanese and U.S. sockeye landings (L_J, L_{us}) are hypothesizes to be important variables and are specified in estimating D_1D. Other variables are assumed to be insignificant and will not be included as explanatory variables in estimating D_1D.

In summary, the UK residual demand for canned sockeye faced by Canada's exporters is that which is "left" by the Japanese and U.S. traders. This residual demand is hypothesized to be a linear function of the UK population (pop), UK personal income (Y), world price of canned sockeye (P_r), world price of canned pink salmon (P_p), Japanese sockeye landings (L_J) and U.S. sockeye landings (L_{us}). The functional relationships are indicated in Equation II-1.

$$Q_D^{UK} = f(+\ pop,\ +Y,\ -P_r,\ +P_p,\ -L_J,\ -L_{us}) \text{ - - - } \qquad \text{(II-1)}$$

where

Q_D^{UK} = UK import of canned sockeye from Canada in standard cases.

pop = UK population.

Y = UK disposable personal income in British pounds deflated by UK WPI (1954=100).

P_r = world price of canned sockeye in British pounds deflated by UK WPI (1954=100).

P_p = world price of canned pink salmon in British pounds deflated by UK WPI (1954=100)

L_J = Japanese sockeye landings in metric tons.

L_{us} = U.S. sockeye landings in metric tons.

The ordinary least squares estimator is applied to Equation II-1, since the world price of canned sockeye is predetermined by the UK and Japanese traders and thus the UK import of Canadian canned sockeye (Q_D^{UK}) is treated as the only endogenous variable in the equation. The empirical result is presented as Equation II-2.

$$Q_D^{UK} = \underset{}{14967000} \underset{(-1.39)}{-274.14\ pop} + \underset{(0.56)^c}{47.623\ Y} - \underset{(-2.06)^a}{189790\ P_r}$$

$$+ \underset{(1.18)^b}{178380\ P_p} - \underset{(-1.61)^a}{15094\ LJ} - \underset{(-0.35)}{1216.2\ L_{us}} \quad \text{- - -} \qquad \text{(II-2)}$$

$$R^2 = 0.52$$
$$d = 3.31$$

a - significant from zero at 10% level.
b - significant from zero at 15% level.
c - significant from zero at 30% level.

The regression coefficient (R^2) is 0.52. The Durbin-Watson statistic (d=3.31) is in the "inconclusive" range, suggesting that one can neither accept or reject the hypothesis that there is no serial correlation in the residuals. The functional relationships confirm prior expectations except that for the UK population. According to the t-statistics in parentheses, the coefficients of P_r and L_J are significant at the 10 percent level, while those of

P_p and Y are significant at the 15 percent and 30 percent levels, respectively. The price elasticity of demand at the mean values of the variables (ϵ_{Pr} = -7.39) is considerably greater than unity. The cross price elasticity of demand with respect to the world price of canned pink salmon at the mean values of the variables (ϵ_{Pp} = 4.21) is also greater than unity. The income elasticity (ϵ_Y = 5.40 is in excess of one.

However, these results are questionable, particularly the coefficient Y, since the linear correlation coefficient Y and pop, (γ^2 = 0.964), is higher than the regression coefficient (R^2 = 0.52). This is a symptom of multicollinearity where the coefficients of the independent variables, especially those of Y and pop, could be intermingled and imprecise. To cope with this multicollinearity problem, this researcher estimates the demand on a per capita rather than on an aggregated basis so that the high correlation coefficient between Y and pop is eliminated. The empirical residual demand per capita equation is presented as Equation II-3.

$$Q_D^{UK}/N = 2.1151 - 0.0034938\frac{Y}{N} + 0.23302P_p - 0.18297P_r$$

$$\qquad\qquad (-1.80) \qquad (1.72)^b \qquad (-2.08)^a$$

$$-0.013881\ L_J - 0.000298\ L_{us} \quad ---- \quad \text{(II-3)}$$

$$(-1.52)^b \qquad (-0.09)$$

a - significant at 5% level. $\quad R^2 = 0.39$
b - significant at 10% level. $\quad d = 2.98$

The regression coefficient drops from 0.52 to 0.39. Again the Durbin-Watson statistic (d=2.98) is in the "inconclusive" range, suggesting that one can neither accept nor reject the hypothesis that no serial correlation is present in the residuals. The t-statistics in parentheses show that the coefficients are significant at the indicated levels. All variables except $\frac{Y}{N}$ have their expected signs. The negative sign for $\frac{Y}{N}$ implies that the UK demand faced by Canada includes a negative income effect, which is contradictory to the results of the aggregated analysis (Equation II-2). The price elasticity of demand at the mean values of the variables (ϵ_{Pr} = 7.3585) is greater than unity and the cross price elasticity of demand at the mean values of the variables (ϵ_{Pp} = 4.7798) is also greater than unity. These two elasticities are similar to the results of the aggregate analysis.

In summary, the UK residual demand faced by Canada is specified and estimated under some severe data limitations. While this specification has omitted some variables, the results show that the price elasticity and the cross price elasticity are both highly elastic. The income elasticity is indeterminate and further research in this area is called for.