Uncertainty, Market Disequilibrium, and the Firm's Decision Process: Applications to the Pacific Salmon Market

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CHAPTER I

INTRODUCTION

The U.S. Pacific salmon industry is a major component of the country's seafood sector and is of considerable importance to various coastal communities in Alaska and the Pacific Northwest. Every day, a wholesaler picks up the phone, goes to the telex or typewriter and engages in a wholesale transaction for salmon. How does the wholesaler decide how much to sell and at what price? Do the factors influencing these decisions change over time? What is the environment in which the manager operates; i.e., what risks and uncertainties, if any, does he or she face? These are among the issues addressed in this study of wholesale price determination in the Pacific salmon market.

The Firm and Microeconomic Theory

Individual firms, be they small proprietorships or large corporations, form the inner workings of a free-market economy. Considering technological relationships, input costs and consumer demand and motivators by project, firms decide what shall be produced, in what quantity, with what inputs and at what prices.

Economic theory attempts to explain market behavior through the use of microeconomic models. Under various assumptions, these models provide a framework within which to understand how the actions of individual firms within an industry lead to aggregate market behavior, and the impact of exogenous changes. The orthodox microtheory representation of the firm is one of extreme simplification. It is a purely analytical construct which is a convenient framework for understanding the existence and operation of firms and markets.

Microeconomic theory has been hailed as a powerful tool in terms of its ability to predict the impact of exogenous changes (Alchian and Allen, 1969; Ofek, 1982). For example, the effect of an increase in an input price may be analyzed in terms of the resultant impact on prices, quantities exchanged and the number of firms in the industry. However, the microeconomic model has been criticized for various reasons. Still, no alternatives have been provided, except new versions of the model, such as monopolistic competition, which incorporate different assumptions or behavioral postulates.

Certain critics of the neoclassical model are dissatisfied with the theory on the grounds that it does not accurately reflect the "real life" decision-making behavior and environment of entrepreneurs. For example, the perfect competition model assumes that firms are price takers and that entrepreneurs equate this price to marginal cost to determine their optimal output levels. These assumptions result in a model which is extremely efficient in its predictive abilities, but the model does not always provide satisfactory explanations about how firms actually make decisions.[1] If the goal is to understand how decisions are undertaken on a daily basis in firms faced with uncertainty, risks, government regulations and the quirks of Mother Nature, extensions of the neoclassical model may be required.

Because the seafood manager often operates under conditions of uncertainty and market disequilibrium,[2] a review of the literature in these areas provides a framework for considering decision making in such an industry. The general consensus in the literature is that firms do not act as price takers when faced with market disequilibrium or imperfect information. The decision maker must estimate the firm's unknown, but downward-sloping, demand curve. Equating perceived marginal revenue with marginal cost, the firm obtains an estimate of its profit-maximizing price and quantity for a given period. Thus, the firms act as price searchers.[3] Various researchers have formulated different models to represent the methods used by firms in their search for optimal price and quantity. Previous studies have also demonstrated that imperfect information may result in price dispersion at equilibrium. Thus, buyers can be characterized as price searchers, and again different studies have suggested various representations of such behavior. It is generally assumed that buyers are aware of the distribution of prices, but must search for the firm charging the low price relative to the costs of a search.

The major goal of the present research is to improve understanding of decision making by participants in a competitive market characterized by uncertainty. In many respects, this study is the first of its kind. Its results provide a greater understanding of the salmon market and take an important step toward increasing knowledge of how markets "work" through improved appreciation of the decision-making process of its participants. As such, the study makes a methodological contribution to economic analysis and a practical contribution to those interested in the workings of the Pacific salmon market.

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[1] The neoclassical model of perfect competition is a model of market, as opposed to firm, behavior. Like any model, it is an abstraction of complex, "real-world" phenomena.

[2] As used here, "market disequilibrium" is defined as a situation in which exchanges are made at prices at which the quantities offered by sellers are different than the quantities buyers would be willing to purchase at those prices.

[3] A price-searching seller, as opposed to a price taker, is one who faces an unknown, but downward-sloping demand curve. In trying to determine the demand curve, the entrepreneur is looking for the profit-maximizing price. Similarly, such conditions of uncertainty indicate that buyers must also be searching for the profit-maximizing price.

Methodology

The establishment and survival of a firm depend upon its ability to generate profits. Thus, a useful starting point for the study of decision making in the wholesale salmon market is the consideration of production functions and cost curves. A Leontief fixed proportions production function (Ferguson, 1969) provides a basic framework from which to consider the possible nature of the cost relationships facing the firm. This is followed by an analysis of revenue functions. The latter are perhaps the most complex part of the discussion. Assumptions about market structure, which is difficult to characterize in any empirical setting, ultimately affect the behavior of the revenue curves facing an individual salmon wholesaler.

It is assumed in this study that individual firms act as profit maximizers which equate expected marginal revenue and marginal costs. It is further assumed that while salmon-selling firms compete actively with each other, they do so in the presence of uncertainty about the behavior of buyers and the reactions of other sellers. The individual entrepreneur, however, is assumed to know his or her marginal cost curve. Because it has access to imperfect information, the firm faces a downward-sloping, but unknown, demand curve. Thus the firm must estimate its demand and marginal revenue curves. On the basis of known information (e.g., costs) and estimates of the demand curve, in each time period the firm determines an optimal profit-maximizing price and output. In fact, the firm sets an "asking price," ex ante, and it is up to the buyers to determine whether or not the optimal quantity will in fact be sold. In the second time period, the seller will revise his or her optimal price and quantity estimate, based on the same factors used in the first time period as well as on information gained from observing his or her own sales in the previous period.

Thus, on the basis of information generated from interviews with salmon industry members as well as concepts advanced in the previous studies, a model is constructed to represent the decision making by sellers of salmon at the wholesale level. The reaction of buyers to the asking price is specified, as is implicitly the resultant reaction of sellers to buyers' decisions.

The model is estimated empirically with the use of weekly data from invoices of wholesale transactions of Pacific salmon for a number of firms. These data represent a unique and rich source of information to the researcher examining decision making by the firm. Additional information, such as dates of fishing seasons and landings, costs to processors and certain proxy variables, assists in the analysis of the invoice data.

Empirical estimation of the model is performed on nineteen subsets of the data, classified by type of salmon product and by firm. The results for the asking price equation reveal that for certain cases sellers of Pacific salmon behave in a manner consistent with price-searching models, rather than as price takers. Furthermore, these results support previous studies which hypothesize the role of various indicators in the decision making of the seller. In the case of the buyers' responses to the asking price, however, the model does not appear to capture some important factors. Some of the probable issues not incorporated in the model are discussed.

Ultimately, then, this research is designed to provide a better understanding of the relationship between decision making at the firm level and associated market processes in a specific setting: the U.S. Pacific salmon industry.

CHAPTER II

UNCERTAINTY, MARKET DISEQUILIBRIUM AND THE FIRM'S DECISION PROCESS

A review of previous literature in the areas of market disequilibrium and the economics of information brings out two salient points. First, the seafood market demonstrates certain characteristics which imply that disequilibrium conditions may often occur. Second, conditions of less than perfect information further the possibility that the market for fishery products may be characterized by price-searching behavior and, consequently, persistent price dispersion.

There has been considerable research in the area of markets characterized by uncertainty. Although much of this work followed Stigler's article (1961) on the role of information in marketing, it was Arrow (1959) who first stated that conditions of less than perfect information may lead to price dispersion even in otherwise competitive industries. Arrow's piece focused on price adjustment in a market in transitory disequilibrium; however, many of the concepts in the subsequent literature on disequilibrium markets and equilibrium price dispersion were in fact addressed in this article.

Arrow states that the "law of one price" and the idea that buyers and sellers are price takers need to be reexamined. Considering a simple model of demand and supply with a Walrasian price adjustment mechanism, he indicates that the issue of who changes the price is not addressed. Arrow argues that in disequilibrium, participants cannot buy or sell all they wish at the prevailing price. Each seller faces a downward-sloping demand curve rather than the perfectly elastic demand curve of perfect competition at equilibrium. Thus, the sellers are playing an active role in moving the price towards equilibrium, as they maximize their profits by attempting to find an optimal price. In a sense then, sellers have at least short-run monopolistic powers. By parallel argument, buyers are monopsonistic and the market may actually be composed of many sets of bilateral monopolies. Disequilibrium conditions in fact rule out the law of one price. Most importantly, Arrow adds that we would also not expect this law to hold if there were imperfect information.

Many issues covered in Arrow's article are reflected in other articles that will be discussed here. Arrow states that conditions of disequilibrium (or uncertainty) imply that the individual sellers (or buyers) must search for the optimal price at which to carry out transactions. For example, the seller's estimate of the demand curve facing his or her firm will be based on guesses as to the prices of other sellers, aggregate demand and supply conditions (implying, it appears, production levels and cost curves of other sellers). With the idea of bilateral monopolies comes the concept of competition between sellers for attracting buyers, because the "range of indeterminancy in each bargaining situation is limited but not eliminated by the possibilities of other bargains" (Arrow, p. 47). Arrow also discusses how the structure of the market under consideration may affect the dynamics of price adjustment, as bargaining power may be stronger on the more concentrated side of the market. The efficiency of the price system for conveying information to buyers and sellers is challenged by Arrow, who points out that sellers must use other sources of information, such as their level of inventories and the prices of other sellers, in making their profit-maximizing decisions.

Arrow found three factors which play a role in the speed of price adjustment, noting that the price in the Walrasian equation should now be seen as an "average price":

(1) A steeper marginal cost curve implies a more rapid response, in terms of price, to a perceived change in demand. It should be noted that the effect on quantity is precisely the opposite; e.g., a steeper marginal cost curve implies a greater change in price and a smaller change in quantity.

(2) Those industries in which inventories play a significant role should yield evidence of more rapid price adjustment to perceived disequilibrium, because the change in marginal cost (due to changes in production costs with shifts in inventories) exaggerates the effect of a shift in demand.

(3) The speed of price adjustment would be lower for industries faced with conditions of imperfect knowledge. This is particularly the case for "poorly standardized" products because it is difficult to read the signals from other markets (e.g., prices, supply conditions) if these are not necessarily perfect substitutes.

It was Arrow, then, who first advanced the idea that firms may not be price takers and that price dispersion may occur in industries which may otherwise be competitive. Such phenomena may appear only in transitory situations of disequilibrium. However, continual disequilibrating factors, or imperfect knowledge, imply that price searching and price dispersion may be more the rule than the exception in certain industries.

Stigler's article "The Economics of Information" reinforces the idea that buyers and sellers must search for the optimal price at which to buy or sell their products, respectively. Stigler argues that price dispersion is a measure of ignorance in the market. It is a biased measure because one must consider "homogeneity of transactions" in the market;[4] however, he maintains that not all price

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[4] Although a good may be homogeneous across all products, Stigler (1961) identifies four other dimensions of homogeneity of transactions: (1) ease in making sales, (2) promptness of payments, (3) penchant for returning goods, and (4) likelihood of buying again.

dispersion is due to heterogeneity. Stigler lists four sources of dispersion, including the costs to sellers of determining their rivals' prices, the ever-changing conditions of supply and demand which make knowledge a very perishable commodity, and the continual appearance of new market participants, who carry their own ignorance and also are themselves a new source of uncertainty for current buyers and sellers. Thus, while both Stigler and Arrow admit that the law of one price does not always hold true, they do so for different reasons. Furthermore, Arrow's dispersion is assumed to be primarily transitory, while Stigler's is permanent. Some of Stigler's sources of dispersion, however, are in fact due to the disequilibrium situations Arrow describes.

While Stigler's article has been criticized on various aspects, the greatest objection arises from his lack of consideration of the reaction of sellers to the price-searching behavior of buyers. In addition to this point, it could be said that Stigler somewhat ignores the price-searching behavior of sellers. Although he states in the beginning of his article that sellers may engage in price-searching behavior, he later indicates that such activity may occur for unique items but that it is "empirically unimportant." This is as disappointing as it is surprising, for it would have been interesting to read some of Stigler's ideas regarding the price-searching behavior of buyers extended to that of sellers. For example, Stigler states that the optimal level of search for sellers is that level where the marginal cost of search is equal to the expected increase in receipts, analogous to the determination of optimal search levels by buyers. However, Stigler states that search costs vary across buyers because of differences in tastes and in opportunity costs (attributed to different income levels). Do search costs vary across sellers for analogous reasons? That is, are search costs higher for a firm with higher revenues than for one with lower revenues? Do factors such as risk aversion affect the costs of (or benefits from) search to an individual firm? And what about the elusive element of entrepreneurial ability? In spite of its shortcomings, this article generated much excitement in market research, as if economists finally were free of the restriction that prices must be equal in a competitive market and that firms just might be able to play a role in determining the prices obtained for their output.

Rothschild (1973) surveyed some of the theoretical work undertaken since Stigler's article, notably those models constructed under various assumptions but with the common factor of imperfect information. The first two types of models discussed lead to a single equilibrium price. This is curious since these works are considered to be inspired by Stigler, yet they refute his notion that price dispersion can exist and persist as the result of imperfect information and optimal price-searching behavior by buyers and sellers. However, as Rothschild explains, it appears that persistent price distribution may occur only if either (a) the market in question is continually subjected to random shocks (exogenous factors), or (b) information is so costly that it is never profitable for buyers or sellers to be fully informed (endogenous factors). Rothschild thus presents two models which allow price dispersion, one for endogenous reasons and one for exogenous reasons, which seem to be more consistent with Stigler's hypothesis, although Stigler would contend that price dispersion is due to both endogenous and exogenous factors which upset the market. Endogenous reasons could include the uncertainty facing individual firms and the costs of their search, whereas an exogenous factor is the ever-changing conditions of aggregate supply and demand. Rothschild concludes that much remains to be accomplished in the realm of understanding market organization under conditions of imperfect information and that modeling markets in this context should include consideration of the behavior of both buyers and sellers and how their interaction leads to some type of equilibrium, be it a single price or a dispersion of prices. Furthermore, he states that the assumptions of what buyers and sellers actually know should be reasonable and that the interaction between sellers in the form of oligopolistic competition should also be considered.

Perhaps the most interesting contribution made by Rothschild in this survey article is his justification for the study of markets under conditions of imperfect information. While some researchers argue that uncertainty and disequilibrium have little effect on the actual numbers generated in empirical economic studies, Rothschild states three reasons for studying such issues. First, involuntary unemployment, inflation and the behavior of holding money do not occur in models of perfect markets; thus, how is an economist to make adequate policy recommendations when faced with such phenomena in the "real world"? Second, there are serious microeconomic consequences associated with the presence of imperfect information in a market, such as employment discrimination. Third, although competitive equilibrium has been shown to exist, economic theory suffers in its inability to explain how it is attained, and research on the role of information may provide useful insights. It appears that another reason may be advanced: microeconomic theory has been criticized because of its assumptions, including its consideration of entrepreneurship. Kirzner (1973) accuses orthodox microeconomic theory of a lack of attention to true entrepreneurial behavior. Kirzner demonstrates that this entrepreneurial element arises when the firm manager decides which marginal revenue and marginal cost curves are relevant to the firm.

The assumption of perfect information is one whose relaxation could lead to new implications about pricing behavior. Futhermore, while economists may find it useful to assume that firms behave as if they equate marginal revenue (a constant, given price) with marginal cost, consideration of behavior under uncertainty may require taking steps beyond this maxim. It is interesting to note that of the studies surveyed in Rothschild's article, the one which assumes radically different behavior on the part of market participants is said to "significantly expand the class of models available to economic theorists" (p. 1292n). Thus, while standard economic models may be useful for analyzing long-run market characteristics, the study of decision making under uncertainty may result in models which more closely reflect the actual daily behavior of entrepreneurs.

Salop and Stiglitz have provided a number of articles concerned with equilibrium price dispersion, the bulk of these following Rothschild's survey piece. As summarized by Stiglitz (1977), these articles focus on the role of imperfect information in the market. Under perfect information, there is one price, participants are price takers and markets clear; furthermore, buyers and sellers may exchange any quantity desired at the prevailing price, and there is a competitive equilibrium which is Pareto Optimal. In the studies of markets characterized by imperfect information, however, equilibrium is not at a single price, firms are not price takers, prices are sources of information and the Pareto Optimal competitive equilibrium may be nonexistent. Firms have monopolistic power under these conditions, at least in the short run. These concepts represent fundamental departures from the traditional view of the competitive market.

In the numerous works following Stigler's article (1961), there have been almost as many different approaches to modeling the behavior of buyers and sellers and the resultant nature of the market (particularly equilibrium) under conditions of imperfect information. These differences may arise from either a different source of price dispersion (i.e., exogenous versus endogenous reasons as discussed by Rothschild) or varying assumptions of the models concerning the cost and degree of information, the form of buyers' demand functions, the cost curves of the firms and the oligopolistic competition between firms.

Salop (1976) states that under conditions of imperfect information, monopolistic competition is the relevant market structure. This result is generated with the use of a model entailing two groups of consumers, each with a different level of search costs, who participate in an industry whose firms produce a homogeneous commodity with an increasing marginal cost function. Salop demonstrates that if both groups have zero costs of gathering information, a single price equilibrium (SPE) will occur at the competitive level. If costs are zero for one group only, and if that group represents a "large enough" proportion of total consumers, then the competitive SPE may still be obtained because of externalities imposed on the uninformed by the informed. When both groups have search costs sufficiently greater than zero, then the only SPE possible is the monopoly price; the existence of profits results in the entry of new firms, and profits are driven to zero. When search costs for one group are sufficiently low, a two-price equilibrium (TPE) will occur, with some firms charging the competitive price and the others charging a price no greater than the monopoly price. The high-price firms attract only the unlucky uninformed customers, while the low-price firms attract those who purchase the information (low-cost searchers) and the lucky uninformed consumers. For equilibrium to hold, all firms must make zero profits.

Salop demonstrates that if the model is generalized to many groups of buyers according to search costs, the TPE still occurs because only complete information may be obtained. However, when varying degrees of information may be obtained, there will be a multiple price equilibrium (MPE). Under conditions of low costs of search with little dispersion among consumers, Salop discusses how prices may oscillate between the competitive price and a "limit price" determined with the level of search costs. Salop illustrates how "dynamically captive markets" are an example of such phenomena.

It is important to note that while Salop considers monopolistic competition to be the relevant framework for the examination of markets with less than perfect information, this refers to the behavior of the market participants rather than any equilibrium which may be obtained. Salop assumes that firms maximize their profits by selecting a price given both the prices of the other firms and the search rules of consumers. This implies that the firm acts as a "Nash" competitor with respect to other firms and a "Stackelberg" competitor with respect to buyers. The presence of monopolistic competition may not only allow price discrimination; it may also imply that the effect on price of increased competition may be difficult to ascertain. While prices decrease with entry, so do sample size and hence search costs for the consumer, with an upward effect on prices.

Salop and Stiglitz (1977) examine a model in which consumers must decide whether or not to purchase complete price information. As in other models, it is assumed that consumers know the price distribution but are unaware of the location of these prices. Two groups of buyers are identified, each with differing costs of acquiring information. As in Salop, firms are assumed to maximize their profits given the prices of competitors (Nash) and to use the buyers' search rules in formulating the firm's own price (Stackelberg). At equilibrium, consumers engage in an optimal level of search, and all firms are assumed to have zero profits (no entry). The results of this analysis are similar to those of Salop in that the authors demonstrate the requirements for SPE at the competitive and "no higher than monopoly" price, as well as price dispersion at equilibrium (TPE in this case).

In his article about the "noisy monopolist" (1977), Salop furthers the argument that under certain conditions, costly information leads firms to exploit their market power and price discriminate. This form of price discrimination, however, is somewhat impersonal in that the firm realizes that under certain conditions profits will be greater by simply "allowing" price dispersion rather than by charging a single price. Salop develops a model demonstrating the firm's attempt to use price dispersion as a mechanism to sort buyers into different groups with different demand elasticities; the firms may take advantage of inelastic demand of inefficient consumers, i.e., those who do not search. The analysis may be generalized to other types of "noise" in both the price and quality of the good, such as packaging, random sales and "contrived" product differentiation.

Stiglitz (1977, 1979) considers the use of models of markets with costly information to explain certain phenomena which are assumed away with the traditional perfect competition model: these include price distribution, advertising and the greater degree of competition in markets with a smaller number of large firms versus a larger number of small firms. Furthermore, Stiglitz addresses the paradox of nonexistence of equilibrium in such markets.

Contrary to orthodox theory, costly information implies that monopoly may be superior to perfect competition in a social welfare sense. This argument follows from the notion that monopoly profits are dissipated when search costs are greater than zero (as in Salop). In addition, lower prices and "more effective competition" may result from a reduction in the number of competing firms (i.e., some form of reverse collusion).

Stiglitz outlines the conditions required for price dispersion, such as continual sources of ignorance, different cost functions across firms, imperfectly arbitraged markets and profit functions with equal peaks at various prices. Quality dispersion and product variety further complicate the issue of costly information in market behavior. As discussed by Salop (1977), problems with heterogeneity may be conveniently examined in the same framework as price dispersion.

Salop and Stiglitz (1982) present a simple model demonstrating the effect of sales on equilibrium under costly information. All buyers are assumed to be identical at the outset, to face a known price distribution and to search for the low-priced goods. The consumer purchases for consumption in two periods and must decide whether to purchase two units in the present time period and incur a fixed storage cost or purchase one unit now and incur market entry costs in the second time period. The model is quite basic; however, the results are easily generalized after relaxing certain assumptions. Salop and Stiglitz demonstrate that equilibrium under conditions of imperfect information may be one of price dispersion, or in the case of costs to enter the market initially, equilibrium may not exist, unless the market generates its own "noise."

In this model, thus, firms face a downward-sloping demand curve (due to costly information) which is a function of the prices set by other sellers. Firms maximize profits by setting their own price, and each firm's profits are a function of the distribution of prices. It is shown that with identical firms, nondegenerate dispersion of prices requires that profits be equal for all firms. This is rationalized with two mechanisms: lower-priced stores sell more of the good, and higher-priced stores may incur higher recruitment costs. Furthermore, the variation in prices may be due to different stores charging different prices or to the decisions of each store to randomly hold sales, as discussed by Salop (1977). The authors also state that variation in price may be an analogy to variation in quality; thus, the "price per effective unit" of the good is at issue, as considered by Salop (1977) and Stiglitz (1979).

Buyers, in turn, are subjected to a process of random search for the lowest price. Sometimes they are "lucky" and purchase more than one unit as the lower price offsets the storage costs. The "unlucky" buyer must return to the market in the next time period, incur entry costs and again try his or her luck.

This model differs from others not only in that it explicitly considers sales (which may occur randomly for one firm across time or for some firms at one point in time) but also in that it examines the notion of purchasing in greater quantity than present needs for future consumption when the buyer locates a price sufficiently low to offset storage costs. The same conclusion remains, however, as in the previous studies, that competition under conditions of costly information may not always have positive social effects, as firms exploit their monopoly power.

A recent article by Carlson and McAfee (1983) examines pricing and output decisions by firms in a market characterized by price dispersion. A model is constructed which exhibits price dispersion (which is persistent) caused by differences in marginal cost curves across firms, although the authors agree that there are certainly other causes of price dispersion which may, in the future, be incorporated into such models. One feature of this model, which appears in several other studies, is that buyers are aware of the array of prices and must search (subject to cost limits) for the best price. Most importantly, however, sellers are aware of the buyers' searching activity and take this into consideration in making their profit-maximizing decision. Significant results from Carlson and McAfee's study include the finding that in equilibrium the demand for an individual seller's output is a linear function of the difference between this firm's price and the average price of all other firms. The study also demonstrates that the profit-maximizing price to be set by the i^{th} firm is a function of that firm's costs, the number of firms, and certain factors reflecting buyers' awareness of the price distribution, as well as sellers' realization of buyers' reactions to the distribution. Results of this theoretical treatment of price-searching behavior yielded evidence that lower-cost firms tend to set lower prices, have a greater quantity demanded and generate higher profits. This study provided a model permitting comparative statics predictions, such as the impact of the imposition of a tax, a change in costs or a change in the number of firms.

Carlson and McAfee's contention that cost differences across firms are necessary for price dispersion to persist may be questionable. In their model, as in others, consumers use a sequential search strategy. These buyers are assumed to have a correct perception of the distribution of prices; their "searching" is to determine which firm charges which price. In a sequential search, if the firm charging the j^{th} highest price maintains that ranking in the next time period's array of prices, then a sequential search implies consumers can eventually know each firm's ranking. The higher-priced firms thus have an incentive to lower their price. The authors feel that cost differences must exist to avoid dissipation of price dispersion. In addition, some rationale must be developed, as is done, for the higher-priced firms to continue attracting at least some customers. However, if firms are not restricted to keep the same ranking (via cost curves or any other factor), price dispersion can still be maintained. In each time period, costs may change for any firm, and there may be information differences across sellers. The price dispersion is maintained and buyers have little or no means of accumulating information about the ranking of firms by price.

Another article on equilibrium price dispersion by Burdett and Judd (1983) demonstrates that such phenomena may occur when there is no ex ante heterogeneity in buyers or sellers. Equilibrium price dispersion in this analysis thus does not depend upon different cost functions for firms, as in Carlson and McAfee, nor do search costs and behavior need to vary across buyers. The sole stipulation is that ex post information levels vary across buyers, for whatever reason. The authors used a "box" demand function with a reservation price and unit purchase, demonstrating that when firms maximize their profits (and are aware of customers' search strategies) and buyers search rationally (with full knowledge of the price distribution), price dispersion may exist at long-run equilibrium with nonsequential and noisy sequential search.

An interesting point advanced by Burdett and Judd is that the previous literature did not explain why different firms charged different prices. This is curious, since Stigler (1961), who is quoted in the article, did provide in his seminal paper numerous reasons prices differ beyond the degree of "homogeneity of transactions." Kawasaki et al. argued that because of conditions of less than perfect information, individual firms faced downward-sloping and unknown demand curves and thus had some control over the prices they receive. Carlson and McAfee demonstrated that unequal cost curves could lead to differing prices, although Burdett and Judd's model did not consider this a requirement for price dispersion. Thus, it is reasonable to state that, in fact, previous studies did consider the reasons prices differ across firms. Indeed, Burdett and Judd demonstrate that profit maximization leads to such dispersion of prices, although there is some sort of "chicken and egg" paradox here, since they begin by assuming that the dispersion exists and trace market participants' reactions to such conditions.

It should be noted that the majority of papers considering price-searching behavior of buyers and sellers analyze such activities explicitly at the retail level (e.g., Stigler, Burdett and Judd, Carlson and McAfee). The focus of the present study is wholesale market transactions, rather than retail. Thus, certain phenomena attributed to consumers facing a dispersion of prices must be characterized in terms of buyers at the wholesale level. Instead of considering that a consumer checks newspaper and other advertisements, in this context the buyer may be gathering price information through canvassing various sellers (by phone, telex, letter, etc.) or obtaining information on prices recently charged by sellers (through fellow buyers, for example). The concept of telephone inquiries was used in the study of the securities market by Garbade et al. (1979).

Firm Optimization

Garbade, Pomrenze and Silber consider the quality of information gleaned by entrepreneurs from the prices of their competitors in their article "On the Information Content of Prices" (1979). Their work represents an attempt to provide an empirical investigation into some of the ideas advanced in an earlier study by Grossman and Stiglitz (1976). The authors state that the supply and demand schedules of an individual dealer (reflecting, it is assumed, the marginal revenue and cost curves) are to some extent a function of those of his rivals. They argue that entrepreneurs make their pricing decisions based on their own information as well as information from other firms, notably their prices. In an empirical study of transactions in securities, a market in which dealers are not continually in contact with each other, it is found that dealers do use the information gained from observing the prices of their rivals. However, dealers do not completely ignore their own information, such as the quantities and prices of their own previous transactions.

The authors also demonstrate that the extent to which the observed prices influence the entrepreneur's revision of his or her own price is a negative function of the dispersion of those prices the entrepreneur observes. In other words, a wider dispersion reflects the "lower quality" of such a set of prices as compared to a set with smaller variance. It is apparently assumed that the variance of the observed prices is simply a reflection of conditions of less than perfect information. It is also demonstrated that the greater the number of quotes in a set of observed prices, the greater is the influence of such prices on the dealer's estimation of his or her optimal price.

What is accomplished in this research, thus, is a demonstration that firms set their own prices according to their own evaluations of where their particular marginal revenue and marginal cost curves lie and revise their estimates with the information gained from other firms' prices. The other firms' prices likewise should reflect their assessment of where their own marginal revenue and cost curves lie. If the firm is using other firms' prices to revise its estimate, it must be to revise its notion of where marginal revenue, rather than marginal cost, lies. Although cost curves may be subject to various uncertainties, it certainly seems unlikely that a different price offered by another dealer implies that the dealer has miscalculated his or her own costs.[5]

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[5] However, if the high-cost dealer continues to observe that his or her price is higher than that of other firms, the dealer may consider the possibility that he or she is using less efficient production techniques or is not aware of sources of lower-cost inputs.

Consider the case of two dealers facing the same revenue curves, but with one dealer having lower costs than the other. In this situation, how does the lower price of the one dealer affect the price of the high-cost dealer? The high-cost dealer may assume that demand (hence marginal revenue) has been overestimated and thus may shift the estimate of the marginal revenue curve leftward and charge a lower price. The lower-price dealer conversely may feel he or she has underestimated demand, and thus may revise the price upward. The result of this confusing testimony is that it may still be contended that firms act as profit maximizers, demonstrated with the convenience of equating marginal revenue and marginal cost. Under conditions of uncertainty, however, marginal revenue may be subject to considerable and continual reappraisal. One source of information for the positioning of a firm's marginal revenue curve is the observation of prices of rival sellers.[6]

There is a very curious aspect about several of the studies in the area of price dispersion. In the perfect competition model, firms act as price takers, and thus, in a sense, the only decisions they need to make are how much will be produced, and with what combination of inputs. Thus, equalization of marginal revenue, which is market price, and marginal cost yields the profit-maximizing level of the quantity to be produced. There is little discussion, in the research to date, of what happens to the level of quantity produced (or sold) when considering the shifting and elusive nature of marginal cost and revenue curves under conditions of uncertainty.[7] The focus always seems to be on price, as we consider price-searching behavior, the dispersion of prices and the informational content of rivals' prices.[8]

When the price charged by a dealer rises, this may be due to three possibilities, each with its own consequence for the level of quantity produced and sold (see Figure 1):

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[6] In addition to the information given by other firms' prices, the firm which charges a price far from the industry mean price will also observe the impact of this upon the level of sales. This "demand reaction," i.e., too many or too few customers, is apparently assumed to be incorporated into what the authors call "the firm's own information."

[7] Or, at most, the price is determined and the quantity sold is left up to the market, i.e., to the buyers.

[8] Some studies have operated under assumptions such as "each consumer purchases one unit of the commodity per time period" and thus the "determination" of optimal quantity simply becomes the number of buyers attracted by the dealer (e.g., Burdett and Judd, 1983).

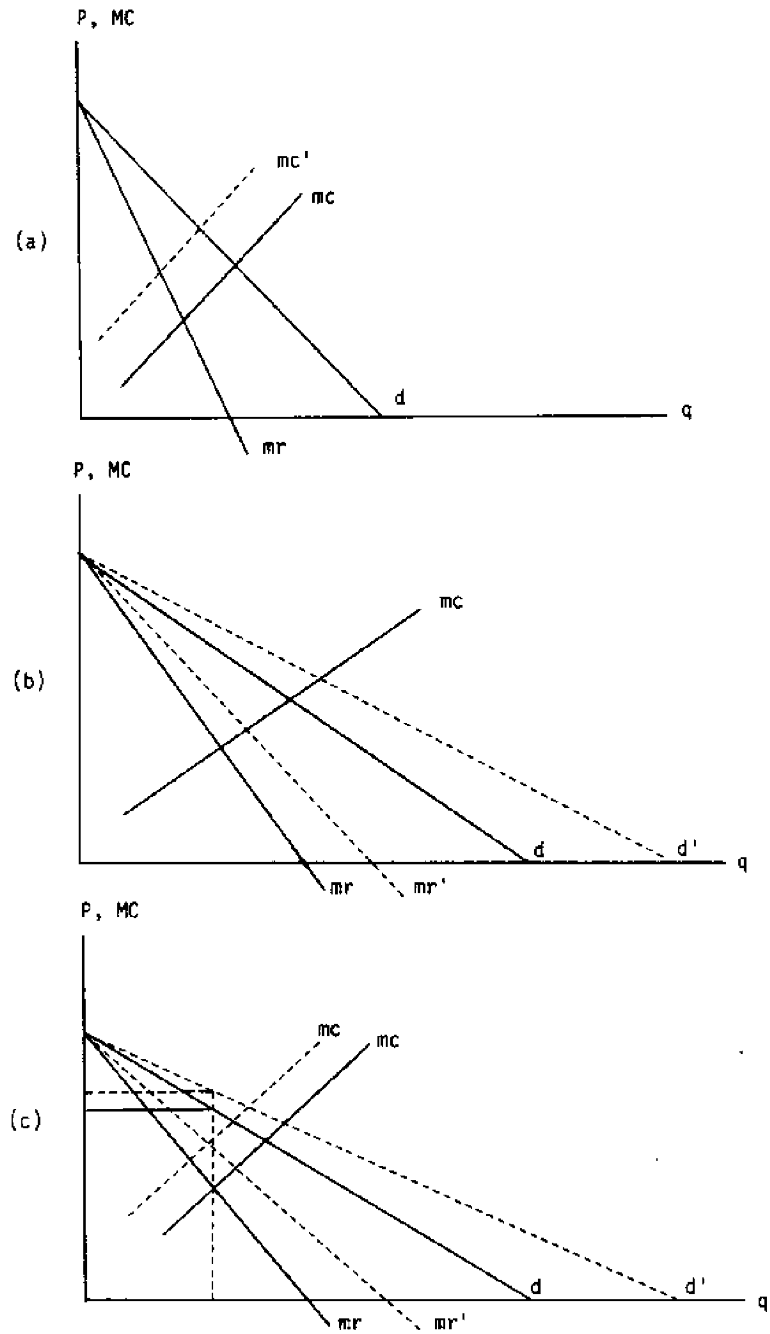

Figure 1. Impact of Changed Estimates of a Firm's Demand and Marginal Cost Curves

(a) marginal cost rises, quantity falls

(b) marginal revenue rises, quantity rises[9]

(c) both marginal revenue and marginal costs rise; quantity may rise, fall or remain constant.

The preoccupation with the changes in price has left the impact on quantity "out in the cold." One possible consequence of this omission is that, in the absence of a price change, it may be assumed that the marginal revenue and cost curves are fixed or unchanged. This is not necessarily the case, however, as is demonstrated in Figure 2. Perhaps a more serious consequence of ignoring the quantity decisions is that we have left out at least half of the role played by the entrepreneur: deciding how much of a good is to be produced.

The individual firm's determination of the optimal level of quantity to produce is not ignored in an article by Kawasaki, McMillan and Zimmermann entitled "Disequilibrium Dynamics: An Empirical Study" (1982). The authors of this study attempt to gain insights into the process of reaching equilibrium by observing the decision-making behavior of firms faced with disequilibrium conditions. It is assumed that because of imperfect information, sellers face an uncertain and negatively sloped demand curve, and thus can, to a certain extent, influence the price they receive. What is most unique about this study is that it is shown that firms use information gained through their levels of inventory and unfilled orders to adjust their choices of optimal price and output levels. Thus, while previous studies may have assumed that firms are changing their price and output levels in response to perceived shifts in marginal revenue or marginal cost curves, this study sees inventories and unfilled orders as important indicators to the firm that price or output levels should be revised. In essence, however, the two techniques are the same. If the marginal revenue and marginal cost curves are assumed to be uncertain, then the firm is continually revising its perception of where these curves lie by incorporating the information gleaned from various indicators. These can include the prices of other sellers (as in Garbade et al.) or the level of inventories and unfilled orders.[10] A low inventory could indicate that the seller has underestimated demand, and thus underestimated price, and ended up with sales that were "suspiciously high." Under Garbade's technique, this would be exhibited by a firm's

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[9] Note that in certain cases demand can increase with no resultant increase in price.

[10] Other possibilities are profit levels, the number of new customers or the loss of old customers. It should be noted that Winter's study (as discussed in Rothschild) perhaps also uses "utilization rate" and "profit per unit of capacity" as indicators, rather than as factors to optimize.

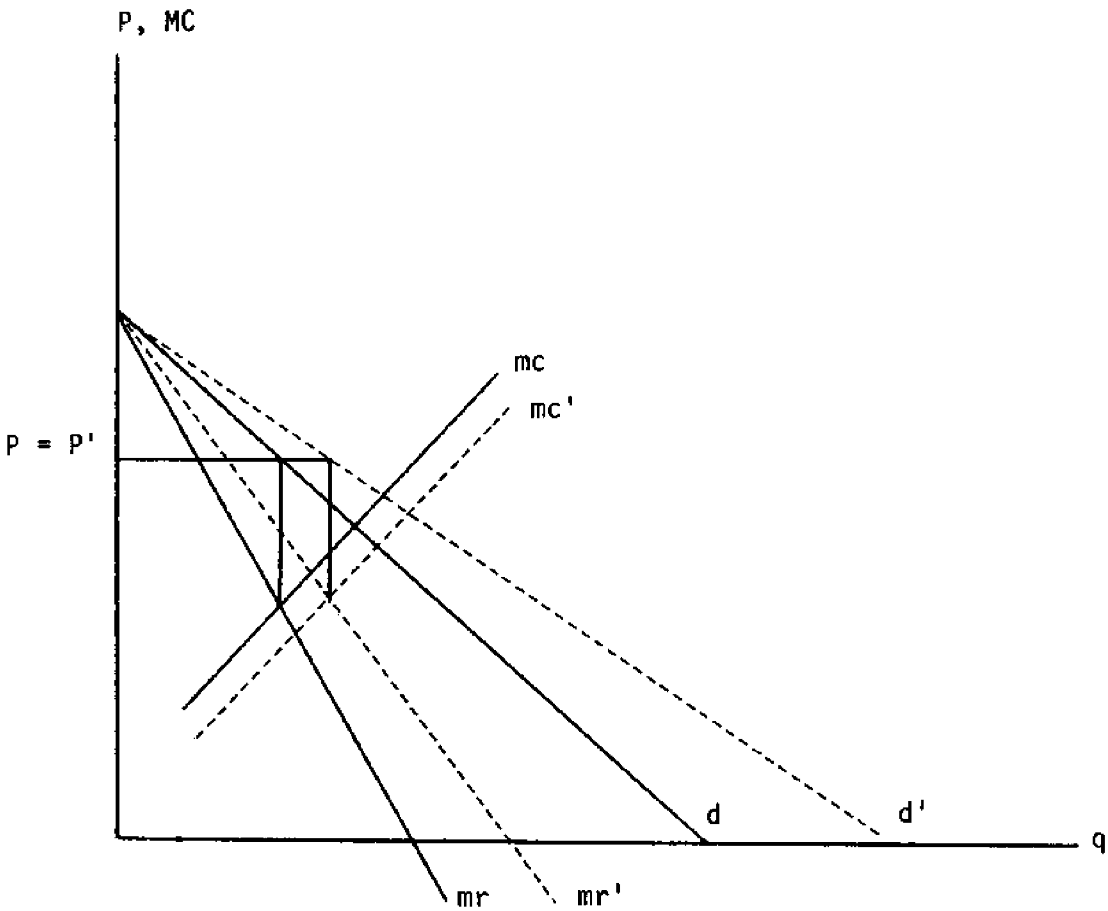

Figure 2. Shift in d and mc Change Optimal Output, Price Unaffected

price being considerably below the mean price of the industry. An interesting conclusion of Kawasaki et al.'s empirical study is that, in the short run, quantities are more flexible than prices in responding to disequilibrium conditions.

Disequilibrium Markets

A related topic in the literature is that of disequilibrium markets. According to Ziemer and White (1982), disequilibrium implies that transactions take place at a nonmarket clearing price, such that some sellers or buyers are unable, at that price, to sell or buy their optimal level of quantity. In these situations, as demonstrated in Figure 3, the "short side of the market dictates" the quantity of goods exchanged. The crucial point in disequilibrium analysis is that in the markets for certain goods the prices observed may not be those at which demand equals supply. As pointed out by the authors, characteristics of a product such as perishability, seasonal trends, production cycles, weather variations and government intervention, as well as ignorance on the part of market participants as to the true equilibrium price, may be indicative of a market which is often, if not nearly always, in disequilibrium.

A discussion of how these characteristics apply to the seafood market appears in an article by Bockstael (1982). It is certainly straightforward that the market for seafood products (particularly fresh) is affected by perishability, institutional constraints, seasonality, the vagaries of weather and biological stock conditions. In addition, Bockstael argues that in the face of disequilibrium, seafood prices may not be immediately or fully responsive, because of forward contracting (particularly in international trade), search costs or transactions costs.

Both of these studies in disequilibrium modeling demonstrate the potential danger of estimating an equilibrium model when in fact the market is in disequilibrium. In the field of fisheries, as pointed out by Bockstael, the results of economic studies may often be directly used in formulating management policy; thus, there is an even greater incentive to estimate the most accurate model possible.

An important point advanced by Ziemer and White is that market concentration on either side of the market may result in certain participants having "informational advantages," such as obtaining (and responding to) information before others. When the response to disequilibrium, in terms of quantities and prices, is inflexible, these differences in information may cause prices to move away from the competitive equilibrium levels.

In the model presented by Ziemer and White, a Walrasian price adjustment mechanism is introduced; this equation represents the impact upon price of a divergence between demand and supply. This seems logical, although it is curious to note that this equation was

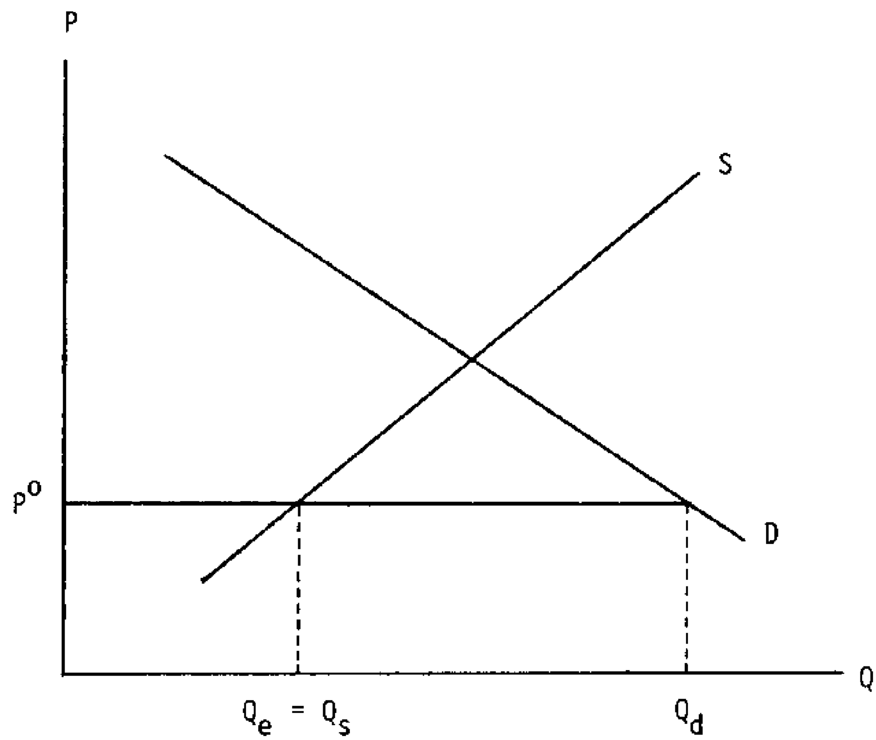

Figure 3. Disequilibrium Market

introduced in order to "describe the nature of buyer and seller behavior in periods when markets do not clear." This statement seems to imply that buyers and sellers are playing a role in "moving" the price towards equilibrium, which counteracts the "price taker" nature of most competitive market models. However, if the statement is taken in the context of Arrow's 1959 article, it appears that Ziemer and White are only furthering the argument that when a market is in disequilibrium, buyers and sellers are price searchers. This may seem a trivial point to emphasize in an article with a good deal more to it; however, this point seems to provide a link between disequilibrium at the market level and decision making by buyers and sellers at the firm level. This link is treated explicitly in Arrow's article; however, it seems to be implicitly understood in the disequilibrium markets studies discussed here.

Conclusions: Literature Review

Focusing on the individual market participant, previous studies attempt to formulate models representing the decision making of buyers and sellers under uncertainty and market disequilibrium. For sellers, the basic concept is that the demand curve is somewhat downward-sloping and unknown; the seller must make educated guesses as to the optimal price and output, based on factors such as costs, prices of other sellers, the price-searching behavior of buyers and the firm's own information, such as its previous transactions, inventory levels and level of unfilled orders. The buyers are characterized as price searchers, sampling and comparing prices of sellers, subject to some limit to expenditures on search.

The entire process appears to be subject to both rational and random elements. For example, firms still attempt to maximize profits, and buyers try to purchase at the lowest price. However, the firm manager must operate with a perceived demand curve and, under certain conditions, may never make a correct estimate, particularly if the curve is continually shifting, and thus knowledge gained in a previous time period is useless for current period decisions. The very action of sampling by buyers implies a persistent element of randomness in their search for the lowest price. Thus, the economist concerned with observing and attempting to understand the daily workings of a market may face all the risks and dynamics of the entrepreneur's environment.

CHAPTER III

PACIFIC SALMON: PRODUCTION AND MARKETS

The major producers of Pacific salmon are the U.S., Canada, the U.S.S.R. and Japan (see Table 1). The imposition of both the abstension line and the U.S. and Canadian 200 mile Fishery Conservation Zones (FCZ's) resulted in a significant shift in the share of salmon harvested in each country, and, consequently, trade flows were affected. The salmon landed in these countries are marketed worldwide and in a variety of product forms: fresh, frozen, canned, smoked, and so on.

The U.S. Fishery

The fishery for U.S. Pacific salmon, one of the highest-valued species produced, is located on the coasts and inland waters of Alaska, Washington, Oregon and northern California. Five species are harvested in the U.S.: chinook, coho, sockeye, chum and pink. Trolling and seining are used in the ocean for harvesting salmon, while the river fishery relies on gillnetting. Pacific salmon are marketed in many countries of the world and in various product forms. Often the salmon are imported by a nonproducing country (or region), processed and re-exported. There may also be some trading between producing countries. Figure 4 demonstrates the marketing channels possible for U.S. salmon. This section examines some of the domestic and overseas markets for U.S. Pacific salmon.

Before undertaking this discussion, it may be useful to consider the importance of the various types of salmon products. Pacific salmon from the U.S. are distinguished along several dimensions in their fresh and frozen form:

1) Species: chinook, coho, sockeye, chum or pink. Coloring and oil content vary across species.

2) Size of individual fish: e.g., 2/4 lb. coho (2 to 4 lb.) vs. 6/9 lb. coho (6 to 9 lb.). Smaller fish tend to have different markets than larger fish.

3) Gear type: troll, seine or gillnet. Troll-caught fish are considered to be higher quality than gillnet fish because (i) troll-caught fish are generally in better condition than gillnets since they are harvested on a hook and line, not in a net where bruising and other damage may occur; (ii) troll-caught fish are usually cleaned or iced on the fishing boat; and (iii) gillnet fish are harvested during the "spawning phase" of the salmon when the meat may be of lower quality.

Table 1. Landings of Pacific Salmon, by Country and Species, 1974-80.

		Salmon Catch 1974-1980 (metric tons)						
		1974	1975	1976	1977	1978	1979	1980
USA:	Chinook	12,844	14,176	15,564	14,822	13,507	14,972	12,942
	Silver	19,010	12,710	18,003	13,604	13,901	18,039	17,813
	Sockeye	22,125	23,734	37,721	40,793	44,773	86,513	94,145
	Chum	19,227	15,330	23,880	26,036	22,900	20,768	38,518
	Pink	18,182	25,492	45,014	56,992	88,394	102,889	115,005
	TOTAL	91,388	91,442	140,272	152,247	183,475	243,181	278,423
Canada:	Chinook	7,637	7,289	7,776	7,522	7,887	6,845	6,540
	Silver	10,378	7,737	9,322	9,857	9,152	10,342	9,025
	Sockeye	21,694	5,681	12,339	17,388	22,321	14,532	7,727
	Chum	12,479	5,389	10,922	6,032	15,855	4,751	16,809
	Pink	11,207	10,239	17,056	24,723	15,331	24,696	13,718
	TOTAL	63,395	36,335	57,415	65,522	70,546	61,166	53,819
Japan:	Chinook	1,867	1,115	1,604	908	1,075	1,227	2,484
	Silver	9,713	8,161	7,697	3,757	5,755	2,708	3,634
	Sockeye	8,155	7,733	8,844	4,499	5,170	5,399	5,959
	Chum	80,146	99,485	78,417	71,931	74,089	101,466	96,920
	Pink	32,537	45,936	29,629	35,264	17,176	24,060	20,101
	Cherry (Masu)	3,101	3,871	3,814	3,822	3,600	2,669	2,779
	TOTAL	135,519	166,301	130,005	120,181	106,865	137,529	131,877
USSR:	Chinook	1,800	2,229	1,956	3,099	2,948	2,408	1,057
	Silver	3,900	3,310	3,556	4,009	2,384	4,060	2,486
	Sockeye	1,000	1,399	1,170	1,869	3,382	2,884	3,888
	Chum	9,200	7,691	10,015	14,678	16,669	23,191	14,556
	Pink	32,100	88,415	53,748	107,496	53,413	97,913	77,367
	TOTAL	48,000	103,044	70,445	131,151	78,796	130,456	99,354
	WORLD TOTAL	338,302	397,122	398,137	469,101	439,682	572,332	563,473

Source: Food and Agriculture Organization, United Nations 1980 Yearbook of Fishery Statistics: Catches and Landings. Various volumes.

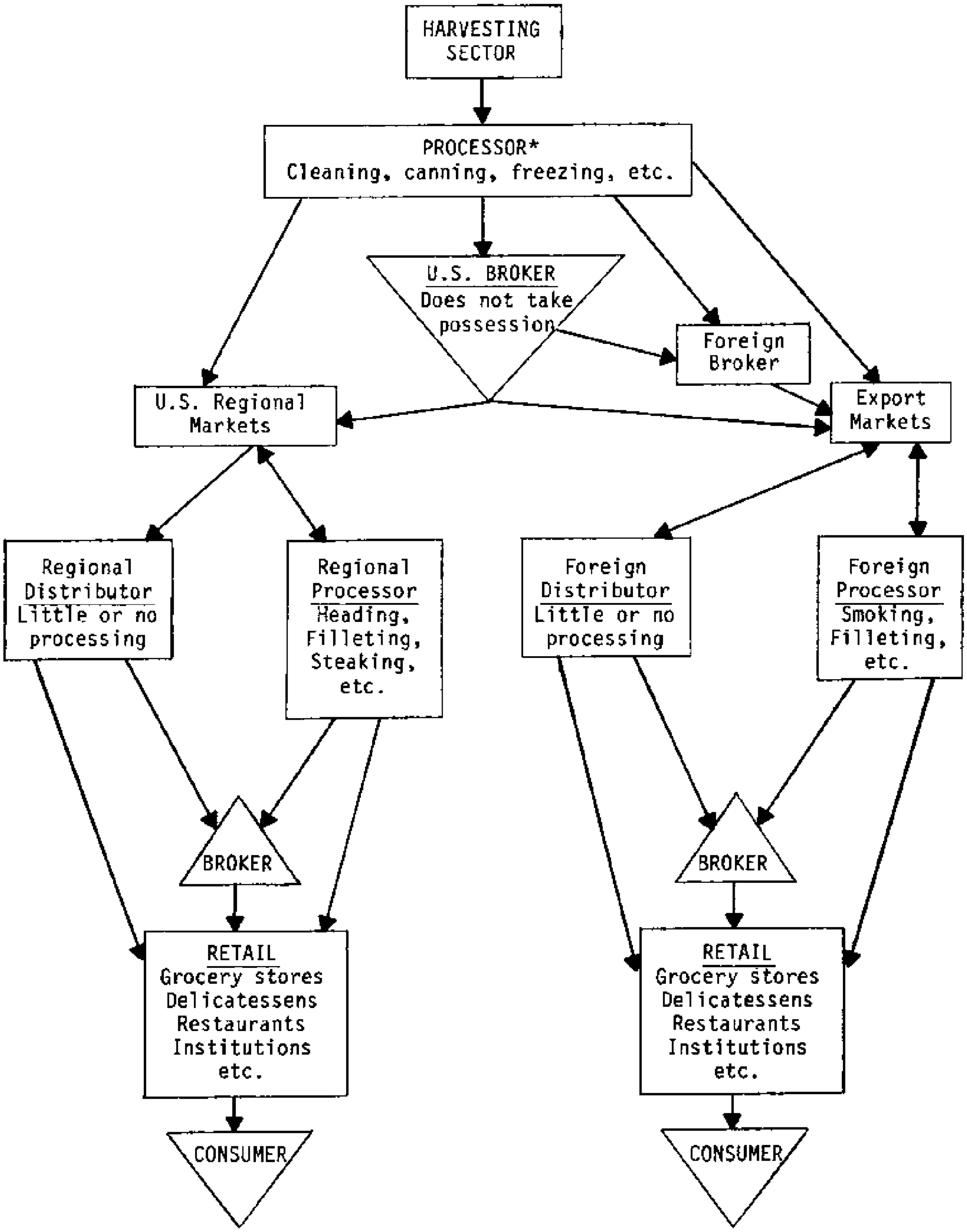

Figure 4. Marketing Channels of U.S. Pacific Salmon

4) Geographical origin of the fish, e.g., "Yakutat chinook" vs. chinook from Oregon.

5) Some processors keep records which enable them to distinguish between salmon from a "day boat" and salmon from a "trip boat," or salmon from a vessel whose operator is known to handle the fish better than other fishermen. The distinction may be profitable inasmuch as the processor or wholesaler may demand a higher price for the higher quality, better-handled fish.

Although these distinctions are important in the salmon wholesale market, the consumer may not realize what type of salmon he or she is purchasing at a grocery store or at a restaurant. Where in the market chain does the fish lose its identity? Consumers are interested in product quality, at least in terms of freshness and lack of bruises; however, species, gear type and origin of the salmon may not be important to most consumers. Wholesale buyers, such as buyers for a supermarket chain, may purchase only certain "types" of salmon because in that way they can be assured of relatively consistent quality. Thus, the presence of many varieties of Pacific salmon presents an interesting complication in examining its market.

Domestic Markets for Pacific Salmon

The bulk of the U.S. canned Pacific salmon pack is sold in domestic markets: 71 percent of the 1981 pack was consumed or stored domestically (Earley et al., 1982). U.S. consumers capture a much smaller share of the fresh, frozen and cured salmon market: less than 32 percent of the total production in 1981 (Earley et al., 1982). Over the past decade, per capita consumption of canned salmon in the U.S. has fluctuated, with 1981 levels below those of 1970. A number of reasons for this decline have been suggested.

1) Increased consumer preference for fresh and frozen fishery products has led to an increased demand for fresh and frozen Pacific salmon which "bids" the fish away from the canning market.

2) Canned tuna competes with canned salmon and thus limits salmon demand.

3) Canning costs, such as labor and materials, have increased considerably.

4) Technological improvements have lowered the costs of storing and transporting frozen seafood products.

In contrast, domestic consumption of fresh, frozen and cured Pacific salmon has been increasing, primarily because of increased supply (hence lower prices). A large share of fresh and frozen salmon sold in the U.S. is consumed in restaurants, and as real per capita income rises in the U.S., more meals are consumed away from home. The species and gear type of salmon purchased by restaurants is generally related to the type of establishment. The higher-class, "white tablecloth" restaurants may tend to purchase more troll-caught salmon, chinook or coho, while less expensive, family-type establishments may purchase other species and gillnet salmon. There has also been an increase in the U.S. in the availability of fresh and frozen salmon in supermarkets and other retail outlets. Again, the species and gear type will vary; however, the smaller-sized fish are generally more popular for sales of whole or half fish. Some restaurants or stores may switch from troll to gillnet fish or from, say, chinook to sockeye solely because they insist on offering fresh salmon rather than frozen. Thus, a myriad of factors underlies wholesalers' choice of type of Pacific salmon. The smoking markets are important in the U.S., particularly in the Los Angeles, Chicago and New York areas. Large, troll-caught chinooks and cohos are the favored species in the smoking trade; large sizes result in less handling per pound of product, while a troll-caught fish will show fewer bruises when processed. However, in this market as well as others, there has been substitution of lower-priced species and net-caught salmon.

Overseas Markets for Pacific Salmon

U.S. exports of fresh and frozen salmon have increased dramatically over the past two decades (see Table 2). In 1981, 29 percent of the canned and nearly 70 percent of the fresh and frozen salmon pack were exported (Earley et al., 1982). Thus, foreign demand for Pacific salmon is of great importance to the U.S. industry. Major importing countries include Japan, various countries of the European Economic Community (EEC) and Canada.

In examining foreign markets for Pacific salmon, it is important to consider what factors affect the demand for salmon overseas. As in domestic markets, income (see Table 3) and prices of substitutes have a direct effect on demand. In the case of foreign demand, however, previous studies (Bell et al., 1978; Lent et al., 1981) demonstrate that new variables, such as the following, come into play.

1) Exchange rates. A recent surge in the value of the U.S. dollar has made Pacific salmon more expensive overseas, thus dampening foreign demand (see Table 4).

2) Tariff and nontariff barriers to trade. Table 5 presents EEC and Japanese import tariffs on fresh and frozen salmon. A reference price on salmon imports was recently proposed by the EEC. U.S. agencies succeeded in blocking the measure, recognizing its potential for harming the U.S. salmon industry. Embargoes have also had detrimental effects on the industry.

Table 2A. U.S. Exports of Salmon: Fresh, Chilled and Frozen.

Year	Total		France		Sweden		Denmark		West Germany		Belgium		Japan		Canada		U.K.	
	Q*	V*	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
1960	2,849	1,677	747	485	14	8	1	1	1	1	210	139	855	457	654	369	243	150
1961	1,094	647	329	203	6	4	1	1	25	14	72	51	00	0	390	192	208	141
1962	1,508	871	584	359	20	12	0	0	15	13	119	89	0	0	433	197	244	138
1963	4,888	2,530	1,549	803	24	14	52	30	136	83	192	128	4	1	1,252	582	1,478	777
1964	22,560	5,371	2,298	1,290	169	79	65	41	34	21	184	113	16,007	1,947	1,364	547	2,139	1,178
1965	10,559	5,330	2,612	1,449	833	430	73	41	170	81	393	253	1,327	587	2,460	997	2,287	1,209
1966	19,845	10,626	4,782	2,978	1,634	888	408	204	327	225	524	358	2,468	920	3,779	1,428	5,136	3,168
1967	18,911	11,846	5,216	3,724	1,621	889	171	105	443	332	667	514	2,218	885	2,527	1,275	4,635	3,180
1968	16,234	10,076	4,031	3,095	1,806	931	53	35	196	176	671	511	2,902	1,130	1,255	631	4,360	2,911
1969	30,553	19,060	4,370	3,635	2,367	1,387	443	177	444	415	780	639	14,137	7,345	2,567	1,403	3,997	2,835
1970	28,201	18,145	5,605	4,946	3,012	1,869	698	236	401	369	1,113	820	7,676	3,826	4,361	1,940	4,221	3,328
1971	32,891	21,258	6,955	5,065	3,389	2,057	456	298	536	450	1,152	961	9,492	4,961	3,983	2,433	4,872	3,542
1972	34,685	28,451	10,608	10,065	6,302	4,703	545	445	770	680	1,502	1,371	3,485	1,728	2,697	1,664	6,232	5,666
1973	60,742	59,641	9,477	9,799	4,106	4,067	911	827	1,257	987	2,412	2,459	27,567	26,776	4,664	4,070	6,603	7,676
1974	28,067	34,924	7,289	10,043	4,278	4,690	600	720	905	1,414	1,970	2,665	4,206	4,885	3,237	3,347	3,547	4,073
1975	48,229	66,863	15,243	22,328	5,267	6,572	1,643	2,069	1,795	2,967	2,433	3,679	10,148	14,085	2,880	3,512	6,006	7,202
1976	41,921	75,645	15,054	29,352	4,019	6,334	1,788	2,741	1,714	3,859	2,633	5,369	5,147	8,535	2,778	4,061	5,555	8,684
1977	69,844	125,396	14,050	30,374	4,121	6,068	1,772	2,827	1,870	4,412	1,949	4,283	33,663	60,593	5,846	5,854	3,784	5,372
1978	125,771	276,257	12,535	31,844	4,170	6,488	976	1,754	2,244	5,610	1,770	4,340	89,806	201,989	3,948	5,065	6,106	10,226
1979	144,365	311,594	17,886	50,989	6,151	9,670	1,443	2,909	2,985	8,595	2,841	8,404	95,278	195,545	7,231	10,544	6,602	14,050
1980	125,465	207,071	14,640	32,976	5,162	8,269	1,294	2,448	2,285	6,192	2,591	5,935	67,626	106,513	20,151	21,730	5,927	10,325
1981	204,130	374,326	18,689	41,700	4,062	6,051	1,690	2,855	1,183	2,719	2,587	5,941	131,332	253,330	24,780	26,273	8,973	14,446

*Units: Q = thsd. pounds
V = thsd. $ U.S.

Source: U.S. Department of Commerce

Table 2B. U.S. Exports of Salmon: Canned.

Year	Total		Netherlands		Belgium-Luxembourg		Japan		France		U.K.	
	Q*	V*	Q	V	Q	V	Q	V	Q	V	Q	V
1960	11,923,969	9,829,813	545,462	397,749	133,388	104,947	1,562	706	23,501	19,400	8,294,414	7,056,916
1961	7,185,705	5,580,264	718,037	518,203	59,566	48,131	600	270	0	0	3,907,994	3,055,803
1962	8,978,323	7,292,239	498,023	349,226	84,692	58,176	0	0	9,832	4,412	6,575,571	5,621,589
1963	10,228,001	8,238,970	551,178	397,371	67,130	47,073	0	0	86,671	50,901	6,858,746	6,006,268
1964	20,923,807	14,851,598	3,363,444	1,242,549	1,484,253	637,500	0	0	294,937	145,220	14,794,852	11,558,669
1965	24,892,169	15,916,426	2,821,930	1,681,237	1,384,007	751,035	0	0	430,798	205,455	16,550,967	10,842,937
1966	20,483,682	14,561,041	1,320,032	922,773	640,049	406,242	0	0	157,804	113,671	14,358,031	10,371,446
1967	20,543,340	15,592,579	1,611,998	1,091,020	480,930	296,058	64,428	84,870	23,820	19,863	16,324,914	12,700,570
1968	5,725,748	4,603,823	1,121,790	803,168	66,732	37,959	0	0	89,190	43,489	3,305,063	2,838,667
1969	15,536,243	11,565,262	1,808,910	1,331,375	993,505	651,957	0	0	0	0	8,122,832	6,383,065
1970	16,811,470	13,134,409	1,671,380	1,334,708	769,654	486,777	15,370	19,948	158,109	148,506	8,398,908	6,864,582
1971	18,232,465	15,928,687	1,964,168	1,605,945	307,354	225,652	209,750	315,867	147,150	115,886	10,364,033	9,513,346
1972	21,358,167	20,898,479	1,387,335	1,417,921	96,547	81,952	511,886	273,717	118,137	119,417	15,831,708	15,673,959
1973	16,941,233	26,812,872	1,040,971	1,737,636	316,347	438,098	225,299	255,378	15,464	21,572	13,463,767	21,559,372
1974	8,319,707	13,257,882	412,857	662,120	463,381	627,859	44,406	155,660	0	0	5,327,896	8,308,407
1975	22,504,320	34,552,270	1,708,804	2,607,527	1,161,341	1,743,955	137,211	160,989	212,143	327,186	13,894,902	22,386,650
1976	19,588,270	33,865,349	2,405,529	4,131,727	1,344,563	1,973,108	200,798	321,074	148,647	363,201	9,352,985	17,184,107
1977	21,274,644	34,031,122	2,537,321	4,191,550	1,189,505	1,654,710	716,681	1,453,015	554,965	1,135,689	8,173,957	13,138,971
1978	32,513,117	49,239,691	4,997,657	7,217,717	1,953,644	2,681,637	1,505,265	2,587,669	881,597	1,092,624	9,839,885	16,882,190
1979	50,718,755	91,917,000	5,720,109	9,707,000	3,360,237	4,694,000	3,077,713	5,512,000	570,961	1,199,000	18,296,090	37,573,000
1980	74,006,000	149,971,000	7,354,000	14,183,000	4,465,000	7,448,000	527,000	1,163,000	454,167	2,333,000	33,012,000	72,588,000
1981	63,494,000	128,616,000	4,865,000	9,345,000	2,972,000	5,043,000	1,241,000	2,673,000	656,052	1,125,985	30,084,000	64,192,000

*Units: Q = pounds
V = $ U.S.

Source: U.S. Department of Commerce.

Table 3. National Income, 1946-81.

Year	U.S. U.S. $ bil.	Canada Can. $ mil.	France F. Francs bil.	U.K. £ mil.	W. Germany D. Marks bil.	Japan Yen bil.	Denmark Kroner mil.	Belgium B. Francs bil.	Sweden Kroner mil.	Italy Lire bil.	Netherlands Guilders mil.
1946	180.3	9,821	25.96	8,662	0	387	13,260	190.6	21,790	0	9,326
1947	198.7	10,985	33.03	9,250	0	1,041	14,580	214.5	23,530	5,178	1,250
1948	223.5	12,560	54.30	10,216	29.9	2,124	15,809	243.9	26,380	5,943	12,887
1949	216.3	13,194	65.39	10,926	63.1	2,884	16,678	249.1	27,220	6,093	14,112
1950	240.6	14,550	71.17	11,515	71.5	3,684	18,854	265.0	29,210	6,619	15,624
1951	278.5	16,555	91.7	11,757	90.3	4,348	19,517	313.1	32,827	7,924	16,969
1952	291.6	18,623	106.7	12,707	102.8	4,959	20,816	320.5	36,180	8,394	17,739
1953	304.5	19,267	111.6	13,604	110.6	5,647	22,014	331.9	36,453	9,410	19,146
1954	300.3	19,002	119.0	14,535	119.7	5,984	22,733	347.2	38,776	9,931	21,606
1955	328.4	20,690	129.2	15,361	137.5	6,528	23,334	367.4	41,523	10,859	24,565
1956	348.6	23,118	143.3	16,746	152.1	7,352	24,892	390.8	44,895	11,614	26,510
1957	364.4	23,950	159.6	17,675	165.8	8,201	26,412	411.4	48,284	12,514	29,045
1958	364.7	24,919	180.0	18,413	177.5	8,341	27,515	413.8	50,195	13,468	29,614
1959	396.5	26,628	193.4	19,163	192.2	9,631	30,429	424.2	53,006	14,338	31,700
1960	417.0	27,400	231.0	20,900	236.0	12,816	33,100	458.0	60,800	17,506	35,100
1961	430.0	28,200	251.0	22,400	258.0	15,156	36,900	481.0	66,400	19,446	37,000
1962	461.0	30,600	280.0	23,400	277.0	17,348	41,300	515.0	71,200	21,958	39,600
1963	458.0	30,800	312.0	25,000	296.0	19,900	43,200	553.0	77,200	25,215	43,100
1964	522.0	32,800	343.0	26,900	324.0	22,752	49,500	622.0	86,100	27,591	51,100
1965	568.0	35,300	368.0	28,700	355.0	25,430	55,300	677.0	94,600	29,665	56,900
1966	625.0	38,800	399.0	30,200	377.0	29,181	60,100	721.0	102,400	32,235	61,600
1967	658.0	43,100	430.0	31,800	375.0	34,505	66,000	763.0	109,900	35,378	67,800
1968	718.0	46,100	478.0	32,500	415.0	40,817	70,900	816.0	115,600	38,254	74,600
1969	775.0	50,500	549.0	35,100	459.0	47,459	80,100	910.0	138,750	41,687	83,800
1970	879.0	74,901	724.4	45,963	610.8	61,929	107,261	1,050.0	155,118	53,270	105,257
1971	949.0	82,085	804.3	50,928	673.2	69,059	117,547	1,168.0	166,290	57,705	118,550
1972	1,040.0	91,620	895.0	55,133	735.2	79,286	133,668	1,280.6	180,354	63,023	135,170
1973	1,171.0	108,792	999.7	66,130	824.4	96,930	150,281	1,630.0	198,173	75,004	154,650
1974	1,255.0	128,386	1,138.8	74,397	881.3	114,406	165,128	1,914.0	222,885	89,322	171,090
1975	1,332.0	142,169	1,275.9	92,776	917.4	132,526	181,586	2,109.0	257,305	100,541	184,530
1976	1,505.0	167,474	1,482.3	109,364	999.2	149,303	208,501	2,415.0	288,040	127,292	214,450
1977	1,666.0	185,700	1,672.0	124,700	1,064.3	158,956	250,500	2,630.0	309,800	153,231	237,600
1978	1,878.0	202,400	1,900.5	144,097	1,149.0	172,980	283,300	2,787.0	432,490	242,700	254,980
1979	2,112.0	230,800	2,171.1	169,600	1,246.0	188,438	312,000	2,966.0	407,090	242,722	269,280
1980	2,298.0	255,600	2,456.8	197,900	1,316.0	203,165	330,000	3,159.0	462,100	305,051	299,700

Source: International Monetary Fund Monthly Bulletin, various issues.

Table 4. Exchange Rates.*

Year	Canada	France	Norway	West Germany	Japan	U.K.	Denmark	Belgium	Sweden	Italy	Netherlands
1960	.9962	4.903	7.150	4.171	359.6	.3567	6.906	49.70	5.180	620.60	3.770
1961	1.0431	4.900	7.140	3.996	361.8	.3562	6.886	49.78	5.185	620.60	3.600
1962	1.0778	4.900	7.150	3.998	359.6	.3569	6.902	49.75	5.188	620.60	3.600
1963	1.0809	4.902	7.140	3.975	362.0	.3575	6.911	49.83	5.200	622.38	3.600
1964	1.0741	4.900	7.140	3.977	358.3	.3584	6.921	49.63	5.148	624.80	3.592
1965	1.0750	4.902	7.150	4.006	360.9	.3568	6.891	49.64	5.180	624.70	3.611
1966	1.0838	4.952	7.160	3.977	362.5	.3584	6.916	50.05	5.180	624.45	3.614
1967	1.0809	4.908	7.150	3.999	361.9	.4155	7.462	49.63	5.165	623.86	3.596
1968	1.0728	4.948	7.150	4.000	357.7	.4194	7.501	50.14	5.180	623.50	3.606
1969	1.0731	5.558	7.150	3.690	357.8	.4166	7.492	49.67	5.170	625.50	3.624
1970	1.0103	5.520	7.140	3.648	357.6	.4178	7.488	49.68	5.163	623.00	3.597
1971	1.0022	5.224	6.703	3.268	314.8	.3918	7.061	44.76	4.858	594.00	3.254
1972	.9956	5.125	6.640	3.202	302.0	.4259	6.846	44.06	4.743	582.50	3.226
1973	.9958	4.708	5.728	2.703	280.0	.4304	6.290	41.32	4.588	607.92	2.824
1974	.9912	4.445	5.205	2.410	301.0	.4258	5.650	36.12	4.081	649.43	2.507
1975	1.0164	4.486	5.585	2.622	305.2	.4942	6.178	39.53	4.385	683.55	2.688
1976	1.0092	4.970	5.185	2.362	292.8	.5874	5.788	35.98	4.126	875.00	2.457
1977	1.0944	4.705	5.139	2.105	240.0	.5247	5.777	32.94	4.669	871.50	2.280
1978	1.1860	4.180	5.022	1.828	194.6	.4915	5.090	28.80	4.295	829.70	1.969
1979	1.1680	4.020	4.926	1.731	239.7	.4496	5.365	28.05	4.146	804.00	1.905
1980	1.1950	4.516	5.180	1.959	203.0	.4193	6.015	31.52	4.373	930.50	2.129
1981	1.1860	5.748	5.807	2.255	219.9	.5241	7.325	38.46	5.571	1,200.00	2.468

*Units: Foreign currency per U.S. $1.00.

Source: International Monetary Fund Monthly Bulletin, various issues.

Table 5. Import Tariffs on Fresh, Chilled and Frozen Salmon.

European Economic Community

Date	Ad Valorem Duty[a] Autonomous	Ad Valorem Duty[a] Conventional
1 January 1971	16	8.4
1 January 1972	16	8
1 January 1973	16	8
1 January 1974	16	8
24 November 1975	16	4
15 November 1976	16	4
14 November 1977	16	4
1 December 1978	16	4
31 December 1979	16	3.8
24 November 1980	16	3.5

Japan

Date	Ad Valorem Duty			
	General	GATT	Preferential	Temporary[b]
1 April 1966	10			
1 April 1969	10			8
31 December 1969	10	8		7
31 March 1970	10	8		7
31 December 1970	10	7		
1 April 1974	10	5		5
March 1979	10	5		5

[a] This tariff had been suspended until early 1981 for several years.

[b] "For the purpose of assessment of duty, a 'GATT' rate shall be applied before a 'Temporary' rate and a 'Temporary' rate shall be applied before a 'General' rate. If, however, a 'GATT' rate is higher than the other rates, the rate applicable shall be the 'Temporary' rate, or if no 'Temporary' is specified, the 'General' rate."

Sources: Official Journal of the European Communities, various issues. International Customs Journal No. 28, various editions, International Customs Tariff Bureau, Brussels, Belgium.

3) Transportation costs. Overseas consumers pay a premium on their Pacific salmon for the cost of shipping it from the U.S. As energy costs rise, transportation becomes even more expensive.

4) Domestic supply of salmon. Japan has her own Pacific salmon fishery, while Europe has an increasing supply of Atlantic salmon.

A significant volume of Pacific salmon is traded between the U.S. and Canada. Both countries produce salmon, often harvesting common stocks, and there are close ties between U.S. and Canadian wholesale firms. Some studies (e.g., Bell et al., 1978) find it useful to consider the two countries as one "supplying region," although there is evidence that the two countries are competitive suppliers in both domestic (U.S. and Canada) and export markets (discussed below). Given the evidence of trade across wholesalers (e.g., to increase SR supply) as well as trade for re-export (e.g., after processing), the issues underlying U.S.-Canadian trade are more complex than those of trade between the U.S. and other countries.

The domestic supply of Pacific salmon in Japan was severely curtailed in the 1970s with restrictions placed on Japanese fishing activity in Soviet and U.S. waters. This factor, coupled with rising population and income in Japan, led to increased imports of Pacific salmon. Japanese purchases of fresh and frozen U.S. salmon grew dramatically in the late 1970s, peaking in 1981 at over 131 million pounds. By value, these 1981 imports represent over 67 percent of total U.S. fresh and frozen salmon exports. Sockeye salmon are the favored species in the Japanese market, in the gutted and head-on princess-style fashion; quality-conscious Japanese consumers prefer head-on fish so that freshness may be better assessed. In 1981, chinook and chum salmon were also important species in U.S. exports to Japan. Also in this year, as in previous years, the U.S. continued to be Japan's major supplier of salmon, accounting for over 88 percent of total imports of fresh and frozen salmon, by value (Earley et al., 1982). Canned salmon is not imported in significant quantities by Japan from the U.S.; however, imports have been increasing since the late 1970s. Salmon roe (eggs) continue to be an important U.S. seafood export to Japan; in 1981, nearly 98 percent by value of U.S. salmon roe exports went to Japan (over U.S. $92,000; Earley et al., 1982).

Several countries of the EEC are significant importers of Pacific salmon, particularly France, West Germany and the United Kingdom. The U.S. and Canada are major suppliers, while fresh salmon imports come primarily from Norway.

France is the most important market for fresh and frozen Pacific salmon in Europe, the U.S. being the primary supplier. U.S. and Canadian exports of salmon to France have been rising steadily over the past few decades. An important source of demand is the smoking market. Much of the larger-sized troll chinook and coho salmon purchased by French importers is destined for the smoking trade. Some of these are re-exported to other countries (primarily European) after processing. Some gillnet fish are also entering the smoking market as preslicing and packaging of the product allows bruises and other flaws to be cut out of the fish. Smaller-sized gillnet salmon, such as chums and pinks, are also imported for sale in the growing supermarket-hypermarket retail outlets. The demand for canned salmon in France, on the other hand, has always been low relative to that for fresh and frozen. The growth in demand for Pacific salmon in France may be attributable to the same factors as in Japan. French per capita income and population are rising, and domestic supplies of Atlantic salmon have long dwindled. Expansion in the smoking industry, particularly the preslicing and packaging production, as well as in the supermarket infrastructure has also been a significant factor.

While Canada has been the primary supplier of frozen salmon to West Germany, the U.S. and, increasingly, Norway are also providing a significant share of imports. An estimated 75 percent of the Pacific salmon imported is destined for the smoking trade (Lent, 1980); these are usually troll chinook and coho salmon, as in France. A smaller percentage of the final, smoked fish product is re-exported than in France. Gillnet pinks and silverbrite chums are imported for retail marketing. As in France and Japan, rising per capita income is an important factor behind Germany's demand for Pacific salmon.

The United Kingdom has long been an important market for canned Pacific salmon. Japanese canned salmon, generally lower-priced, had dominated the U.K. market over the past two decades; since the late 1970s, however, the U.S. and Canada jointly have captured the largest share. Sockeye salmon is acclaimed by the British as the favorite species for canned salmon because of its red color and oil content. Increases in the prices of sockeye over the past decade, however, have resulted in switching to the less expensive canned pink and chum salmon. Nevertheless, 1981 U.S. exports of canned salmon to the U.K. were dominated by sockeye. Indeed, U.K. purchases of canned sockeye accounted for 60 percent by weight of total U.S. sales of canned sockeye (Earley et al., 1982). Canned salmon is popular in the U.K. for use in salads and sandwiches, particularly at afternoon teas. The fresh and frozen market for Pacific salmon in the U.K. is but a fraction of that for canned salmon. The value of U.K. imports of fresh and frozen salmon from the U.S. in 1981 was 22 percent that of the canned salmon imports. Small coho salmon are preferred for the fresh and frozen trade; however, as in the canned market, other species (chums and sockeyes) have been imported as coho salmon prices rise.

As for other markets for Pacific salmon, Denmark's imports of fresh and frozen Pacific salmon from the U.S. surpassed West Germany's in 1981. Some of these imports are processed (e.g., smoked) and then re-exported. The Danish smoking process is popular throughout Europe.

Sweden, which is not an EEC country, has its own Baltic Sea Atlantic salmon fishery, supplying approximately 10 percent of her domestic salmon consumption. U.S. exports of fresh and frozen salmon to Sweden have increased since the late 1960s, reaching over 5 million pounds in 1980. The growth of supermarket chains in Sweden has fueled the sales of frozen foods, including Pacific salmon. Silverbrite chum and pink salmon are imported for sale in these retail outlets in smaller sizes for sale whole or cut into roasts. There is also some processing of Pacific salmon imported into Sweden, such as "gravad lax" (pickled salmon) and smoked salmon.

Atlantic Salmon

Examination of the world market for Pacific salmon is not complete without considering the role of Atlantic salmon, particularly in the European market. Atlantic salmon (salmo salar) is pink-meated and oily like Pacific salmon and was once abundant in the rivers and seas of Europe. Pollution, dams and overfishing had devastated the Atlantic salmon stocks by the late 1800s, leaving many runs irreversibly destroyed. A small commercial Atlantic salmon fishery now exists in Scotland, perhaps because of private property rights (Lent and Johnston, 1981), and in the Baltic Sea because of Swedish enhancement efforts. There is also a wild Atlantic salmon fishery off the west coast of Norway, although landings have been declining. The supply of Atlantic salmon is increasing, however, primarily because of the development and expansion of salmon farming in Norway. Since the early 1970s, Atlantic salmon (as well as pink-meated trout) have been raised in pens along the west coast of Norway. Production reached 4 thousand metric tons in 1979, of which 90 percent was exported fresh to countries in the EEC (see Table 6). Production is expected to continue to increase significantly in the 1980s. There is some evidence that the increased supply of farmed salmon may affect the European market for Pacific salmon. Pacific salmon have been imported by European countries to some extent as a substitute for Atlantic salmon. Indeed, many firms and processors importing Pacific salmon also purchase Norwegian farmed fish. These salmon are valued for their freshness, quality and uniformity. Many importers feel that because of the divergence in quality, Atlantic salmon are "in a market of their own" and do not compete directly with Pacific salmon (Lent, 1980). For example, Pacific salmon may be sold in a supermarket while farmed Norwegian salmon tends to be consumed in finer restaurants. On the average, farmed Norwegian salmon is more expensive than Pacific. However, as production increases in Norway, with a possible drop in price, the two fish prices may converge. Previous empirical studies have shown that the quantity of Pacific salmon demanded decreases as supplies of Atlantic salmon rise (or as Atlantic salmon prices fall). Increases in farmed salmon production thus appear to be important for the Pacific salmon market.

Pacific salmon landed in the U.S. thus are ultimately consumed in a variety of product forms (fresh, frozen, canned, smoked, and so on) in many different regions of the world. Factors underlying the final

Table 6. EEC Fresh Salmon Imports from Norway.

Year		West Germany	France	Benelux	U.K.	Denmark
1976	Q*	190	224	15	14	127
	V**	1,251.10	1,252.22	98.39	73.79	771.45
1977	Q	372	213	183	58	188
	V	2,784.33	2,388.36	1,478.89	494.10	1,468.62
1978	Q	454	272	158	207	214
	V	3,165.46	2,383.02	1,325.31	1,459.12	1,473.14
1979	Q	788	808	159	355	807
	V	7,289.12	6,828.58	1,377.50	3,116.86	6,854.62
1980	Q	774	784	165	106	625
	V	9,150.39	8,507.13	1,883.82	1,169.56	6,681.79
1981	Q	1,102	1,705	305	326	1,090
	V	9,057.89	12,828	2,420.12	2,617.38	8,266.39

*Q = thsd. Kg.
**V = thsd. $ U.S.

Source: EEC Trade Volumes, various issues.

distribution of salmon products include consumer tastes, income, prices (of salmon and its substitutes), barriers to trade, exchange rates and transportation costs. This discussion of the world market for Pacific salmon has revealed many complexities which must be taken into consideration in studying the marketing of Pacific salmon. The issues addressed in this research are how the individual buyers and sellers at the wholesale level are making their decisions on what quantity of salmon to exchange and at what price. With this background of the industry and the ideas advanced in previous studies, the following chapter considers these issues in greater detail.

CHAPTER IV

MODEL FORMULATION

Production Functions, Cost Functions and Revenue Functions: Fresh and Frozen Pacific Salmon Wholesalers

This study is concerned with the behavior, particularly price and output decisions, of individual wholesalers of fresh and frozen Pacific salmon. Microeconomic theory provides a framework within which to observe the factors which play a role in the entrepreneur's decision-making process. The study starts with a simple model. Complications are then added (through relaxing assumptions) to include considerations of uncertainty and market disequilibrium.

Production Functions

Consider a firm which produces whole frozen salmon of any of the five species, three gear types and various sizes. This firm purchases raw whole salmon from fishing vessels, heads and cleans (if necessary), glazes and freezes each fish (unless the fish is sold immediately), using labor and equipment. The salmon are stored in the firm's freezers until sold.

According to the process described above, the production function for a fresh and frozen Pacific salmon wholesaler would have the following variables:

OUTPUT: q = whole frozen salmon, in numbers

INPUTS: S = whole, raw salmon, in numbers

L = labor, in hours

K = machinery use, in hours

The production function relates the maximum output per unit of time to inputs used per unit of time. It is assumed that there is one production function for each type of salmon produced, e.g., medium-sized troll cohos.[11] While the production functions may be similar across sizes and species, the "S" input will not be the same. In order to produce one medium frozen troll coho, the producer must use one raw, whole medium troll coho. This stipulation implies that an appropriate format for the production function in this case is the

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[11] This approach, rather than a multiple-product model, is used for ease of presentation and for consistency with the firm decision model presented in later sections.

Leontief fixed proportions production function. This function has the property of L-shaped isoquants; input ratios are assumed to remain constant at all output levels, implying there is no substitution between inputs.

The following production function may be specified

$$q = \min\left(\frac{S}{\alpha 1}, \frac{L}{\alpha 2}, \frac{K}{\alpha 3}\right),$$

where q, S, L and K are as specified above and the α_i's are the input coefficients. Because it takes one unit of "S" to produce one unit of q, the production function may be written as

$$q = \min\left(\frac{S}{1}, \frac{L}{\alpha 2}, \frac{K}{\alpha 3}\right)$$

$$= \min\left(S, \frac{L}{\alpha 2}, \frac{K}{\alpha 3}\right) .$$

The boldest assumption needed in this analysis is that labor and machinery are used in fixed proportions, i.e., that they are not substituted for each other. This amounts to assuming a production technique such as the following: there is a certain machine which heads, guts and cleans the fish; workers have the responsibility of feeding the fish into the machine at one end (at a fixed rate) and packing and freezing them at the other end (again, at a fixed rate). The assumption thus stipulates that labor inputs are used in constant proportion to machine use.

Continuing with the Leontief production function above, for fixed proportions the following properties hold true along the Pareto ray:

$$S = (1)q, \quad L = (\alpha_2)q, \quad K = (\alpha_3)q$$

and the input ratios are constant:

$$S/L = 1/\alpha_2, \quad S/K = 1/\alpha_3, \quad L/K = \alpha_2/\alpha_3 \text{ at all levels of q.}$$

Furthermore, since it is not possible to obtain more than one frozen salmon from one raw fish, it is assumed that the α_i's are constant (as demonstrated by setting $\alpha_1 = 1$) and that the production function exhibits constant returns to scale.

Cost Functions

Under the more general case of production functions with variable proportions, input prices are included at this point in the analysis.

Cost functions are calculated from the production function, such that total, average and marginal costs may be expressed in terms of output. Once the profit-maximizing level of output is determined (by equating marginal revenue and marginal cost), then the economically efficient quantities of each input employed may be calculated. With the Leontief case, the input composition (ratios) is given by technology--i.e., the production function. The only task for the entrepreneur is to determine the level of output. As will be discussed in a later section, in certain circumstances the entrepreneur must also determine the profit-maximizing price at which to sell the output.

Let input prices be designated at p_S, p_L and p_K for salmon, labor and equipment use, respectively. For the moment it will be assumed that input prices are constant. Total Cost may be expressed as the sum of input usage times their respective prices (assuming no fixed costs):

$$TC = (p_S)S + (p_L)L + (p_K)K.$$

Using the property that along the Pareto ray $x_i = \alpha_i q$ for any input x_i, Total Costs may be expressed as

$$TC = q((1)p_S + (\alpha_2)p_L + (\alpha_3)p_K).$$

Given the assumption that all α_i's and p_i's are constant, the Total Cost curve is of the form

$$TC = \beta q$$

and thus $AC = TC/q = \beta$

$$MC = dTC/dq = \beta$$

and $AC = MC$

These equations are demonstrated in Figure 5.

There is some argument as to whether input prices may actually be assumed to hold constant over all levels of production in the processing of Pacific salmon. Labor in particular may be subject to increases in price as demand increases since some salmon processing plants are located in remote areas, and processing must be undertaken almost immediately. The incorporation of input supply conditions such as $p_L = \lambda_0 + \lambda_1 L$, where $\lambda_0, \lambda_1 > 0$, results in a Total Cost function of the form

$$TC = \gamma_3 q + \gamma_2 q^2 \qquad \gamma_3, \gamma_2 > 0,$$

and average and marginal costs become

$$AC = \gamma_3 + \gamma_2 q,$$

$$MC = \gamma_3 + 2\gamma_2 q.$$

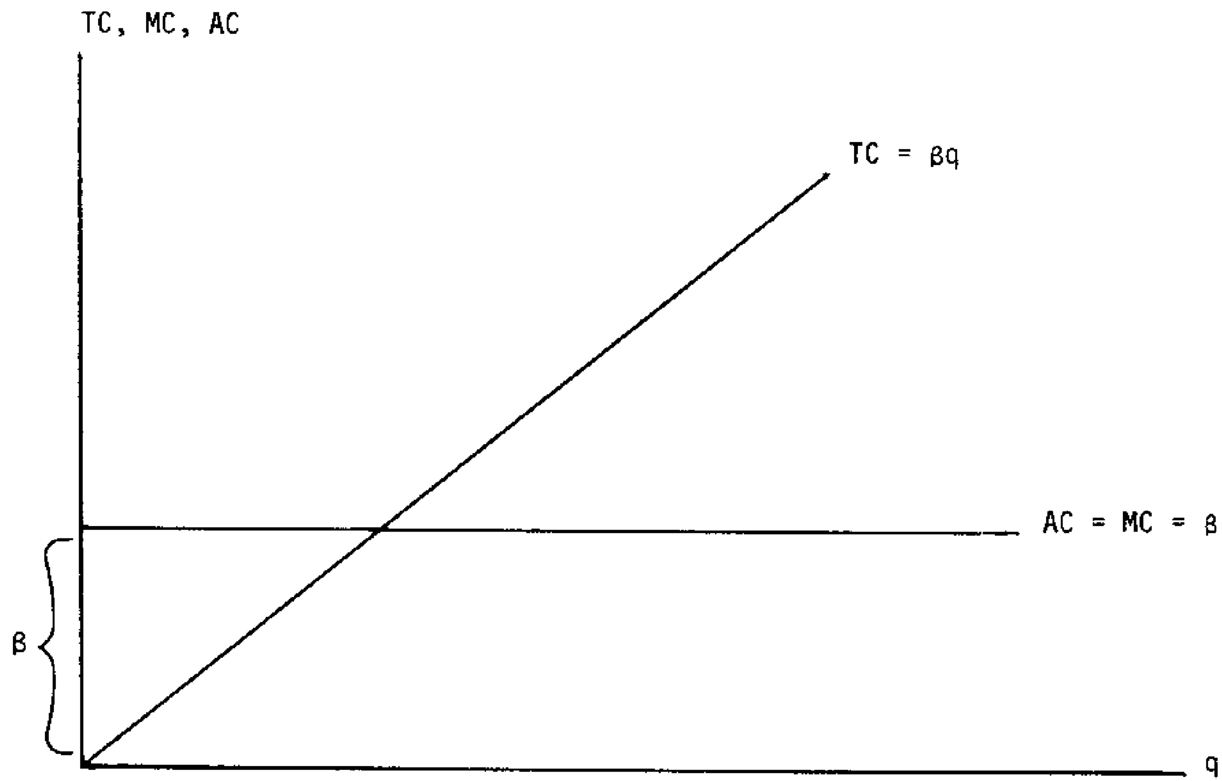


Figure 5. Cost Curves for Salmon Processors

The graph of the cost functions with at least one variable input price is demonstrated in Figure 6.

Fixed costs may be included in the cost functions in order to obtain a final notion of the behavior of cost curves facing Pacific Northwest salmon producers. Fixed costs to such firms may include land, buildings, storage facilities and interest costs. Assuming fixed costs = FC,

$$TC = FC + \gamma_3 q + \gamma_2 q^2 .$$

Thus

$$AC = \frac{FC}{q} + \gamma_3 + \gamma_2 q$$

and

$$MC = \gamma_3 + 2\gamma_2 q .$$

The cost functions now take the form illustrated in Figure 7.

Revenue Functions

A total revenue function allows the calculation of marginal revenue which, in turn, is equated with marginal cost to determine the profit-maximizing level of output and in some cases the profit-maximizing price of output for the entrepreneur. Assume that P = price of output or the price of the particular type of salmon under consideration. Total revenue (TR) is as follows:

$$TR = Pq$$

and marginal revenue is

$$MR = dTR/dq = P(1 + 1/e),$$

where e = price elasticity of demand.

Under conditions of perfect information, if the producer is a monopolist, then the demand curve facing his or her firm is in fact the market demand. If the producer operates in a perfectly competitive market, then the elasticity of demand facing the firm is infinite, and marginal revenue is in fact the market price. The two cases are illustrated in Figure 8.

As stated earlier, it is not obvious that the wholesale market for Pacific salmon is perfectly competitive; nor is it a strict monopoly. Certain characteristics of the Pacific salmon industry indicate that the demand curve facing the individual salmon wholesaler is somewhere between the monopoly and perfect competition examples above.

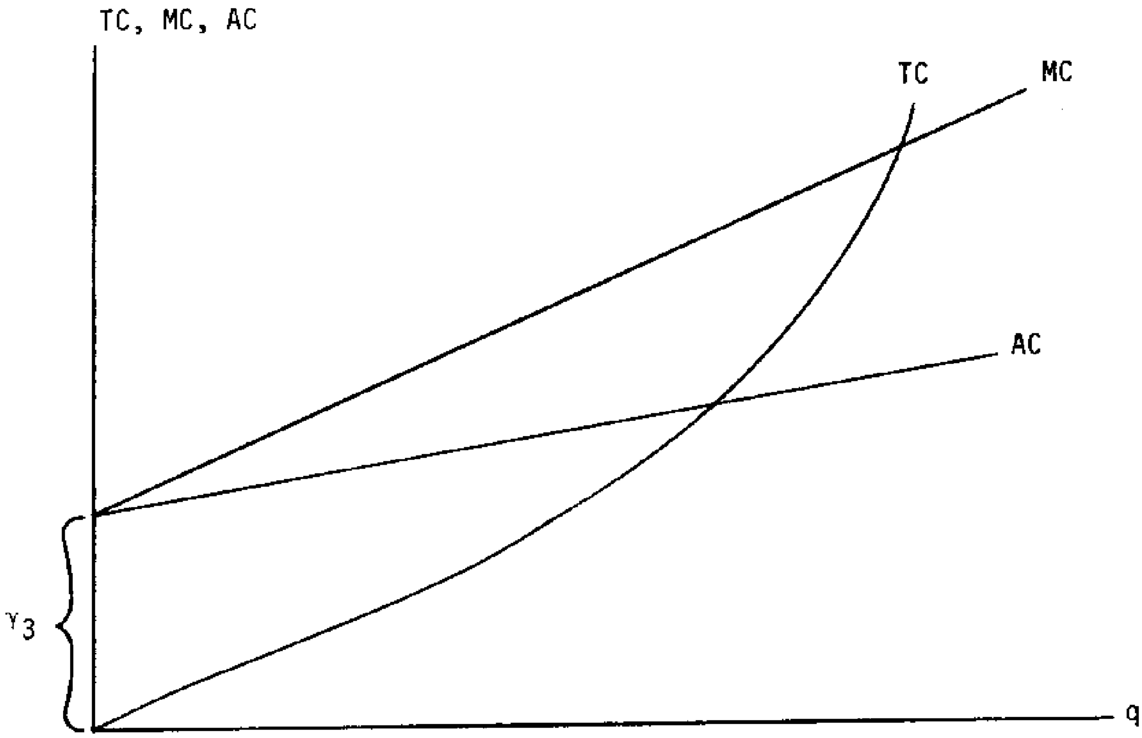


Figure 6. Cost Curves with Variable Input Price

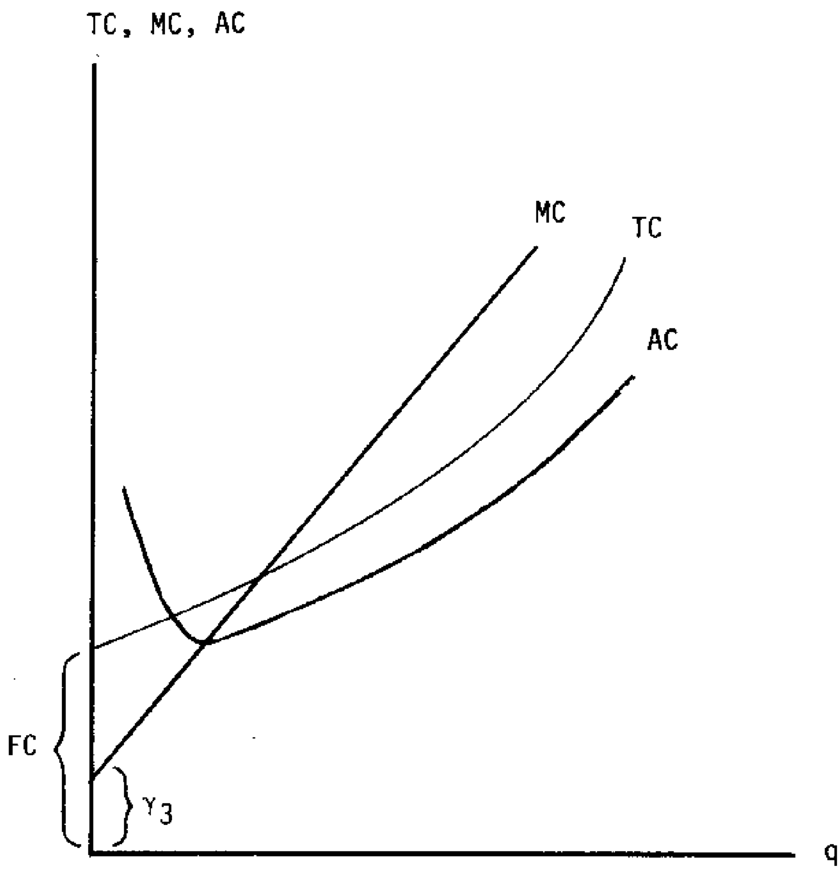


Figure 7. Cost Curves with Fixed Costs

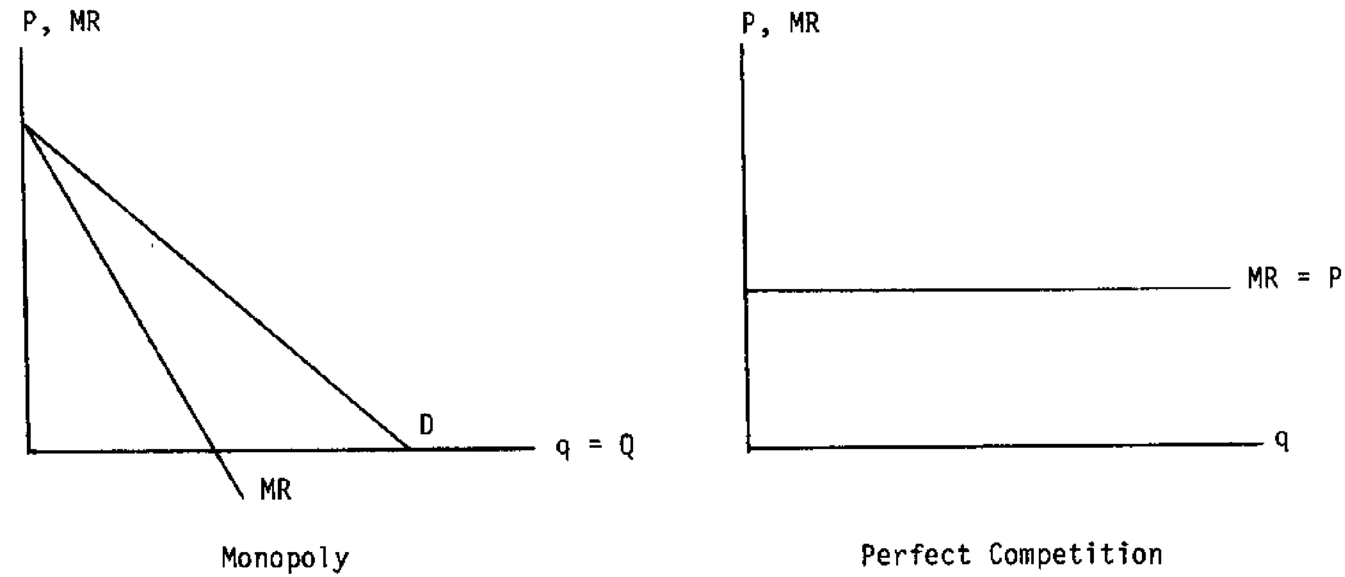


Figure 8. Demand and Marginal Revenue Curves

Decision Making and the Salmon Market

The issues discussed in the previous literature provide evidence that the Pacific salmon wholesale market may be characterized by price-searching participants. The tendency for seafood markets to be in a state of disequilibrium and the notion of less than perfect information imply that each seller may face an uncertain, but downward-sloping demand curve. The ideas generated from previous studies as well as characteristics of the salmon market may be used to formulate a framework for observing the decision-making behavior of the participants.

The notion that firms behave as if they equate marginal revenue and marginal costs is retained in the following discussion. However, it is assumed that marginal costs are known by each firm, whereas, in fact, each firm can only estimate its marginal revenue curve. Another assumption throughout this discussion is that the firm only produces or sells if mr = mc at a $P^* > AC$, as shown in Figure 9.

In the first time period, the firm equates its known MC to its estimate of MR. Assume that the firm makes its first estimate of MR using information from a set of n observed prices, $\{P_1, P_2, \ldots, P_n\}$. The firm uses the mean of this set of prices, $\overline{P}$, in estimating its demand and marginal revenue curves; thus,

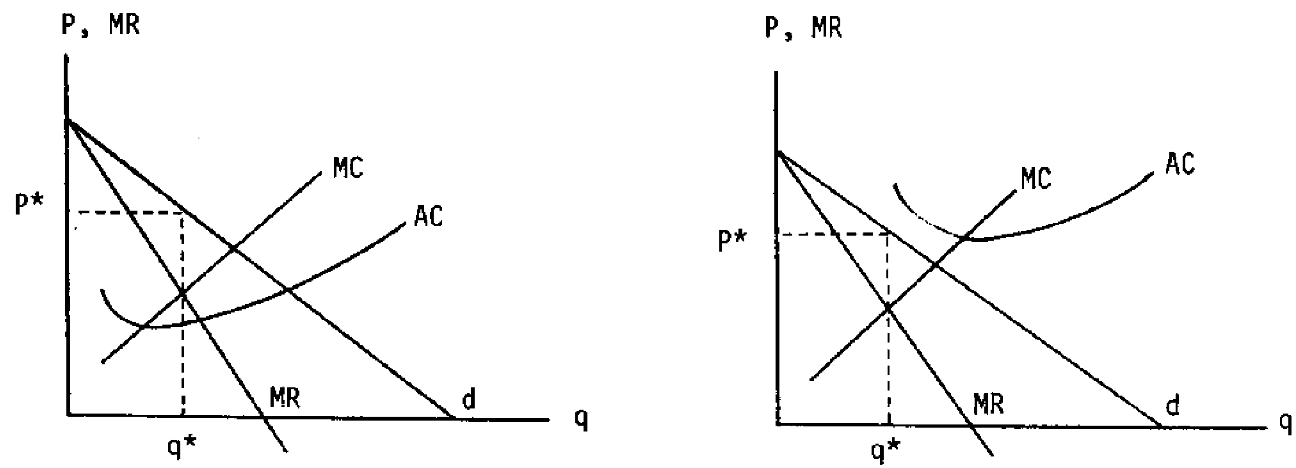
$$MR = f(\overline{P})$$

$$\text{and } MC = g(\text{Costs}), \text{ where Costs} = h(\text{Output}).$$

By setting MR = MC, the firm can solve for the profit-maximizing price and output level.

Assume that this process may be described as follows. This firm is a price searcher. The procedure it follows is one of first finding its estimate of optimal price (P^*). It may at that time also specify an optimal level of quantity (q^*). However, it is up to the buyers in the end to accept or reject this price, based upon their canvassing activities of the prices of various sellers. Thus, quantity actually sold may in effect be left up to the buyers' discretion. Stated in other terms, a seller may, at least over a short period of time, stick to his or her guns and continue to charge a price of P^*. The seller cannot, however, stick to his or her estimate of optimal quantity to sell; he or she cannot force buyers to purchase q^* of his or her goods. The seller may end up selling less or more (assuming the firm has inventories), according to whether he or she overestimated or underestimated the firm's marginal revenue curve (hence price), respectively. Thus, the following equations may characterize the price-searching behavior by producers and the response by price-searching buyers in time period 1:

$$P_1^* = f(\overline{P}_1, \text{Costs}_1, \ldots)$$



Produce

Do Not Produce

Figure 9. Price and Average Cost

$$q_1 = g(P^*_1, \overline{P}_1, \ldots), \text{ where } q_1 \gtreqless q^*_1.$$

The seller sets a price according to factors influencing his or her estimate of MR and actual MC curves. The buyers purchase q_1 according to this firm's price and the m prices of other sellers; buyers are also observing a set of prices $\{P^1, P^2, \ldots, P^m\}$. The actual amount sold, q_1, may be greater than, equal to or less than the amount the firm hoped to sell, q^*_1.[12]

In the next time period, the firm has more information of its own to use in determining its new profit-maximizing price, namely, its sales in the previous period, as compared to optimal sales level.

$$P^*_2 = f(\overline{P}_2, \text{Costs}, (q^*_1 - q_1) \ldots).$$

Thus, the revised price estimate is a function of the divergence between estimated optimal level of sales and actual sales, as well as the industry average price and costs. The firm's perception of selling "too few" or "too many" salmon will change its estimate of MR. The response by buyers to this firm's new price may again be stated as

$$q_2 = g(P^*_2, \overline{P}_2, \ldots).$$

The firm continues to adjust its estimate of marginal revenue by using its own information as well as the information from the prices of other firms. If it is assumed that the firm can obtain information about other firms' prices only in the previous period, while buyers do their price searching in the current time period,[13] then the model takes the following general form:

$$P^*_t = f(\overline{P}_{t-1}, \text{Costs}_t, (q^*_{t-1} - q_{t-1}) \ldots)$$

and

$$q_t = g(P^*_t, \overline{P}_t, \ldots)$$

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[12] It is interesting to note that Kawasaki et al. found that quantity adjusts more rapidly than price when firms are in disequilibrium. Could this be due to the idea that firms play a more direct role in setting their price (at least asking price) than in determining the actual amount they sell? An important difference, however, is that Kawasaki et al. contended that firms adjust quantities, while this hypothesis states that buyers "determine" quantity sold, at least in the short run. There may be some confusion due to the difference between quantity sold and quantity produced, or between desired quantity and actual quantity.

[13] This is equivalent to assuming that buyers make their decisions instantaneously while sellers have a period of adjustment.

The model thus consists of two equations. The first specifies the relationship between price, P_t^* (actually, the seller's asking price) and the key price-determining variables. The price variable then appears as an explanatory variable in the second, quantity-determining equation. The sellers then are hypothesized to set an estimated optimal price (ex ante), and the buyers subsequently determine the quantity actually transacted (ex post).

The model may now be compared with the concepts advanced in the studies discussed earlier:

- Arrow and Stigler argue that under certain market conditions, such as disequilibrium and uncertainty, buyers and sellers may be characterized as price searchers, not price takers. The present model reflects this view in that (1) firms must estimate their demand curve and thus use various indicators in setting an optimal price, and (2) buyers observe a set of prices and compare the average of these with the asking price of each seller.

- Garbade et al. state that sellers use the information gained from observing the prices of other sellers in revising their own price; this is demonstrated in the first equation hypothesizing P_t^* to be a function of $\bar{P}_t$. However, Garbade et al. say that the use of the industry mean price as an indicator is diminished as the variance of the set of observed prices increases and is increased as the number of prices observed, n, increases. This suggests the inclusion of additional exogenous variables in the "asking price" equation:

$$P_t^* = f(\bar{P}_{t-1}, \text{Costs}_t, (q_{t-1}^* - q_{t-1}), \sigma^2_{P_{t-1}}, n),$$

where

$\sigma^2_{P_{t-1}}$ = variance of prices in observed set

n = number of prices in observed set

- Kawasaki et al. find that the level of inventories and unfilled orders acts as an indicator to the firm that it is in disequilibrium and that it needs to revise its estimate of demand. This may be represented by the variable $(q_{t-1}^* - q_{t-1})$, demonstrating the divergence between desired and actual quantity sold.

- Arrow also argues that a firm's estimate of demand (hence MR and P*) will be based upon "guesses" as to the level of supply, the prices of other sellers and aggregate demand. The prices of other sellers appear in the equation in the form of $\bar{P}_{t-1}$ and $\sigma^2 P_{t-1}$. However, what about aggregate supply and demand? Demand may be reflected in the quantity actually purchased by buyers, q_t, which in turn is fed back into the price equation.

• Rothschild et al. state that it is important to consider the price-searching behavior of both sides of the market, that is, buyers and sellers. By including the prices of other sellers in the equation for quantity demanded from an individual seller, we can observe the price-searching activity of buyers, or at least, the substitution effect between salmon from this seller and that of all other sellers. It is expected that as the industry-wide average price increases, all else remaining constant, this seller sells more salmon. Analogous to the quantity measures above, would some divergence measure be more meaningful in order to demonstrate the relative magnitude of P_t^* versus $\bar{P}_t$?[14]. The model of Carlson and McAfee suggests that a useful approach is to hypothesize that quantity sold is a linear function of the difference between this firm's price and the average price of all other firms. Thus the demand equation becomes

$$q_t = g(P_t^* - \bar{P}_t) = a_0 + a_1 (P_t^* - \bar{P}_t) , a_1 < 0 .$$

• Several previous articles (e.g., Burdett and Judd, Stigler, Carlson and McAfee) assume that buyers know the distribution of prices offered by sellers, but that they are unaware of which firms charge which prices. The model in this study does not explicitly state that buyers know the price distribution, but incorporates the assumption that buyers know the average price of a set of other dealers' prices. This average price could be thought of as representing a sort of "going price" of which buyers are aware. Actual demand faced by each firm depends to a certain extent on the random factor of whether or not this firm will be canvassed by any given buyer. In fact, buyer-seller loyalty plays a large role in the salmon market. Interestingly, Carlson and McAfee argue that the presence of certain sellers with "reputations" leads to more differentiating of firms, with the resultant effect of a greater possibility for price dispersion.

In stating that prices diverge, we assume that because of less than perfect information, some buyers will continue to purchase at the higher prices simply because they are not aware of the lower prices

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14 What is lacking here is Arrow's idea that disequilibrium is characterized by a set of bilateral monopolies. This model shows no one-on-one confrontation between buyers and sellers, only sellers setting asking prices and buyers responding to these. The quantity actually sold is then used to revise the price estimate. The salmon market may, in fact, be more closely represented by such bilateral monopolies, or at least by a certain buyer acting with a certain seller (particularly considering the role of loyalty between buyer and seller). It has been suggested that this concept of bilateral monopolies may be most relevant in cases of large transactions, which could be distinguished in the empirical analysis to test the model.

available elsewhere or they incur high search costs. A firm whose price is on the upper end of the distribution of prices may be getting signals that it has overestimated its demand curve, as shown in Figure 10. If sales are consistently less than expected, i.e., $(q^* - q) > 0$, then this is an indicator to the firm that it has overestimated demand.

Considerable complications may arise in the study of the decision-making behavior of wholesalers of fresh and frozen Pacific salmon because of the confusion over production, sales and inventory. If the model above were applied to a manufacturing firm of, say, pencils, where production may take place on a year-round basis, then the process would be more straightforward. In each time period, the pencil manufacturer produces a certain volume of pencils, q_t^*, according to the estimates of MR and MC, and attempts to sell these at the estimated optimal price P_t^*. If the manufacturer actually ends up selling less than q_t^*, the excess goes into inventory; if he or she sells more, he or she depletes the existing inventory. In the salmon business, however, the issues are not as clear-cut. During the fishing season, it may be true that a dealer purchases and processes a certain volume of salmon according to his or her estimate of the level of quantity at which MR = MC. However, if the dealer wishes to sell any salmon after the close of the fishing season, he or she must also be purchasing salmon during the season for sale out of season. Apparently such purchases would be based on estimates of demand in the future. It is not apparent then that the salmon firm's manager bases his or her decisions on optimal price and quantity to offer for sale in an off-season time period on equalization of MR and MC of production. Producing salmon during off-season periods is in effect going to the freezer and taking salmon out--or depleting inventories.

Inventories at the end of the season are to some extent reflections of the firm's estimate of what demand will be in the coming time periods. The firm's trade-offs between sales now and sales later will depend on several factors, including current demand versus estimated future demand (hence prices), storage costs and storage capacity, interest rates, and some estimate of transactions costs in the future, such as transport costs and exchange rates, as opposed to their values in the present time period. It could be hypothesized, then, that the firm makes some decision on the quantity to purchase, and later faces decisions (many of them) on the prices at which to sell these salmon, based on profit-maximizing behavior.

Given the adaptations arising from consideration of previous studies, the model now takes the following general form:

$$P_t^* = f(\overline{P}_{t-1}, \text{Costs}_t, (q_{t-1}^* - q_{t-1}), \sigma^2_{P_{t-1}}, n)$$

$$q_t = g(P_t^* - \overline{P}_t).$$

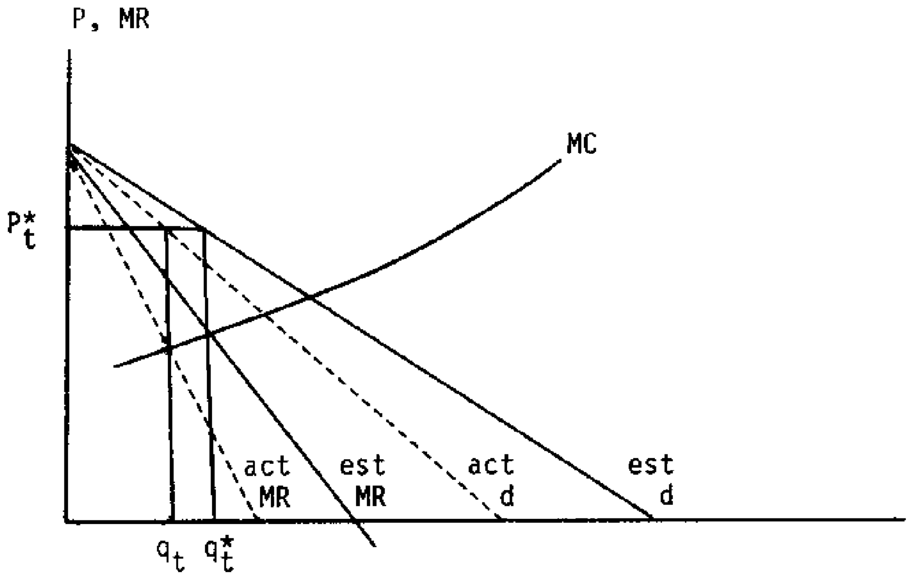

Figure 10. Estimating Demand

These equations are hypothesized to represent the behavior of price-searching sellers and buyers in a market characterized by costly information or disequilibrium. Firms are setting their prices at a level P_t^* and expect to sell q_t^* and maximize their profits. Buyers attempt to locate the lowest price for the salmon product they wish to purchase by comparing each firm's price with the average price of an observed set. In the following chapter, an attempt is made to empirically estimate these relationships with the use of data collected from wholesalers of Pacific salmon.

CHAPTER V

EMPIRICAL ESTIMATION

The Data

The primary data used in the empirical estimation of the price-searching model are observations recorded from sales invoices of Pacific salmon wholesalers during a 1977-78 study of the Pacific Northwest salmon industry (Bell et al., 1978). Observations were taken from those firms which agreed to allow collection of the data on their sales invoices, for as many years as possible. An attempt was made to obtain the following information from each invoice: seller, date, species, size, gear type, product form, pounds in the transaction, price per pound and destination (buyer's name if possible, geographical region if not). In some cases, certain items were missing from the invoice, particularly the buyer's name (as the seller wished to protect the buyer's confidentiality), the gear type and size of the salmon. An explanation of some of these variables follows

Seller. The names of the firms from which the data were collected are coded to insure confidentiality. Distinguishing between dealers permits the observation of price adjustment within one firm and across firms. Data were collected from two firms in California, two firms in Oregon and five firms in Washington; the Washington firms included some Alaskan operations.

Date. Daily, weekly, monthly and annual indicators allow analysis of the movement of prices through time as well as consideration of the impact on pricing decisions of the various fishing seasons. The date also permits a more detailed look at adjustment processes.

Species. There are five species of salmon, as discussed earlier. In some cases other descriptions of the salmon are provided, such as geographical origin (e.g., Yakutat, Alaska Kings), grade (#1 or #2)[15] or more specific nomenclature (redskin silvers, red kings, white kings, and so on).

Size. The size of the salmon being sold is usually expressed in terms of its weight range, e.g., 4/6 lb. troll cohos. Certain species, notably pinks and chums, are categorized as small, medium and large.

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[15] Where the quality of a #1 salmon is judged by sellers and buyers to exceed the quality of a #2 salmon.

Gear Type. Most salmon sold at the wholesale level are characterized by three gear types: troll, gillnet and seine. While the importance of these qualifiers at the final consumption level is questionable, with these data it should be possible to observe the impact of gear type on the wholesale price of salmon.

Product Form. Salmon may be sold in many forms; on these invoices the major categories are fresh, frozen, canned, smoked, pickled, salted, steaks and fillets.

Pounds in the Transaction. These observations may be used to weight the price of the salmon sold, assuming that larger transactions have more of an impact on the market.

Price per Pound. This factor also may be weighted and is one of the most crucial variables in the analysis.

The model which is tested in this study advances certain hypotheses about the decision-making behavior of sellers of Pacific salmon. The model might be said to represent the decisions of a "typical" firm. While it would be difficult to define a "typical salmon wholesaler," under ideal conditions it would have been preferable to take a random sample of the population of salmon firms. The nine firms observed in this study admittedly do not represent a random sample; they are in the sample because they agreed to cooperate with researchers in the 1977-78 study and release the information contained in their invoices. Thus, this group of firms represents a biased sample. It is difficult to assess any particular direction to this bias, except that perhaps these firms tended to be, in some cases, larger than the average firm.

Two species are selected for empirical estimation: kings and silvers. In contrast with sockeyes, pinks and chums, these two species are sold almost exclusively in fresh and frozen form. Furthermore, these are the only species for which observations occur for all nine firms. The category of kings includes red kings, Alaska kings, and others associated with various geographical regions. White kings, tules (salmon about to spawn) and pales are omitted since they represent kings of significantly lower quality (and price) than other kings and also account for a small percentage of total sales of kings. Silvers also include those associated with various geographical regions, as well as "redskin" silvers. Seine-caught salmon and gillnet salmon are grouped as "net caught" for purposes of this analysis. All kings and silvers are classified as small, medium or large by converting weight range measures as reported on the invoices into S, M or L as in Table 7. Only those observations for fresh and frozen whole salmon are included. Figure 11 illustrates the sorting of the data by species, gear type and size.

For those cases which are incomplete, e.g., missing gear type, size or species name, the entire observation is eliminated. It would be extremely difficult, and risky, to attempt to fill in the missing

Table 7. Size Classification for King and Silver Salmon.

Kings			Silvers		
Large	Medium	Small	Large	Medium	Small
		(pounds)			
18/up	10/18	4/7	8/12	4/8	under/2
18/30	11/up	7/11	8/up	4/9	2/4
30/up	11/18	8/up	9/12	5/8	under/4
	15/up	under/11	12/up	6/7	3/4
	under/18			6/8	3/5
				6/9	3/6
				6/up	4/6
				under/9	4/up
					under/5
					under/6

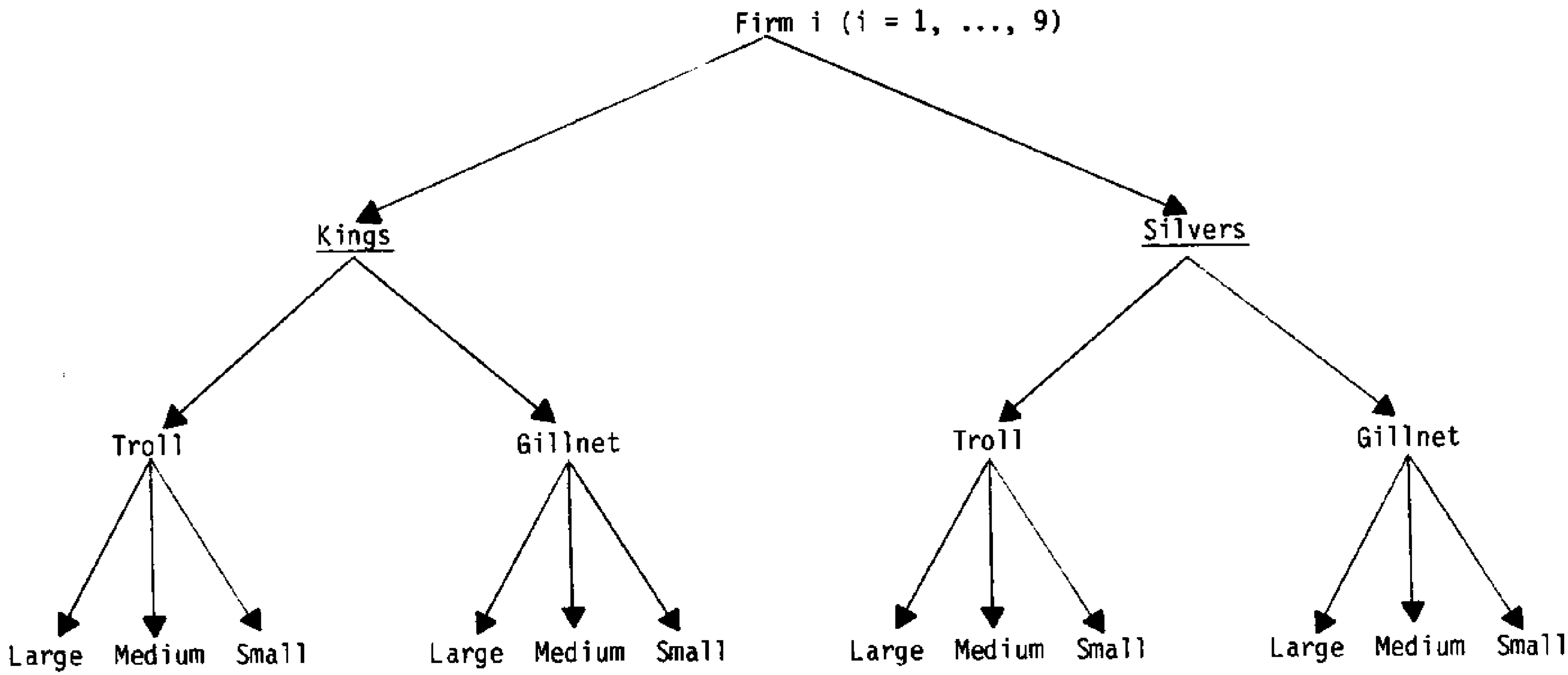

Figure 11. Sorting of Cases for Empirical Estimation.

data. Furthermore, there is no evidence that missing cases for gear type or size, which present the greatest problem, are anything but random.

There is a problem, however, with large proportions of missing data in a given set. For two of the Washington firms, in particular, there is a very high percentage of missing cases on the gear types (approximately 94 percent and 66 percent for these firms in 1976). Aside from the fact that it would be difficult, if not impossible, to estimate the model with so few observations, there is a complication in that it might be unreasonable to expect that these complete observations alone will accurately reflect the decision-making behavior of these firms. However, as discussed below, those observations which are complete may be of some use in estimating the model.

Exchange Rates, Tariffs and Transportation Costs

As discussed in Chapter III, Pacific salmon are sold in a variety of regions in the U.S. and in foreign markets. Thus, the prices as reported on the invoices need to be interpreted with care. The role of exchange rates, tariffs and transportation costs is considered in the following discussion.

Figure 12 demonstrates, with the use of a four-quadrant diagram, the impact of a change in the exchange rate. The upper-left quadrant contains a linear function (ER) representing the exchange rate; this is used to translate excess demand in the importing country (in this example, ED_F for France) into excess demand in U.S. dollars (ED_{US}), the currency of the exporting country. The effect of an appreciation of the French franc against dollars is illustrated with an upward shift in the ER line, from ER_1 to ER_2. The equilibrium price in U.S. dollars, determined by the intersection of ES_{US} (excess supply in the U.S.), rises from P_1 to P_2 after the change in the exchange rate.

U.S. salmon producers export their product to many countries, not just France. The total demand faced by U.S. exporters includes domestic plus excess demand from all the countries importing salmon. A horizontal summation of all the excess demand curves yields a total excess demand curve, which in turn is equated with excess supply to determine a world price. Assuming a competitive market, this price holds true for all markets, domestic and foreign. Thus, a change in one importing country's exchange rate, as demonstrated above, shifts the total excess demand curve and affects the world price. The essential point is that the new world price resulting from a change in one country's exchange rate applies to <u>all</u> countries. Furthermore, the price in U.S. dollars on the invoices used in this study should not vary by country of destination due to the exchange rate.

Using a similar argument, it may be shown that, as with exchange rates, import tariffs in the individual country importing Pacific

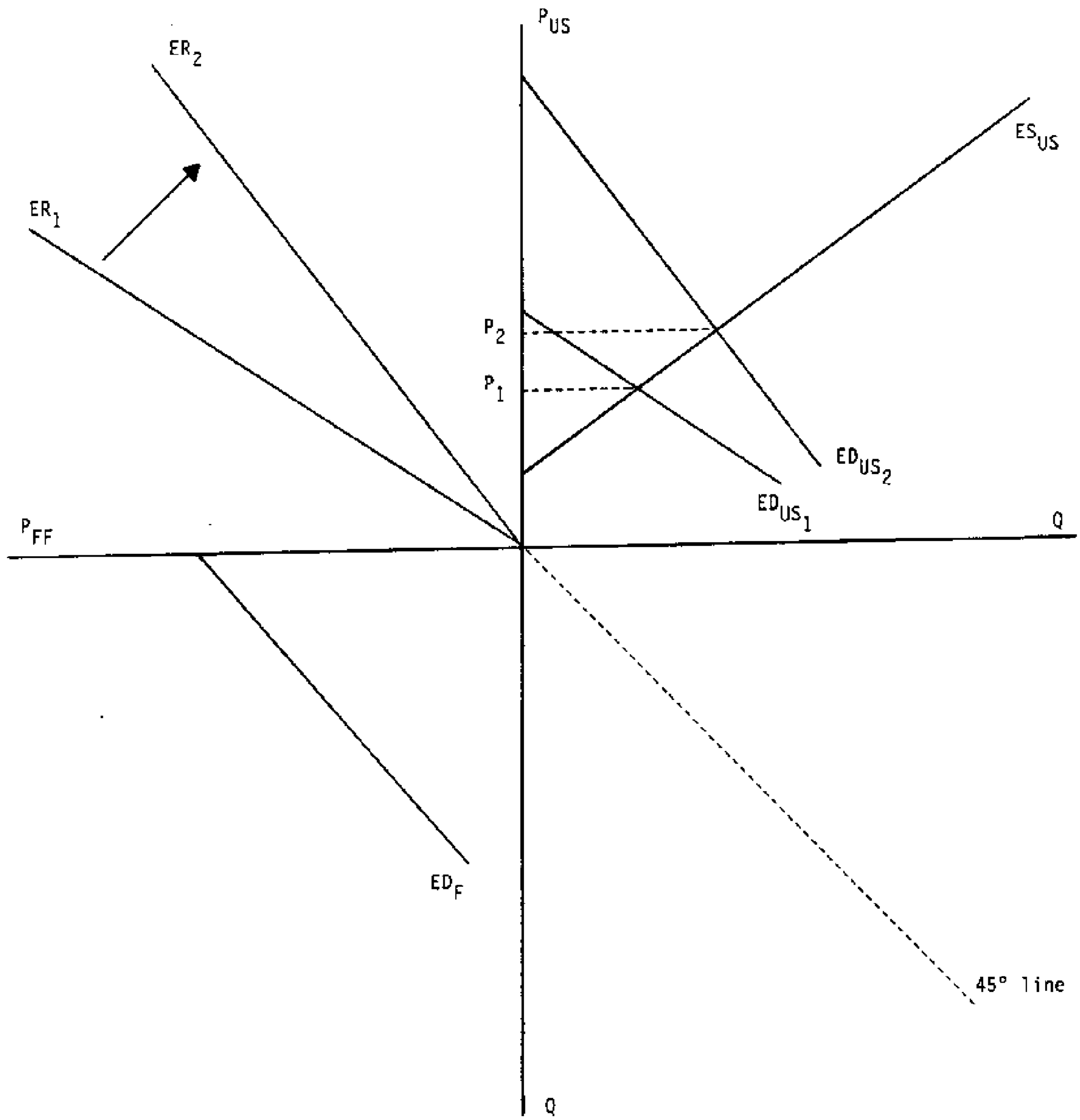

Figure 12. Exchange Rates and International Trade
Source: Edwards (1982)

salmon should not affect the price as it is shown on the invoices. Tariffs are paid by the importing country once the product arrives at its destination. In the case of an ad valorem tariff, this in effect changes the price in the importing country by some factor T. Assume the exchange rate relation is $P_{US} = c_1 (P_{FF})$. With a tariff, the price in U.S. dollars in the importing country may be stated as $P_{US} = c_1 (T)(P_{FF})$. It may be assumed that $(c_1)(T) = c_2$. Therefore, $P_{US} = c_2 (P_{FF})$. Thus, the imposition of an import tariff is analogous to a change in the exchange rate. As with the results demonstrated above, the world price is affected; however, the impact is "shared" by all importers, and the price in U.S. dollars on the invoices should not reflect tariff differences in the various countries of destination. It should be noted, however, that the quantity demanded in the country of destination will decrease as a result of an increased tariff or a devaluation of the currency.

If transportation costs are included in the price quoted on the invoice, salmon shipped to various destinations will exhibit different prices. Three of the firms surveyed for this study state that their prices are F.O.B. (firms 4,9 and 10). Two firms (firms 7 and 8) distinguish between F.O.B. and C.I.F., with the percentage of prices which are F.O.B. being approximately 15.11 percent and 42.34 percent, respectively. For the remaining four firms, there is no statement as to whether the prices are F.O.B. or C.I.F. If we select several examples at random from these firms with no F.O.B./C.I.F. classification, we can make a price comparison for salmon products sold in the same week to different destinations. For example, the price differential for one firm (firm 1) which may not be completely due to differences in transportation costs (e.g., quality aspects, volume of sale, and so on) ranges from approximately 4 percent to 10 percent.[16] It appears that eliminating the C.I.F. observations for those firms with the classification not only would result in a significant loss of freedom in certain cases; it would also imply that the data which are not distinguished as F.O.B. or C.I.F. would be less meaningful than those which are distinguished.

These invoice data are highly disaggregated; each observation represents one transaction. While economic studies may frequently suffer from problems of aggregation, working with extreme microlevel data such as those in this study presents special problems. Some generalizations need to be made, as seen above. It has been assumed that various types of king salmon may be grouped as kings. This categorization may seem to imply that the differentiation of king salmon, which is certainly undertaken by wholesalers, is not relevant to the marketing of salmon. The three size categories further

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[16] If the transportation cost per pound is equal for kings and silvers, the differential should be more pronounced for silver salmon than for kings.

exacerbate the problem of generalization, as some larges could be "extra-larges" and some smalls "extra-smalls." However, if the twelve categories of salmon products discussed above were broken down into even finer classifications, it would be impossible in most cases to estimate the equations in the model; indeed the estimation of some equations has already been eliminated by the twelve-fold division of the data. Furthermore, it is felt that even with the generalization which was required in this study, the model should reflect in some general fashion the pricing decisions of salmon wholesalers.

The 1976 Chinook and Coho Fisheries

The years for which the invoice data were collected varied across firms. This analysis focuses on 1976 because it is the year for which data were collected for all nine firms. This is fortunate since 1976 was a particularly interesting year for the salmon industry in the U.S. Not only was it the year of the imposition of the 200 mile limit, but exports were just beginning to expand, particularly to Japan and France (see Chapter III). Further discussion of the characteristics of the 1976 season should provide useful insights for the estimation of the model.

Seasons

The 1976 chinook and coho seasons for Washington, Oregon and California are shown in Table 8. It should be noted that 1976 seasons were determined by the individual state governments as the new federal regulations required with the passage of the FCMA in that year amounted to adopting the individual states' regulations pending regional councils' action. For Washington, the troll seasons occurred primarily in the summer and early fall, while the gillnet seasons began in July and ran through the end of the year. The Oregon troll fishery began in May for chinook and in late June for coho, running through the end of October for both species. In California, which has no commercial gillnet fishery, troll fishing for chinook and coho ran from spring through early fall.

Specific information on 1976 fishing seasons for chinook and coho in Alaska was available. However, this information was provided only for individual districts within several regions with different open seasons for a great number of specific areas. In addition, the regulations often stated opening dates while closing dates were to be determined by "emergency" orders; the dates of these closures were unavailable. Therefore, a more efficient method for observing chinook and coho season regulations may be that of examination of landings data.

Table 9 shows landings of chinook and coho for Alaska by gear type and region. These data are not available by month; however, section (b) of the table provides some insights into the timing of the

Table 8. 1976 Chinook and Coho Seasons for Washington, Oregon and California, by Gear Type.

State/Species	Chinook	Coho
Washington		
Troll	May 1 - June 22 July 1 - October 31	June 15 - 22 July 1 - October 31
Gillnet[a]		
Willapa Bay	July 6 - August 20; various days in August, September and October; November 4-30	
Grays Harbor	July 6 - August 13; various days in September, October, November and December	
Oregon[b]		
Troll		
North of Tillamook Head	May 1 - June 14 July 1 - October 31	July 1 - October 31
South of Tillamook Head	May 1 - October 31	June 15 - October 31
California[c]	April 15 - September 30	May 15 - September 30

[a] Not including Indian fisheries.

[b] No information on gillnet seasons available.

[c] California has no commercial gillnet salmon fishery.

Source: Washington Department of Fisheries, Pacific Fishery Management Council and California Department of Fish and Game (correspondence).

Table 9. Alaska 1976 Chinook and Coho Catch by Gear Type, by Region and 1976 Chinook and Coho Catch by Region, by Month.

Gear Type/Species		Region: Southeastern	Central	Western	Total
		(pounds)			
Net[a]	Chinook	145,416	1,296,285	4,474,861	5,916,562
	Coho	2,649,449	3,503,393	1,292,332	7,445,174
Troll	Chinook	2,952,803	12,272	0	2,965,075
	Coho	3,673,005	2,836	0	3,675,841

Month	Region/Species: Southeastern		Central		Western	
	Chinook	Coho	Chinook	Coho	Chinook	Coho
	(metric tons)					
January	1.24	---	---	---	---	---
February	2.26	0.03	---	---	0.01	0.02
March	7.01	---	---	---	0.04	---
April	32.20	---	---	---	0.12	---
May	223.76	---	199.25	---	0.54	---
June	546.75	31.20	244.94	0.17	1,392.51	0.10
July	303.07	375.60	129.15	445.50	641.38	12.68
August	203.09	1,366.00	20.12	728.97	10.16	538.98
September	55.73	1,066.52	0.05	414.91	0.53	38.69
October	18.20	39.73	---	0.64	0.01	---
November	8.92	3.45	---	---	---	---
December	3.41	---	---	---	---	---

[a] "Net" includes purse seine, beach seine, drift gillnet and set gillnet.

Sources: Alaska Department of Fish and Game Statistical Leaflet No. 29. International North Pacific Fisheries Commission: Statistical Yearbook (1976).

seasons by gear type. In the western region, all chinook and coho were harvested by the net fishery; June and July were the months with the greatest landings. For the central region, 99.1 percent of the chinook and 99.9 percent of the cohos were net caught. Thus, the monthly figures for chinook and coho in the central region apply almost exclusively to the gillnet fishery. May, June and July were the most productive months for chinook while coho were harvested primarily in July, August and September. For the southeastern region, 95 percent of the chinook were troll caught, with the greatest landings occurring from May through August. Coho in the southeastern region were landed with both troll and net equipment, 58.10 percent and 41.91 percent by quantity, respectively. It is difficult in this case to discern the share of monthly coho landings in each fishery. In summary, these figures provide a general indication of the timing of Alaska seasons in 1976. The gillnet fishery appears to have occurred primarily in May, June and July for chinook, and in June, July, August and September for coho. Troll fishing for chinook was concentrated in the months of May, June, July and August; for coho, the troll season is uncertain.

Landings

The U.S. harvest of chinook salmon for 1976 is shown in Table 10. Washington was the state harvesting the greatest share of chinook in that year (39.28 percent), followed by Alaska (29.46 percent) and California and Oregon (16.37 percent and 14.90 percent, respectively). May through September appeared to be the most important months for the chinook fishery in the four states, a period which generally coincides with the seasons discussed above. Total U.S. chinook landings in 1976 rose approximately 10 percent over 1975 levels.

Washington fishers also harvested the most coho salmon in 1976 with nearly 32 percent of the total catch (see Table 11). Oregon and Alaska held about equal shares of the harvest (29.21 percent and 29.02 percent, respectively), followed by California (10.09 percent). The months with the greatest landings were June through October, again reflecting the information on seasons. In contrast with chinook, total U.S. landings of coho salmon were up 41.64 percent over the previous year's catch.

Salmon Market Structure: 1976

A 1975 study of the Pacific Northwest salmon industry (Jensen, 1975) provides some insights into the market structure of the processing sector during this period. Jensen points out that since 1959 the salmon processing industry has been characterized as a "strong oligopoly," with four firms accounting for a large percentage of the production. It should be noted that Jensen's study concentrates on market structure at the ex-vessel level. Given the larger number of fishers relative to buyers, the conclusion that

Table 10. 1976 Landings of Chinook (King) Salmon, by State and by Month.

Month	State				
	Alaska	Washington	Oregon	California	Total U.S.
	(metric tons (round weight))				
January	1.24	5.34	---	---	6.58
February	2.27	13.51	---	---	15.78
March	7.05	14.18	30.79	---	52.02
April	32.32	15.02	---	243.48	290.82
May	423.55	413.76	86.95	639.86	1,564.12
June	2,184.20	643.28	143.61	689.31	3,660.40
July	1,073.60	764.75	301.32	391.10	2,530.77
August	233.37	1,354.14	515.68	194.25	2,297.44
September	56.31	1,832.19	737.15	89.64	2,715.29
October	18.21	293.72	212.25	---	524.18
November	8.92	37.14	17.54	---	63.60
December	3.41	6.28	---	---	9.69
Year Total	4,044.45	5,393.31	2,045.28	2,247.64	13,730.68

Source: International North Pacific Fisheries Commission: Statistical Yearbook (1976).

Table 11. 1976 Landings of Coho (Silver) Salmon, by State and by Month.

Month	State				
	Alaska	Washington	Oregon	California	Total U.S.
	(metric tons (round weight))				
January	---	0.68	---	---	0.68
February	0.05	0.03	---	---	0.08
March	---	---	---	---	---
April	---	---	---	---	---
May	---	0.68	---	368.65	369.33
June	31.47	442.84	791.30	755.80	2,021.41
July	833.78	1,418.35	2,517.29	516.20	5,285.62
August	2,633.95	957.15	1,236.30	110.01	4,937.41
September	1,520.12	915.60	259.38	9.87	2,704.97
October	40.37	1,536.61	226.58	---	1,803.56
November	3.45	207.42	65.31	---	276.18
December	---	48.27	0.08	---	48.35
Year Total	5,063.41	5,527.63	5,096.24	1,760.53	17,447.81

Source: International North Pacific Fisheries Commission: Statistical Yearbook (1976).

bargaining power is stronger on the buying side is understandable. This study deals with the wholesale market. Some of the ideas advanced in Jensen's study, however, may be applicable to the wholesale market.

From interviews and from observations of the data collected from the invoices of sellers of Pacific salmon at the wholesale level, various characteristics of the market may be discussed. It appears that high entry costs (particularly in the canning industry) limit the number of wholesalers of Pacific salmon. Furthermore, the relatively high level of risk associated with this industry may also account for the survivability of larger firms. There are numerous buyers; however, these range from small purchasers (e.g., individual restaurants and fish shops) to large buyers (e.g., domestic and foreign smoking companies and supermarket chains).

At first blush, then, it appears that bargaining power at the wholesale market level is concentrated on the seller side, and this may be the case for the majority of transactions. However, there is some evidence that large purchasers of Pacific salmon may be able to exert more influence on the prices at which transactions are carried out. Given Arrow's notion of bilateral monopolies, as discussed in Chapter II, this evidence seems to suggest that the "range of indeterminancy" will be skewed in a certain direction according to the size of purchase--reflecting, it is assumed, the greater bargaining power of larger buyers.

Estimation of the Model

In order to prepare the data for estimation, the observations from all firms are recorded such that the individual variables and format are consistent for the entire industry. The data are divided into twelve files according to the classification in Figure 11. Prices and quantities are calculated on a weekly basis, on the assumption that a week is short enough to be consistent with short-run behavior and long enough to permit the averaging out of possible errors in recording daily figures. The observations are ordered by firm, and by week and date within each firm.

Several of the variables hypothesized to influence asking price and quantity sold require preliminary manipulation of the data. Industry-wide figures include $\overline{P}_t$, $\hat{P}_t$ and n, as defined in the previous chapter. Thus, for each week, for each of the twelve types of salmon, a set of prices $\{p^1, p^2, \ldots, p^n\}$ occurs; n varies by week (and in certain weeks is 0) and is hypothesized to represent the sample of prices a dealer might observe in any given week in order to better estimate his or her firm's demand curve. In this data set, in fact, $\{p^1, p^2, \ldots, p^n\}$ is the total set of prices (in the data set) for that type of salmon in week t. There is some bias, therefore, in assuming that all the nine firms observe the same set;[17] however, there is once again a strong possibility of losing too many observations if a random subset of $\{p^1, p^2, \ldots, p^n\}$ were used for each firm. It should also be noted that the firm's own price is included in the subset; this approach was also taken in Garbade et al.

The average price calculated from the industry-wide data is a weighted average:

$$\bar{P}_t = \frac{\sum_i P_t^{i*} q_t^i}{\sum_i q_t^i}$$

and the variance is a weighted variance:

$$\sigma P_t^2 = \frac{\sum_i (P_t^{i*} - \bar{P}_t)^2 q_t^i}{\sum_i q_t^i}$$

Because a firm might engage in more than one transaction for a given type of salmon each week, some additional values must be generated. First, an "average asking price" ($\bar{P}*$) for firm i is calculated for each week:

$$\bar{P}* = \frac{\sum_j P*_j \cdot q_j}{\sum_j q_j}, \quad j = 1, \ldots, z$$

where z = number of transactions for that firm, for that type of salmon each week. In addition, the presence of more than one transaction per week requires the summation of quantity sold for each firm. Thus, the second equation in the model becomes

$$q_t^s = g(\bar{P}_t^* - \bar{P}_t),$$

where $$q_t^s = \sum_j q_{j,t}, \quad j = 1, \ldots, z.$$

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[17] It is also assumed that all buyers observe this set.

There is a problem with estimating the equation for asking price, since one of the exogenous variables, q_t^* (optimal quantity) is not directly observable. In some previous studies (such as Kawasaki et al.) the quantity $(q_t^* - q_t^s)$ is represented through changes in inventories. In the salmon industry, however, there is some argument as to whether $(q_t^* - q_t^s)$ may be adequately represented by shifts in inventory, since there is some confusion, as discussed earlier, between production and inventory.[18]

It may be demonstrated that, <u>ceteris paribus</u>, if

$$(\overline{P}_{t-1}^* - \overline{P}_t^*) > 0,$$

then

$$(q_{t-1}^* - q_{t-1}^s) > 0.$$

However, it would be inappropriate to use the difference between asking price in two periods as a proxy for the divergence between desired and actual quantity sold; $\overline{P}_t^*$ would appear in the equation as both the endogenous and an exogenous variable. It appears that the best proxy that can be advanced for $(q_{t-1}^* - q_{t-1}^s)$ is q_{t-1}^s, the amount sold in the previous time period.[19] This is admittedly an imperfect proxy. However, it does follow the hypothesis of previous studies (e.g., Garbade et al.) that the firm uses its own information in estimating its optimal price, such as quantities exchanged in recent time periods.

<u>Costs</u>

The equation for asking price includes a factor "Costs_t," representing the role of production costs in determining marginal costs; these in turn are equated with estimated marginal revenue to arrive at an optimal price and quantity, $\overline{P}_t^*$ and q_t^*. Thus, there is a need to provide some factor reflecting costs to the Pacific Northwest salmon producer. The cost of the salmon input, which is ex-vessel price, is obviously an important factor. However, given the practice of setting a minimum ex-vessel price for salmon before the season through negotiations between fishers and processors, this price varies very little within a given season. Furthermore, ex-vessel prices do not include bonuses paid to the fishers, although even these may not affect the price per pound but by a constant amount, as demonstrated in the following example.

Assume that processors pay bonuses according to how many pounds each fisher landed during the season. Suppose two fishers work for

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[18] Furthermore, inventory figures are not available by firm.

[19] If desired quantity were constant, this approach would be legitimate.

the same packer, with the following description of season landings and revenues:

	Fisher #1	Fisher #2
Total Pounds Landed in Season	10,000	100
Minimum Ex-vessel Price	$1.00	$1.00
Gross Revenue	$10,000	$100
Bonus	$500	$5
Total Gross Revenue	$10,500	$105
Price Received per Pound (Cost per lb. to Processor)	$1.05	$1.05

Thus, even if data on bonuses were available, if these vary across fishers in approximate proportion to total landings sold to the processor, "true" ex-vessel price still is fairly constant throughout the season.

Another important cost is wages. The Bureau of Labor Statistics publishes a monthly wage for workers in canned, cured and frozen seafoods. These data, shown in Table 12, may provide useful information on changes in the firm's cost functions during the season. The data were interpolated in order to obtain weekly figures; these calculations imply the assumption that movements in wages between monthly points follow along a straight line.

Estimation of Price Equations

Data

The data sets and firms for which the estimation of the price equations is possible are identified in Table 13. Certain data sets, such as those for gillnet silvers, do not have sufficient observations for estimation. Some of the sets listed in the tables skip one observation, and thus, analysis requires dropping two observations because of the use of lagged variables.

It should be emphasized that although the equations are estimated only for those firms listed in Table 13, the information for the remaining firms is included in the calculation of average industry

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[20] In what follows, for notational convenience, $\sigma^2_{P_t}$ and $\sigma^2_{P_{t-1}}$ are replaced by σ^2_t and σ^2_{t-1}, respectively.

Table 12. Average Hourly Earnings, 1976; Canned, Cured and Frozen Seafoods.

Month	Wage
January	3.71
February	3.74
March	3.83
April	3.85
May	3.85
June	3.84
July	3.88
August	3.88
September	3.94
October	3.93
November	4.00
December	4.04

Source: Bureau of Labor Statistics: Employment and Earnings. Various issues; Table C-2.

Table 13. Estimated Equations.[a]

Salmon Product			Firm # (no. of weeks)			
Species	Size	Gear-Type				
Kings	Small	Troll	1 (19)	3 (24)	5 (27)	7 (15)
Kings	Medium	Troll	1 (22)	3 (24)	5 (25)	7 (16)
Kings	Large	Troll	1 (22)	3 (27)	5 (27)	7 (15)[b]
Kings	Medium	Gillnet	10 (25)[b]			
Kings	Large	Gillnet	7 (17)[b]	10 (15)		
Silvers	Small	Troll	3 (20)	5 (21)		
Silvers	Medium	Troll	3 (17)	5 (29)		

[a] These subfiles had a minimum of 15 observations. Equations were not estimated for the remaining five salmon products due to insufficient observations.

[b] These files had one missing observation.

price ($\overline{P}_t$) and the variance of industry price (σ^2_{Pt}). For some weeks, however, only one firm sold a given type of salmon. In this case, $\overline{P}_t = \overline{P}^*_t$. If the firm engaged in only one transaction, or if it sold more than once at the same price, then the variance of industry price is zero. If, however, the firm sold salmon more than once that week, and if the price varied over the week, then variance is greater than zero. Thus, the data may show $\overline{P} = \overline{P}^*_t$ and $\sigma^2_{P_t} = 0$.[20] This phenomenon occurred only infrequently, however.

In certain cases, the relevant weeks over which a firm's asking price equation is estimated include observations where $\overline{P}_t = \overline{P}^*_t$ (and thus the price difference equals zero) or where the variance of price is zero. Some argument needs to be advanced over how to handle such cases. The calculation of the variance of price used in these equations is undertaken with the expectation that it reflects the actual variance of price observed by the firm manager in that week. This seems fairly reasonable, except in the cases where the data sets show a zero variance. It is highly likely that another firm, which was not in the survey, also sold salmon that week, and thus zero is an unsatisfactory estimate for the actual variance.[21] If the week under consideration is out of season, then the true variance may be more inclined to be close to zero as fewer transactions are made; however, a zero variance in "middle" of the data sets does not appear reasonable. For these reasons, then, cases where the calculated variance equals zero are eliminated from the equations.

For the firms which have weeks in their data sets where $\overline{P}^*_t = \overline{P}_t$, there is often a zero variance as well, such that the observation is omitted. However, for those cases where variance is not zero, more than one observation is used for the calculation of the average price. It thus appears reasonable to assume that the zero price difference is simply a reflection of the proximity of the firm's average price that week to the average industry price. In such an instance, it would be expected that zero is not an unreasonable estimate for the price difference. Thus, for those cases for which the price difference is zero but the variance is greater than zero, the observation is included in the analysis.

The above discussion of zero price differences and variances pertains to "special cases." In most weeks, there is a substantial degree of price variation across sampled firms. These variations in price may be the result of quality differences, special buyer-seller relationships and other factors discussed earlier. However, the classification system used in this analysis is designed to reduce the influence of these factors. Thus, the data as arranged in these subsets permit testing of the model of price-searching behavior by buyers and associated buyer reactions.

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[21] The exclusion of sales made by firms outside the sample may also result in misestimation of the variance.

Model

A subset of the data sets in Table 13 was used to test various aspects of the model. Such testing can be regarded as the hypothesis-generating phase of the empirical study. The theoretical development outlined earlier provides little guidance regarding the appropriate functional form for estimation, the period of analysis and, most important, the way in which the model can be subjected to a critical test in the environment of this particular industry. Three versions of the model were selected for application to the 19 data sets. These appear in Table 14. The following discussion focuses on the various considerations which led to the selection of these versions of the asking price model.

One of the first issues faced in specifying an appropriate estimating equation pertained to the variable n, the number of price quotes observed by the seller. In Garbade et al. the effect of n and the variance are demonstrated with the use of a composite variable:

$$x_{t-1} = \sigma^2_{t-1}(\overline{P}_{t-1} - \overline{P}^*_{t-1})/n_{t-1} \text{ , where } \partial\overline{P}^*_t/\partial x_{t-1} < 0 \text{ .}$$

This composite variable exhibited mixed results in some of the preliminary runs. It appears that there are some problems resulting from the definition of n in this model as opposed to that of Garbade et al. In the present model, if one dealer engages in 10 transactions and all of these are at the same price P*, these prices would imply n=10. In Garbade's model, n would be unity. Thus, it seems that, because of the different meaning of n in this model, the effect of observing a set of price quotes would be better represented by an "adjusted variance" variable.

$$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1}) \text{ .}$$

Thus, the effect of the number of price quotes on the faith placed by the seller in the observed price differences is not estimated here because the data do not permit calculation of the "number of price quotes" in the Garbade et al. sense. The influence of n, however, is probably reflected in the variance measure.

A positive coefficient for the adjusted variance variable is hypothesized, since the firm's confidence in the lagged average industry price decreases when it is derived from a set of prices with a greater variance. This may be demonstrated by taking the derivative:

$$\partial\overline{P}^*_t/\partial\overline{P}_{t-1} = \alpha_1 - \alpha_2\ \sigma^2_{t-1} \text{ .}$$

Table 14. Price Equations Estimated.

Equation	Model Version (Expected Signs of Coefficients)
I	$\overline{P}^*_t = \alpha_0 + \underset{(+)}{\alpha_1}\overline{P}_{t-1} + \underset{(+)}{\alpha_2}[\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})] +$ $\underset{(+)}{\alpha_3}(Wages_t) + \underset{(+)}{\alpha_4}[\overline{P}^*_{t-1} \cdot q^s_{t-1}]$
II[a]	$\overline{P}^*_t = \beta_0 + \underset{(+)}{\beta_1}\overline{P}_{t-1} + \underset{(+)}{\beta_2}[\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})] +$ $\underset{(+)}{\beta_3}[\overline{P}^*_{t-1} \cdot q^s_{t-1}]$
III[a]	$\overline{P}^*_t = \gamma_0 + \underset{(+)}{\gamma_1}\overline{P}_{t-1} + \underset{(+)}{\gamma_2}[\sigma_2(\overline{P}^*_{t-1} - \overline{P}_{t-1})] +$ $\underset{(+)}{\gamma_3}(Wages_t)$

where:

$\overline{P}^*_t$	= Firm average weekly price
$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$	= Adjusted variance (σ^2_{t-1} = var(P_i))
$Wages_t$	= Seafood industry wages
$\overline{P}^*_{t-1} \cdot q^s_{t-1}$	= Sales of firm
and $t = w, \ldots, W$	(weeks)

[a] Results reported in Appendix B.

As the average industry price increases, $\overline{P}^*_t$ increases. However, this increase is dampened by the factor $\alpha_2\sigma^2_{t-1}$, which increases as σ^2_{t-1} rises. Thus, a positive coefficient is expected for α_2.

Another difficulty arose with the specification of q^s_{t-1} as a proxy for the divergence between desired and actual sales. It was felt that if q^s_{t-1} increases by a significant amount, then there is a greater probability that q_{t-1} was greater than q^*_{t-1} and that the firm would tend to raise its price in the presence of greater perceived demand. The performance of q^s_{t-1} was unsatisfactory (in terms of t-values), which suggested that an alternative proxy might be more appropriate, rather than rejecting the hypothesis that the divergence between desired and actual sales led to adjustments in the asking price. Thus, a new proxy was constructed: lagged sales, as measured by

$$\overline{P}^*_{t-1} \quad q^s_{t-1} .$$

The use of this alternative proxy did not change the signs of the proxy variable coefficient for any of the test equations; however, results in terms of adjusted R^2 and t-values were slightly higher. Because there is some question over whether lagged sales is a satisfactory proxy for the divergence between desired and actual quantity sold, equation III (results in Appendix B) is estimated for the entire 19 data sets. As seen in the tables, dropping the lagged sales proxy resulted in changed coefficient signs for the other explanatory variables in only three cases. This suggests that including this proxy does not disturb the directional influence of the industry and own price variables on the pricing decisions of salmon sellers.

Wages are often highly correlated with other exogenous variables, particularly lagged average price. It appeared that this correlation, which in some cases is as high as .90, might have been interfering with the estimation of the true model. Since the seafood wage level affects the costs of the dealers, it would be expected to affect the asking price. However, the impact of wages on the price level may already be included in the level of average industry price, $\overline{P}$. Unless wages change dramatically from one week to the next, the average price from the last time period may already be accounting for labor costs. Thus, equation II estimates the price relationships without the wage variable (see Appendix B). There are two cases in which the elimination of the wage variable changed a coefficient on another exogenous variable. For both of these, there was a correlation between wages and the other variable in question, e.g., .90 for firm 7, large troll kings. In all other cases, however, there is stability in the estimated relationships among prices and price variance.

Results for Equation 1

The purpose of estimating these equations is to see if, in fact, the postulated model of firm behavior reflects the pricing decisions of actual participants in the salmon industry. In some cases, the model appears to support some of the hypotheses advanced in the previous literature, as modified to reflect characteristics of the salmon industry. In other cases, the model appears to be less appropriate. An attempt is made, then, to consider why the model is representative of pricing decisions in certain cases and not in others and what adjustments or alternative models might be appropriate for these other cases.

Troll Kings

The estimated coefficients for small, medium and large kings are shown in Tables 15, 16 and 17, respectively, along with the associated statistics.[22] For all nine equations estimated for firms, 1, 3 and 5, lagged average industry price is positive and significant. These results imply that these firms do in fact use last week's average industry price as an indicator for their estimates of demand and adjust their own asking price accordingly. Furthermore, the estimated coefficients for adjusted variance are positive in all nine equations and often significant. These results indicate that the use of lagged average industry price in formulating the asking price is reduced as variance increases, a finding which gives further empirical support to Garbade et al.'s hypothesis, as modified in the present study.

The coefficient on wages is positive in six of the nine cases as hypothesized. The proxy for divergence between desired and actual quantity sold is positive in five cases, and insignificant in all but one case. The correlation between wages and other exogenous variables and the difficulties with the proxy for $(q^*_{t-1} - q_{t-1})$ led to some confusion in interpreting the results for these two variables.

It is apparent then that the model does represent certain aspects of pricing decisions for these three firms. However, results for firm 7 indicate that the decision-making behavior of firm 7 does not follow that of the model--or that of the other three firms. There are apparently some differences between the firms which are brought out by the model. From the Data Tables in Appendix A, we see that the first

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[22] The Durbin-Watson d statistic (D-W) as reported in Tables 15-21 should be interpreted with caution. The presence of a lagged endogenous variable as an explanatory variable results in a biased estimate of serial correlation. In this model, however, the lagged endogenous variable appears as a product with another variable (lagged sales) and as a difference from and product with two other variables (lagged adjusted variance); thus, the Durbin-h statistic is difficult to calculate. The resultant bids from these two composite variables are uncertain, and the derivation of another measure for serial correlation is beyond the scope of this study.

Table 15. Price Equations: Kings, Small, Troll.

		Exogenous Variables				
Firm (n)	Adj R^2 (D-W)	Constant (t)	$\overline{P}_{t-1}$ (t)	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$ (t)	$Wages_t$ (t)	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$ (t)
1 (18)	.15613 (1.6434)	2.8840 (.2104)	0.4351 (1.4472) 1*	4.0172 (1.0015)	-.4890 (-.1333)	0.9675E-05 (.5466)
3 (23)	.73996 (1.8220)	-7.2333 (-1.0568)	0.5694 (3.0365) 5*	5.6305 (1.9803) 2*	2.0694 (1.1222)	0.4511E-06 (.3386)
5 (26)	.59328 (1.6980)	-1.3431 (-.2936)	0.4027 (2.6691) 4*	1.9873 (1.0657)	0.6626 (.5342)	0.1067E-04 (2.0162) 2*
7 (14)	.03621 (.9837)	-31.0516 (-1.8292) 1*	-.2988 (-.4152)	-4.1200 (-1.2668)	8.7316 (1.9302) 2*	-.6711E-05 -.5800)

Note: t-value confidence levels for all results:

1* = 90%　　4* = 99%
2* = 95%　　5* = 99.5%
3* = 95.5%　　6* = 99.9%

Table 16. Price Equations: Kings, Medium, Troll.

Firm (n)	Adj R^2 (D-W)	Exogenous Variables: Constant (t)	$\bar{P}_{t-1}$ (t)	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$ (t)	$Wages_t$ (t)	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$ (t)
1 (21)	.26791 (1.6908)	1.2485 (.1856)	0.2910 (1.9464) 2*	1.2579 (1.3675) 1*	0.5582E-01 (.3102E-01)	-.2593E-05 (-.7795)
3 (23)	.75816 (1.5551)	-7.4892 (-.9769)	0.5108 (3.5012) 5*	2.5763 (1.8211) 2*	2.1763 (1.0683)	0.15801E-05 (.7867)
5 (24)	.43377 (1.5732)	-5.0449 (-.6473)	0.3438 (1.4435) 1*	0.5204 (.1653)	1.6972 (.8024)	-.6530E-06 (-.1189)
7 (14)	.28630[a] (1.6476)	9.3907 (.2763)	-.4266 (-.6251)	-1.8661 (-1.0123)	-1.5530 (-.1710)	.5068E-05 (1.6771) 1*

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%　　4* = 99%
2* = 95%　　5* = 99.5%
3* = 95.5%　　6* = 99.9%

Table 17. Price Equations: Kings, Large, Troll.

Firm	Adj R^2	Exogenous Variables				
		Constant	$\overline{P}_{t-1}$	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$	$Wages_t$	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$
(n)	(D-W)	(t)	(t)	(t)	(t)	(t)
1 (21)	.57639 (1.9584)	24.5617 (2.9936) 5*	1.0213 (4.1284) 6*	6.9741 (3.5068) 5*	-6.3649 (-2.842) 4*	-.2478E-05 (-.2447)
3 (26)	.8487 (1.46201)	4.9338 (.7162)	0.7980 (4.5697) 6*	4.5411 (2.6699) 4*	-1.1630 (-.6205)	0.8771E-06 (.5872)
5 (26)	.5572 (2.26633)	-3.2577 (-.3092)	0.7503 (2.1830) 3*	5.3191 (1.1429)	1.0221 (.3502)	-.5043E-06 (-.6843E-01)
7 (13)	.28308[a] (2.7155)	14.8859 (.2142)	0.3368 (.1307)	9.4646 (1.1302)	-3.3698 (-.1729)	0.2028E-05 (.1544)

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%   4* = 99%
2* = 95%   5* = 99.5%
3* = 95.5%   6* = 99.9%

particular characteristic of firm 7 is that it is selling salmon over somewhat different time periods. For the medium and large kings, a missing observation causes a discontinuity in the data set. Furthermore, it appears that firm 7 is engaging in some larger transactions, on average, than the other firms. Much of this salmon is being sold frozen, while that of firms, 1, 3 and 5 is sold primarily fresh. The large, frozen salmon transactions of firm 7 may be indicative of forward contracting, which would imply that a more appropriate model for firm 7 would entail greater lags on both the average industry price and the adjusted price. This further suggests the need to exercise care in distinguishing between dates on which sales are consummated and dates on which deliveries are made. Unfortunately, data on the former are not generally available.

Gillnet Kings

The results of estimating the price equations for gillnet kings, shown in Tables 18 and 19, also indicate that the model may not always be appropriate. Again, one of the problems with these results may be attributable to the discontinuity and lower degrees of freedom of the data sets. It should again be noted that for firm 7, at least, the predominance of frozen salmon may indicate that a greater lag on the price and adjusted variance variables would be more reflective of price determination in this case. Another important factor is the possibility of greater heterogeneity with gillnet salmon as opposed to troll caught. In some cases, such as firm 7 and firm 10 for the medium gillnet kings, the firm's average price is predominantly below the average industry price. These firms may be selling salmon which is, for some reason, of lower quality than that of the average gillnet king.[23] This also suggests that there may be important (large) sellers of gillnet salmon which are not included in the analysis. Hence, the appropriateness of the model should not be rejected without further exploration of the structure of this segment of the salmon market.

Troll Silvers

The price equations for small and medium troll silvers, shown in Tables 20 and 21, are estimated for firms 3 and 5. Aside from the results for firm 3's medium salmon, the estimated coefficients generally support the findings of the equations for troll kings. The estimated coefficients for lagged average industry price and adjusted

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[23] For one of these firms, which will not be identified in order to maintain confidentiality, a significant amount of Indian fish was sold. These are generally harvested further upriver and thus are considered to be of lower quality.

Table 18. Price Equations: Kings, Medium, Gillnet.[a]

Firm	Adj R^2 [b]	Exogenous Variables				
		Constant	$\bar{P}_{t-1}$	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$	$Wages_t$	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$
(n)	(D-W)	(t)	(t)	(t)	(t)	(t)
10 (15)	.09341 (1.6122)	13.0148 (1.0949)	-.1610 (-.3353)	-7.2776 (-.4967)	-2.6331 (-.8635)	-.1606E-05 (-.3581)

[a] There were 26 cases; however, one case was deleted because of the lagged variables, and nine cases were deleted because $\sigma^2(\bar{P}^*_{t-1} - \bar{P}_{t-1})$ was equal to zero. Poor results (e.g., low t-values and R^2) may be due to skipping over cases.

[b] All adjusted R^2 were reported as equal to zero. therefore unadjusted R^2 is presented.

Table 19. Price Equations: Kings, Large, Gillnet.

Firm	Adj R^2	Exogenous Variables				
		Constant	$\overline{P}_{t-1}$	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$	$Wages_t$	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$
(n)	(D-W)	(t)	(t)	(t)	(t)	(t)
7 (13)	.10332[a] (1.2357)	20.8039 (.6639)	0.3411 (.4204)	0.2575E-01 (.1400E-01)	-5.0141 (-.6069)	-.9159E-05 (-.7463)
10 (10)	.16758 (0.8526)	-15.6559 (-.5348)	-.6550 (-2.3552) 2*	-1.8246 (-1.4093)	5.1575 (.6739)	-.2878E-05 (-.3849E-01)

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90% 4* = 99%
2* = 95% 5* = 99.5%
3* = 95.5% 6* = 99.9%

Table 20. Price Equations: Silvers, Small, Troll.

Firm (n)	Adj R^2 (D-W)	Exogenous Variables: Constant (t)	$\overline{P}_{t-1}$ (t)	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$ (t)	Wages_t (t)	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$ (t)
3 (19)	.71222 (1.8668)	-5.7631 (-1.6781) 1*	0.2306 (1.3789) 1*	11.9463 (1.9728) 2*	1.8371 (1.9743) 2*	-.7443E-06 (-1.1283)
5 (20)	.50867 (1.6925)	4.4437 (.7190)	0.9304 (2.5353) 3*	4.8127 (.9698)	-1.0935 (-.6264)	0.1193E-07 (.1565E-01)

Note: t-value confidence levels for all results:

1* = 90% 4* = 99%
2* = 95% 5* = 99.5%
3* = 95.5% 6* = 99.9%

Table 21. Price Equations: Silvers, Medium, Troll.

Firm	Adj R^2	Exogenous Variables				
		Constant	$\bar{P}_{t-1}$	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$	$Wages_t$	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$
(n)	(D-W)	(t)	(t)	(t)	(t)	(t)
3 (16)	.13528[a] (2.2979)	-6.3374 (-.5859)	-.5246 (-.9249)	-6.5297 (-.5585)	2.4401 (.8180)	-.4659E-05 (-.7229)
5 (28)	.53083 (1.2227)	-2.8784 (-1.1383)	0.5088 (3.0006) 5*	8.0842 (1.0907)	0.9859 (1.4068) 1*	0.5451E-06 (.7326)

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%   4* = 99%
2* = 95%   5* = 99.5%
3* = 95.5%   6* = 99.9%

variance are positive and significant in three of the equations. There is no clear indication why the results for medium silvers for firm 3 do not coincide with those for the other three equations, although it may be important to note that firm 3, on average, charged a price below the industry mean. The data set for firm 3's medium silvers also covers a shorter time period than do the other sets.

Summary: Price Equations

It has been demonstrated that, in the face of price disequilibrium, firms do not necessarily behave as price takers in the Pacific salmon market. The firm managers are attempting to determine "true market price" or their demand curve through the use of various indicators. In most cases, the average price from last week is used, although the use of this information is dampened by the presence of variance in the prices observed. In some cases, sales in the previous week also play a role in determining the firm's estimate of optimal asking price. These results are shown to apply to a certain number of cases, particularly in the sale of fresh salmon.

Results of Estimation: Quantity Equations

The use of $(\overline{P}^*_t - \overline{P}_t)$ as the explanatory variable in the estimation of demand for a firm's product is suggested in the study by Carlson and McAfee, as discussed in Chapter IV. For reasons discussed below, however, it was felt that a more appropriate form for the demand for a firm's salmon each week is

$$q^s_t = g(\overline{P}^*_{t-1} - \overline{P}_{t-1}) \ .$$

There are at least two factors underlying this approach. First, given the fact that $\overline{P}^*$ represents an average price for transactions made throughout the week, $\overline{P}^*_{t-1}$ might provide a closer estimate of the price at which a given q^s_t was actually sold, particularly for transactions made (or at least negotiated) towards the beginning of the week. Secondly, since sellers are changing their price during the week, buyers are probably reacting to last week's price (or the price towards the beginning of the current week, which is closer to last week's price) and, thus, their action of search, taken collectively, influences the price at which they actually purchase. This is another way of stating that some of the decisions made in the salmon market are made under disequilibrium conditions, e.g., in response to last week's price for this week's transactions. Thus, the theoretical model of quantity demanded from each firm is estimated empirically with a one-period lag on the price difference variable.

One-third (32 percent) of the quantity equations estimated for the 19 data sets have an adjusted R^2 greater than zero. The coefficient on price difference is unexpectedly positive in 79 percent of the estimated equations. Table 22 reports results for a few of those data sets for which the asking price model, discussed in the previous section, appeared to be most appropriate. The rest of the estimated equations appear in Appendix B, Table B-8. It should be noted that the use of the prices predicted by the asking price model, as opposed to the observed prices themselves, does not significantly affect the results.

The estimation of quantity demanded by each firm as a function of its price alone is also attempted. While the adjusted R^2 values are not improved over those for the price difference model, the expected negative sign on the average firm price appears in 42 percent of the equations (See Table B-9). As is the case with some of the estimated equations for asking price, it appears that some other factors are at work in the determination of quantity sold by each firm. Some of these issues are addressed in the following discussion.

First, it should be noted that Carlson and McAfee state that the relation

$$q_t^s = g(\bar{P}_t^* - \bar{P}_t)$$

will hold at equilibrium when there is price dispersion in the market. As discussed in the previous section, it is possible that these weekly data are not equilibrium data. This implies that their approach may be more suitable for data which are less short run in nature, such as monthly data. Furthermore, Carlson and McAfee call this equation the "demand equation." In fact, in this estimation, q is quantity sold. It may be that, particularly if these are disequilibrium data, quantity demanded = quantity sold. For example, a seller who sets a relatively low price may sell all his or her inventory of that salmon and thus have to turn away buyers. In this case, quantity demanded > quantity sold.[24] Fluctuations in supply (at the ex-vessel level) lend additional support to the possibility of such phenomena and suggest that certain supply factors may be at work here.

In addition, this model for quantity demanded from each firm does not take into account the fact that buyers may not be aware of the location of lower prices. Previous studies do assume that buyers know the price distribution; however, the buyers do not know <u>where</u> the lower prices are located (which firms). In these previous studies, the notion of search costs is included, such that some buyers will be informed and some uninformed. These studies also introduce some probabilities of uninformed buyers being "lucky" and "unlucky." In

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[24] This would be equivalent to Kawasaki et al.'s indicator of unfilled orders.

Table 22. Results: Quantity Equations.

Salmon Product	Firm (n)	R^2 (D-W)	Exogenous Variables: Constant (t)	$(\bar{P}^*_{t-1} - \bar{P}_{t-1})$ (t)
Kings, Small, Troll	1 (18)	0.18094 (2.159)	1,582.951 (3.407) 5*	2,586.952 (1.880) 2*
	3 (23)	.00719 (1.407)	8,915.581 (1.502) 1*	-10,728.742 (-.390)
Kings, Medium, Troll	1 (21)	.08264 (2.381)	4,906.093 (2.995) 5*	4,704.624 (1.308)
	5 (24)	.00961 (2.280)	2,105.957 (2.911) 5*	1,323.524 (0.462)
Kings, Large, Troll	3 (26)	0.16126 (1.101)	10,481.677 (4.756) 5*	15,270.249 (2.148) 3*
	5 (26)	.00271 (2.170)	1,460.689 (2.633) 4*	474.586 (.255)
Silvers, Small, Troll	3 (19)	.04744 (0.5848)	25,652.321 (3.113) 5*	60,118.237 (.920)

Note: t-value confidence levels for all results:

1* = 90%   4* = 99%
2* = 95%   5* = 99.5%
3* = 95.5%   6* = 99.9%

the present model, it is hypothesized that when a seller's price rises relative to other sellers' prices, his or her quantity sold falls. In fact, the seller may still be able to attract some buyers, particularly the unlucky uninformed.

In addition, this model does not consider the role of buyer-seller loyalty, which can be very crucial in the seafood industry. A seller who raises price relative to the industry average may continue to attract some buyers because of his or her reputation for high quality salmon (or because some buyers are uninformed, as discussed above). Even if buyers are aware, then, they may consider a move to another seller too risky; thus, a larger price differential is required before switching to an unknown (or uncertain) seller. This characteristic of the Pacific salmon market may be related to Salop's (1976) concept of "dynamically captive markets" in which prices can oscillate over time. These issues are particularly relevant to a fishery product market in which there may be considerable heterogeneity, or at least apparent heterogeneity (to the buyer) of the good in question. These characteristics of the seafood market suggest that market price may in fact reflect "price per effective unit" of the good. In other words, although the price may vary between two firms' large troll kings, the actual price of usable product may be similar.

While it is difficult to make inferences about the coefficients determined in the estimation of the quantity equations, the high frequency of a positive estimated coefficient on the lagged price difference merits consideration. When the average industry price of a salmon product rises, aggregate quantity demanded falls. If the price of an individual seller rises by less than the increase in industry price, this seller may also sell less salmon; however, it would be expected that the seller will capture a larger share of the market. Thus a market shares model might be more appropriate since the present model does not take into consideration the issue of the impact of changes in aggregate demand and supply, i.e., the determination of P.

One final issue underlying the determination of quantity sold is discussed in Chapter II. On pages 15 to 19 there is a discussion of the relation between changes in quantity and price as the marginal cost and marginal revenue curves shift. Figures 1 and 2 demonstrate two interesting possibilities which may occur when the firm's marginal cost and perceived demand curve shift: (i) price may change with no change in output; (ii) output may change with no change in price. If indeed the firm has accurately (or closely) estimated its true demand curve, then prices may vary without any change in quantity and vice versa. The lack of a strong relationship between price and quantity in these estimated equations may be partially attributable to such phenomena.

Some of these issues may be considered in greater detail by taking advantage of those data sets for which buyer names are available. The price equations were clearly distinguished by seller, which allowed for comparison of the results according to various seller characteristics. Unfortunately, the buyers' responses are aggregated in this weekly examination of quantity sold by each seller. It would be interesting to see, for example, whether or not buyers do need a significant price differential before "switching" to another seller. Other issues such as forward contracting and tie-in sales may also be considered by focusing on one or two firms for which such information is available.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study is to address some issues concerning the Pacific salmon industry which previously either have not been approached or have been considered only within the framework of the theory of perfect competition. In this research an attempt is made to model the short-run decision-making behavior of buyers and sellers of salmon at the wholesale level.

The traditional approach is to assume that sellers (and buyers) are price takers. Firms in this case equate their known, perfectly price-elastic demand curve with their marginal cost curve, thereby determining an optimal output level. For long-run studies, such as those examining annual trends in the salmon market, this approach has been satisfactory.

However, if the goal is to explain how market participants make their decisions on a daily basis, a different approach is required. The rationale for seeking an alternative to the perfectly competitive, price-taking model stems from various characteristics of the Pacific salmon market which appear, at least in the short run, to diverge from those of the theoretical competitive market. These characteristics include price and quality variation, buyer-seller loyalty, imperfect information, seasonal variations in production and government regulation.

A review of the literature concerned with uncertainty and market disequilibrium provides some clues as to how to approach some of these issues. Various theoretical and empirical models in the previous research provide some guidelines for constructing a model of seller and buyer behavior. A model hypothesized to simulate the behavior in the market for fresh and frozen Pacific salmon postulates a price-setting equation for each seller and a quantity-accepting relationship for the wholesale buyers of salmon.

The empirical test of the asking price equation, which models the behavior of price-searching sellers, produces evidence that in several cases this model does reflect decision making by the surveyed firms. For those cases where the model appears to be appropriate, it demonstrates that each seller estimates an asking price as a function of several factors, some observable by the analyst and some apparently not. The most important explanatory variables in the Pacific salmon market are the lagged average industry price and the lagged divergence between this firm's price and the average industry price, as modified by the variance of industry price. These results lend empirical support to previous theoretical work which suggests that firms use average industry prices as a source of information but that prices are not perfect aggregators of information. The firm's response to the average industry price in terms of modifying its own price is tempered as the variance of the set of observed prices increases, apparently reflecting a lower assessment of the quality of information gleaned from a set of prices with a higher variance.

Furthermore, these results support previous findings that the firm uses its own information in revising its asking price. The data limitations of this study required the use of a proxy--lagged sales--for the information gained by the firm from its own previous transactions. However, it is encouraging to note that in certain cases this variable exhibits the expected positive sign, reflecting the notion that greater sales in the previous time period may be an indication to the firm that it has underestimated the demand curve it faces.

The role of wages in price formation is found in these equations to be primarily as expected, with the implication that as wages rise, costs, and therefore asking price, increase. Some collinearity between this variable and other exogenous variables is present; however, examination of the equations without this variable reveals that the relationship between asking price and the first two explanatory variables is not affected.

The model is estimated for individual firms rather than cross-sectional data sets in order that certain peculiarities of sellers could be discerned, such as relative size, geographical location, penchant for few large sales (vs. numerous small sales) and price or quality variations. It is hoped that the variations in results across firms are better addressed in light of characteristics of each firm.[25] Furthermore, the classification of the salmon products into the finest categories possible which still allow estimation of the equations also permits comparison of results according to the nature of the product in question. Some of these issues have been addressed in the interpretation of the results.

Thus, the hypothesized model of price-setting behavior appears to apply in certain cases to wholesale sellers of Pacific salmon. For those cases where the model may not be appropriate, various explanations are proposed, from characteristics peculiar either to the firm or to the salmon product. Most of these problems suggest an alternative formulation of the model which, in some cases, may require the use of data which are unavailable. Some difficulties, however, may be statistical in nature and thus could, in certain instances, be redressed through the collection of additional or more complete data sets.

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25 The results of this research suggest that any future attempts at pooling data for estimation of the model might be most meaningful if undertaken with stratified samples of firms, e.g., fresh vs. frozen sales.

The empirical estimation of the asking-price equations merits careful consideration, as the results can only fail to reject the behavioral hypotheses. It should be noted, however, that there are few studies which attempt to empirically estimate individual firm behavior under uncertainty or disequilibrium. As demonstrated in this study, there are many issues to address in considering the role of these factors in the Pacific salmon market.

The formulation of the model of buyers' responses to the asking prices of sellers attempts to permit testing of the hypothesis that buyers, much like sellers, search for an optimal price at which to carry out their transactions. The hypothesis is represented with a simple equation which states that the quantity demanded from each seller is a linear function of the difference between this firm's price and the average industry price. The results of empirical application of this model to the Pacific salmon industry indicate that the approach is inappropriate or at least requires modification. Some elements of buyer behavior are suggested by the results (such as the possible divergence between ex ante buyer behavior and ex post market results, as earlier identified by Kirzner); however, this is clearly an area for further investigation. There are apparently many other issues at stake in the determination of quantity sold by each seller which are not addressed in the model.

Weekly data recording salmon sales have a high probability of being disequilibrium data. For the price equations, this phenomenon should only reinforce the results, which demonstrate the price-setting activities of sellers under market disequilibrium (or uncertainty). For the quantity equations, however, the presence of disequilibrium may be at least partially responsible for unexpected results. An alternative formulation which might be more appropriate for representing the response by buyers could include factors such as buyers' costs of search, buyer-seller loyalty and the relation between quantity sold and quantity demanded. Unfortunately, some of these would be difficult to obtain or quantify.

Nonetheless, it is clear that the research has uncovered some systematic relationships. Salmon sellers respond to information provided by the reactions to their own prices, to the prices charged by competitors and to the distribution of those prices. Because of the competitive nature of the salmon market and the presence of uncertainty, sellers use this information in devising their own pricing strategy. Rather than behaving as passive price-takers, salmon sellers are active market participants who respond to economic signals. Here, then, is the behavior which allows the economist to speak of "movements toward equilibrium" and "market responses to changes in economic conditions." This issue has been addressed in a theoretical context in the past. Empirical evidence is now available to suggest price-searching behavior and competitive markets as entirely compatible. This evidence also improves our understanding of workings of the market for Pacific salmon.

Finally, this research provides a methodological departure point for analysis of other sectors which do not fully correspond to assumptions of the perfectly competitive model. Certainly, the framework developed here can be applied with modification to other industries and markets.

Recommendations for Future Research

The search for answers to the questions addressed in this study has raised many more interesting questions. The examination of decision-making behavior of salmon market participants reveals that much remains to be studied before economists can begin to understand the implications of imperfect information and disequilibrium markets in the seafood sector. It is hoped that the consideration of such issues in the fishery products industry may be applicable to other markets exhibiting similar characteristics.

Some of the problems with the estimation of the equations, particularly for the buyers' reactions, stem from the inability to distinguish across buyers, as is possible for sellers with the price equations. For data sets in which buyers are identified, a few of these issues may be better approached through focusing on transactions among given pairs of buyers and sellers.

For example, for one seller the average price ($\bar{P}_t^*$) and quantity sold (q_t^s) are calculated across all transactions, large and small. However, since the results for some of the equations imply that large transactions may be operating under different assumptions of price formation, selection of only those transactions of a specified minimum size may permit testing of alternative hypotheses. Using only those average asking prices and quantities sold for larger transactions, then, would permit examination of the following questions: might it appear that greater lags on the $\bar{P}_t$'s are required to represent price-setting behavior, implying forward contracting? If so, do these lags increase as the season progresses? What is the impact on the market of such practices, particularly if the price at the time of delivery is relatively far from the overall industry average? There may be some evidence that forward contracting increases price dispersion, and thus, variance of industry price, which, according to results in this study, would imply a slower adjustment of firm prices to the industry average.

Distinguishing across buyers in the transactions for the quantity equations may permit examination of issues such as buyer-seller loyalty, tie-in sales and the phenomenon of "dynamically captive markets." A rigorous analysis of these issues would require having complete data sets for all sellers in the industry, such that the switching of buyers from one seller to another or the purchase by one buyer of certain salmon products from different sellers could be studied.

Given fluctuations in supply (and demand) of salmon products, the model of buyers' reactions to the distribution of prices they encounter in the market may be more amenable to a market shares model. The use of

$$(q_t^{si} / \sum_i q_t^{si}) = g(\bar{P}^*_{t-1} - \bar{P}_{t-1}),$$

where "i" identifies sellers, may circumvent some of the problems which arise in the estimation of the quantity equations in this model because of the lack of aggregate market information.

Are these issues of market participant behavior crucial enough to warrant further research? The seafood industry is a sector in the U.S. economy which is subject to frequent shocks, given fluctuations in supply, government regulations and other factors discussed earlier. These characteristics of the industry imply that seafood processing is risky for the entrepreneur, as evidenced by "boom and bust" years. Given the importance of the seafood industry to isolated geographical areas, where resources may not be perfectly mobile, the impact of disequilibrium conditions and uncertainty on decision making is an important issue. A better understanding of the behavior under these conditions may permit improved assessment of the impact of fishery policies, including management of the stock (e.g., season, size and gear regulation), import tariffs on seafood products and allocation of foreign fishing rights within the Fisheries Conservation Zone. Most important, the study of buyer and seller behavior under disequilibrating conditions may provide some evidence on the speed of adjustment, which suggests some optimal path for the adoption of new policies.

In addition, this study has provided some interesting challenges. In some cases, answers have been found in traditional microeconomic theory. In other instances, additional factors have been used, from both previous theoretical studies and knowledge of the peculiarities of the salmon industry. Perhaps this study has provided some preliminary insights into some of the more important issues in the relationships among uncertainty, market disequilibrium and search behavior of firms.

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APPENDIX

DATA TABLES

Table A-1. Average Values: Price Equations.

Salmon Product	Firm	$\overline{P}^*_t$	$\overline{P}_{t-1}$ [a]	$\sigma^2_{\overline{P}_{t-1}}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$	$Wages_t$ [a]	$\overline{P}^*_{t-1}\ q^s_{t-1}$
Kings, Small, Troll	1	1.8941	2.0615	-.0134	3.8791	1,956.1972
	3	1.9263	2.0707	-.0114	3.8837	17,616.5960
	5	2.1288	2.1646	-.0021	3.8962	2,126.1225
	7	2.4776	2.4669	-.0035	3.9282	7,132.0872
Kings, Medium, Troll	1	2.1043	2.4173	-.0349	3.8869	7,997.2480
	3	2.1381	2.3648	-.0256	3.8837	10,586.1957
	5	2.3599	2.3699	-.0022	3.8856	5,089.1233
	7	2.4858	2.4646	-.0160	3.8903	31,228.9231
Kings, Large, Troll	1	2.4284	2.7097	-.0214	3.8869	4,829.7194
	3	2.4975	2.6904	-.0161	3.8911	17,092.7441
	5	2.7555	2.7337	-.0035	3.8962	3,272.2558
	7	2.5145	2.7225	-.0234	3.8868	15,258.1848
Kings, Medium, Gillnet	10	2.3152	2.6183	-.0033	3.9078	7,939.6629
Kings, Large, Gillnet	7	2.0238	2.5146	-.1208	3.8948	11,502.1466
	10	2.5612	2.4017	.0384	3.8513	1,114,0569
Silvers, Small, Troll	3	1.7358	1.8010	-.0033	3.8912	33,356.8200
	5	1.8940	1.8060	.0055	3.8931	35,601.1508
Silvers, Medium, Troll	3	2.0631	2.1694	-.0026	3.9100	9,948.4601
	5	2.0743	2.1296	-.0011	3.9235	18,732.7627

[a] Varied by subfile due to different time periods covered in the regression.

Table A-2. Average Values: Quantity Equations.

Salmon Product	Firm	q_t^s	$(\bar{P}^*_{t-1} - \bar{P}_{t-1})$	$\bar{P}^*_{t-1}$
Kings, Small, Troll	1	1,009.2222	-.2218	1.7487
	3	10,568.2739	-.1540	1.8328
	5	987.4346	-.0593	2.0423
	7	2,876.7143	-.0034	2.2963
Kings, Medium, Troll	1	3,353.1190	-.3301	1.9971
	3	10,628.8913	-.2472	2.0286
	5	2,067.7958	-.0288	2.2558
	7	9,711.9286	.0871	2.4047
Kings, Large, Troll	1	1,881.6429	-.3117	2.3022
	3	6,940.1538	-.2319	2.3821
	5	1,441.4500	-.0405	2.6208
	7	5,875.1538	-.3751	2.1675
Kings, Medium, Gillnet	10	934.6957	-.1916	2.2477
Kings, Large, Gillnet	7	7,707.0000	-.4367	1.9989
	10	388.5714	.0556	2.4406
Silvers, Small, Troll	3	20,431.5263	-.0868	1.6439
	5	18,540.3500	.0672	1.8065
Silvers, Medium, Troll	3	4,927.2500	-.1409	1.9142
	5	8,474.8036	-.0613	1.9957

Table B-1. Price Equations: Kings, Small, Troll.

Firm	Equation	Adj R^2	Exogenous Variables				
			Constant	$\bar{P}_{t-1}$	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$	$Wages_t$	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$
(n)		(D-W)	(t)	(t)	(t)	(t)	(t)
1	II	.21534	1.0569	0.4010	4.0537	---	0.1008E-04
(18)		(1.6092)	(3.5948) 5*	(2.6369) 4*	(1.0505)	---	(.5995)
	III	.19840	4.1821	0.4660	4.5366	-.8335	---
		(1.5694)	(.3179)	(1.6191) 1*	(1.1944)	(-.2367)	---
3	II	.73641	0.4429	0.7464	6.3062	---	0.5442E-06
(23)		(2.1020)	(1.9534) 2*	(7.3138) 6*	(2.2541) 3*	---	(.4065)
	III	.75207	-7.3347	0.5507	5.8871	2.1082	---
		(1.7258)	(-1.0986)	(3.1476) 5*	(2.2001) 3*	(1.1731)	---
5	II	.60649	1.0989	0.4679	2.1787	---	0.10284E-04
(26)		(1.7044)	(5.7549) 6*	(5.3571) 6*	(1.2103)	---	(1.9944) 2*
	III	.53661	0.2757E-01	0.3931	2.0401	0.3220	---
		(1.3427)	(.5709E-02)	(2.4117) 3*	(1.0250)	(.2455	---
7	II	.0566[a]	1.5848	0.3644	-.9627	---	-.1329E-05
(14)		(1.0422)	(.9330)	(.5110)	(-.3036)	---	(-.1049)
	III	.10017	-28.1316	-.4952	-4.0560	8.0995	---
		(.9268)	(-1.7959) 1*	(-.8073)	(-1.2914)	(1.9093) 1*	---

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90% 4* = 99%
2* = 95% 5* = 99.5%
3* = 95.5% 6* = 99.9%

Table B-2. Price Equations: Kings, Medium, Troll.

Firm	Equation	Adj R^2	Exogenous Variables				
			Constant	$\bar{P}_{t-1}$	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$	$Wages_t$	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$
(n)		(D-W)	(t)	(t)	(t)	(t)	(t)
1	II	.31094	1.4570	0.2946	1.2561	---	-.2607E-05
(21)		(1.6949)	(6.3191) 6*	(3.1339) 5*	(1.4102) 1*	---	(-.8160)
	III	.28481	0.4551	0.2935	1.1448	0.2521	---
		(1.7513)	(.6926E-01)	(1.9864) 2*	(1.275)	(.1431)	---
3	II	.75636	.6979	0.6409	3.2772	---	0.4012E-06
(23)		(1.6744)	(3.4386) 5*	(7.9523) 6*	(2.6050) 4*	---	(.2381)
	III	.76301	-4.1099	0.5445	2.8130	1.2958	---
		(1.3709)	(-.6538)	(3.9444) 6*	(2.0557) 2*	(0.7690)	---
5	II	.4439	1.2023	0.4946	1.4223	---	-.2252E-05
(24)		(1.8534)	(3.6105) 6*	(3.4132) 5*	(.4879)	---	(-.4439)
	III	.46168	-5.3701	0.3299	0.4082	1.7884	---
		(1.5755)	(-.7547)	(1.6287) 1*	(.1394)	(.9305)	---
7	II	.06918	3.5812	-.5180	-1.6709	---	.4947E-05
(14)		(1.6151)	(3.7462) 5*	(-1.2833)	(-1.2149)	---	(1.7724) 1*
	III	.06325[a]	-4.7742	-.2619	-.9095	2.0284	---
		(2.2132)	(-.1334)	(-.3568)	(-.4774)	(.2114)	---

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%	4* = 99%
2* = 95%	5* = 99.5%
3* = 95.5%	6* = 99.9%

Table B-4. Price Equations: Kings, Medium, Gillnet.

		Exogenous Variables				
Firm (n)	$R^{2\,a}$ (D-W)	Constant (t)	$\overline{P}_{t-1}$ (t)	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$ (t)	$Wages_t$ (t)	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$ (t)
10 (15)	.02582 (1.6014)	2.808 (2.2593) 3*	-.1938 (-.4096)	-6.0984 (.4229)	--- ---	-.7761E-06 (-.1793)
	.08179 (1.6174)	11.9436 (1.0819)	-.1026 (-.2367)	-4.6573 (-.3823)	-2.3991 (-.8394)	--- ---

a Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90% 4* = 99%
2* = 95% 5* = 99.5%
3* = 95.5% 6* = 99.9%

Table B-5. Price Equations: Kings, Large, Gillnet.

Firm	Equation	Adj R^2	Exogenous Variables				
			Constant	$\overline{P}_{t-1}$	$\sigma^2_{t-1}(\overline{P}^*_{t-1} - \overline{P}_{t-1})$	$Wages_t$	$\overline{P}^*_{t-1} \cdot q^s_{t-1}$
(n)		(D-W)	(t)	(t)	(t)	(t)	(t)
7 (13)	II	.06203[a] (1.2815)	1.8224 (.9524)	0.1424 (.1990)	0.5379 (0.3413)	--- ---	-.7982E-05 (-.6830)
	III	.04090[a] (1.3848)	17.2536 (.5713)	0.1961 (.2554)	-.9021E-01 (-.5047E-01)	-4.0397 (-.5079)	--- ---
10 (10)	II	.24332 (.8896)	4.0645 (6.1431) 6*	-.5990 (-2.3672) 2*	-1.5366 (-1.3189)	--- ---	-.5041E-05 (-.7078E-01)
	III	.30611 (.8400)	-15.7127 (-.5887)	-.6530 (-2.6172) 2*	-1.8218 (-1.5436) 1*	5.1702 (.7406)	--- ---

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%	4* = 99%
2* = 95%	5* = 99.5%
3* = 95.5%	6* = 99.9%

Table B-7. Price Equations: Silvers, Medium, Troll.

Firm (n)	Equation	Adj R^2 (D-W)	Exogenous Variables: Constant (t)	$\bar{P}_{t-1}$ (t)	$\sigma^2_{t-1}(\bar{P}^*_{t-1} - \bar{P}_{t-1})$ (t)	$Wages_t$ (t)	$\bar{P}^*_{t-1} \cdot q^s_{t-1}$ (t)
3 (16)	II	.08267[a] (2.3547)	2.4833 (2.9619) 4*	-.1852 (-.4856)	-5.4329 (-.9750)	--- ---	-.5994E-05 (-.9750)
	III	.09419[a] (2.3799)	-8.5674 (-.8434)	-.5013 (-.9035)	-5.7991 (-.5081)	2.9861 (1.0561)	--- ---
5 (28)	II	.51169 (1.3203)	0.6589 (2.4108)	0.6665 (5.1525)	10.9473 (1.5055)	--- ---	0.4455E-06 (0.5896)
	III	.53989 (1.1875)	-2.7410 (-1.0976)	0.5393 (3.3198)	8.6208 (1.1802)	0.9370 (1.3564)	--- ---

[a] Unadjusted R^2

Note: t-value confidence levels for all results:

1* = 90%	4* = 99%
2* = 95%	5* = 99.5%
3* = 95.5%	6* = 99.9%

Table B-8. Results, Quantity Equations (Price Difference).

Salmon Product	Firm (n)	Adj R^2 (D-W)	Exogenous Variables: Constant (t)	Exogenous Variables: $(\overline{P}^*_{t-1} - \overline{P}_{t-1})$ (t)
Kings, Small, Troll	5 (26)	.07918 (2.6413)	1,154.686 (2.576) 4*	2,821.885 (1.775) 2*
	7 (14)	0 (.82097)	2,875.461 (2.485) 3*	365.617 (-.106)
Kings, Medium, Troll	3 (23)	.12108 (1.5797)	14,872.413 (5.051) 6*	17,168.161 (2.008) 2*
	7 (14)	0 (1.7301)	9,791.126 (1.727) 1*	-909.568 (-.665E-01)
Kings, Large, Troll	1 (21)	.24218 (1.2632)	3,275.349 (4.958) 6*	4,471.103 (2.719) 4*
	7 (13)	0 (1.6950)	7,139.798 (2.833) 4*	3,371.693 (.956)
Kings, Medium, Gillnet	10 (23)	0 (1.2032)	1,142.734 (1.617) 1*	1,085.745 (.509)
Kings, Large, Gillnet	7 (15)	0 (1.8665)	10,199.085 (2.417) 3*	5,706.193 (.968)
	10 (14)	0 (2.1320)	385.806 (3.468) 5*	49.699 (.824E-01)
Silvers, Small Troll	5 (20)	0 (2.4912)	15,914.746 (2.662) 4*	39,100.586 (.756)
Silvers, Medium, Troll	3 (16)	0 (1.5555)	5,581.031 (4.016) 6*	4,640.858 (.764)
	5 (28)	0 (1.7007)	8,023.451 (2.029)	-7,360.434 (-.347)

Note: t-value confidence levels for all results:

1* = 90%   4* = 99%
2* = 95%   5* = 99.5%
3* = 95.5%   6* = 99.9%

Table B-9. Results, Quantity Equations (Firm Price).

Salmon Product	Firm (n)	Adj R^2 (D-W)	Exogenous Variables: Constant (t)	Exogenous Variables: $(\bar{P}^*_{t-1})$ (t)
Kings, Small, Troll	1 (18)	0 (1.7511)	1,730.709 (1.198)	-412.580 (-.518)
	3 (23)	.04475 (1.6493)	31,090.682 (2.059) 2*	-11,643.99 (-1.425) 1*
	5 (26)	.08107 (2.1593)	4,551.401 (2.233) 3*	-1,745.068 (-1.790) 2*
	7 (14)	0 (.9053)	-515.269 (-.136)	1,477.161 (.940)
Kings, Medium, Troll	1 (21)	.13130 (2.0454)	12,178.519 (2.689) 4*	-4,419.013 (-2.006) 2*
	3 (23)	.02688 (1.2649)	21,277.106 (2.454) 3*	-5,249.136 (-1.268)
	5 (24)	0 (2.3390)	575.884 (.185)	661.382 (.494)
	7 (14)	0 (1.9384)	-720.565 (-.425)	4,338.351 (.650)
Kings, Large, Troll	1 (21)	.22846 (1.1235)	6,473.786 (3.606) 6*	-1,994.684 (-2.631) 4*
	3 (26)	0 (.7975)	7,579.892 (1.066)	-268.563 (-.923E-01)
	5 (26)	0 (2.1966)	427.764 (.183)	386.778 (.446)
	7 (13)	.03290 (1.8674)	-206.707 (-.373E-01)	2,805.983 (1.187)
Kings, Medium, Gillnet	10 (23)	0 (1.1681)	-390.898 (-.151)	589.768 (.526)
Kings, Large, Gillnet	7 (15)	.08957 (1.7447)	-3,173.184 (-.461)	5,713.139 (1.542) 1*
	10 (14)	0 (2.2240)	89.210 (.247)	122.657 (.863)
Silvers, Small, Troll	3 (19)	.26358 (.95014)	75,687.419 (3.623) 5*	-33,611.716 (-2.728) 4*
	5 (20)	0 (2.4054)	8,186.510 (.397)	5,731.437 (.517)
Silvers, Medium, Troll	3 (16)	0 (1.3591)	4,551.502 (1.070)	196.296 (.915E-01)
	5 (28)	0 (1.7632)	-4,842.892 (-.286)	6,673.147 (.805)

Note: t-value confidence levels for all results:

1* = 90% 4* = 99%
2* = 95% 5* = 99.5%
3* = 95.5% 6* = 99.9%