AN ABSTRACT OF THE THESIS OF

VILAILUCK CHAROENKUL for the MASTER OF SCIENCE
(Name of student) (Degree)

in Agricultural Economics presented on Sept 4, 1970
(Major) (Date)

Title: ANALYSIS OF DEMAND FOR CANNED PINK SALMON

Abstract approved: Redacted for privacy
Richard S. Johnston

The purpose of the study was to estimate the parameters of the demand equation for canned pink salmon at the processor-distributor level. Opening prices for the years 1951 to 1965 were used, along with disposable income and tuna prices, as an independent variable in a demand equation in which quantity demanded was the dependent variable. The method of least squares was applied to estimate the coefficients of the linear equations. These coefficients for the demand equation were used to calculate price, income, and cross-elasticity figures. It was tentatively concluded that, at the processor-distributor level, the demand is price-elastic, while the computed elasticities were > 1 and < 1 for income and tuna prices, respectively.

The effect of inventories was explored and found to have a

significant impact on the demand analysis, although further work is required here.

Analysis of Demand for Canned Pink Salmon

by

Vilailuck Charoenkul

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1971

APPROVED:

Redacted for privacy

Assistant Professor of Agricultural Economics
in charge of major

Redacted for privacy

Head of Department of Agricultural Economics

Redacted for privacy

Dean of Graduate School

Date thesis is presented September 4, 1970

Typed by Velda D. Mullins for Vilailuck Charoenkul

ACKNOWLEDGMENT

I owe a debt of gratitude to many whose influence may be seen in various subtle ways. My major professor, Dr. Richard S. Johnston, has generously contributed his talent and time during all stages of this thesis, and has never failed to be patient and helpful; I am grateful to Dr. Charles Land, not only for his suggestions, but who also helped me solve the problems during the regression analysis course. Dr. Joe B. Stevens willingly served on my committee, and William Jensen gave helpful information for this study.

My efforts here would not have been successful without the unlimited sacrifices, encouragement, and devotion of my dear Mother, and brother, Viratana Charoenkul, M. D. I am also extending thanks to my many reassuring friends, and finally to Karen Prinz, who has helped me correct English.

TABLE OF CONTENTS

LIST OF TABLES

ANALYSIS OF DEMAND FOR CANNED PINK SALMON

I INTRODUCTION

Statement of the Problem

There is little objective information available on the nature of demand for canned salmon products--especially canned pink salmon--among United States consumers. Nor is it known how this demand makes itself felt through the various functional levels of the industry. In recent years, Frederick V. Waugh of the University of Maryland, and Virgil J. Norton, of the University of Rhode Island[1/], have done some research concerning the relationship among prices and quantities of canned salmon and canned tuna. In their estimating equations, consumption is treated as the dependent variable, with prices and consumer income as the independent variables. Their statistical results[2/] indicate that the direct

---

1/ Waugh, Frederick V. and Virgil J. Norton. Some Analyses of Fish Prices. Washington, D. C. May 1969. 194 p. (Working paper No. 22)

2/
$$q^s = 4.088 - 0.914 \text{ inc} - 0.034p^s - 0.012p^t \qquad R^2 = 0.89$$
$$\qquad (4.743) \qquad (2.276) \qquad (0.539) \qquad d = 1.02$$
$$q^t = 0.541 + 0.956 \text{ inc} + 0.010p^s - 0.094p^t \qquad R^2 = 0.97$$
$$\qquad (9.709) \qquad (2.534) \qquad (8.653) \qquad d = 1.18$$

elasticity and the cross elasticity are of opposite sign, so that an increase in the price of canned tuna results in an increase in the consumption of canned salmon. Waugh and Norton are careful to point out that these are not the elasticities of the "true demand curves", however, since they include both supply and demand phenomena (see Waugh and Norton, p. 25 and 69). In all of the equations the correlation coefficients are quite high, the t-values are very significant and the Durbin-Watson statistics are rather low.

$$\log q^s = 0.342 - \underset{(5.434)}{1.294} \log inc - \underset{(0.727)}{0.170} \log p^s + \underset{(1.565)}{0.291} \log p^t \quad R^2 = 0.92, \; d = 1.22$$

$$\log q^t = 0.305 + \underset{(7.520)}{1.295} \log inc + \underset{(2.986)}{0.504} \log p^s - \underset{(8.332)}{1.121} \log p^t \quad R^2 = 0.97, \; d = 1.40$$

q^s = per capita consumption of salmon (pounds)

q^t = per capita consumption of tuna (pounds)

p^s = deflated price of salmon (dols/case)

p^t = deflated price of tuna (dols/case)

inc = deflated consumer disposable income per capita (thousands of dols/year)

number in parentheses are t-value associated with coefficients above

R^2 = the squared correlation coefficient

d = the Durbin-Watson statistic.

Another, William R. Wood[3/], who has studied the same subject as Waugh and Norton, found rather similar results. In his equations, price is the dependent variable, quantity and consumer income are independent variables. When per capita data are used in the equation, the direct and cross price flexibilities[4/] have the same sign[5/], so that an increase in quantity of canned tuna results in a decrease in the price of canned salmon. When the aggregate data are used, the flexibilities are of opposite sign.[6/] In both equations, the t-values are not significant and the correlations are quite

---

3/ Wood, William R. A demand analysis of processed salmon from the West Coast. Master's thesis. Oregon State University. Corvallis, Oregon. June 1970. 78 numb. leaves.

4/ Price flexibility is the ratio of a percentage change in the price of the commodity to the associated percentage change in its consumption. For example, price flexibility is defined as $\frac{\partial p}{\partial q} \cdot \frac{q}{p}$. Price elasticity is defined as $\frac{\partial q}{\partial p} \cdot \frac{p}{q}$.

5/ $$p^s = \underset{}{0.75818} - \underset{(-0.861)}{0.10967\, Q^{sd}/N} - \underset{(-0.188)}{0.00005\, Y/N} - \underset{(-0.026)}{0.00300 M^t/N}$$

$$- \underset{(-0.385)}{0.01240 \sin 18°} + \underset{(0.628)}{0.01484 \cos 18°}$$

$R^2 = 0.313$ D.W. = 1.815

6/ $$p^s = 0.54537 + \underset{(0.706)}{0.00204\, Q^{sd}} - \underset{(-1.034)}{0.000017\, Q^{sd}}\ N + \underset{(0.053)}{0.00003\, \text{Agg. D.}}$$

$$\text{inc. } Y + \underset{(0.773)}{0.00055 M^t}$$

$R^2 = 0.356$, D. W.= 1.639

low.[7/]

Because the results of Waugh and Norton, and Wood, were not identical more detailed research should be done. Since there are several species of salmon and several final consumption forms, it was decided to focus on one species and one final market form. Accordingly, canned pink salmon was selected for analysis. Some problems can be expected to occur, as pointed out by Mark E. Rubinstein.[8/]

---

p^s = price of canned salmon (dols/pound).

Q^{sd}/N, Q^{sd} = per capita consumption, aggregate consumption of canned salmon (pounds)

Y/N, Agg. D. Inc.Y = per capita disposable income, aggregate disposable income (billions of dols).

M^t/N, M^t = quantity consumption of canned tuna per capita; aggregate consumption of canned tuna (pounds).

R^2 = the coefficient of determination.

D. W = the Durbin-Watson statistic.

t-value is in parenthesis.

7/ Foote (5) classifies commodities as substitutes when the cross elasticity is positive or the price flexibility is negative.

8/ Rubinstein, Mark E. The history of concentration in the canned salmon industry of the United States. Bachelor's thesis, Harvard College, April 1966. 128 numb. leaves.

"The Bureau of Commercial Fisheries has recently undertaken a statistical demand analysis of canned salmon, but the results are not usable because the estimated coefficients were not statistically significant. The analysis was hampered by lack of data on the prices for red and chum canned salmon and on the amount of inventory carryover. Even statistics provided by the federal government are not reliable. Charles H. Lyles, Acting Chief for the Branch of Fishery Statistics in the Bureau of Commercial Fisheries, said in an interview with me in Washington, D. C., 'The salmon pack is the best of the salmon statistics. The statistics on the catch are horrible considering the magnitude and importance of the industry. Compared to other fishing industries, data on the salmon industry is the poorest.' William F. Royce, Director of Fisheries Research Institute in Seattle, and Charles H. Hinkson, Economic Development Coordinator of the Department of Economic Development and Planning for the State of Alaska in Juneau, both have written me that to their knowledge data is not available for an adequate economic analysis of the industry." 9/

While data limitations constitute a serious threat to the usefulness of the results, it is hoped that the present study will reveal

---

9/ Op. cit. (8) p. 4-5.

at least general relationships among variables affecting the demand for canned pink salmon.

Purpose of the Study

The main interest of this study will be in estimating the parameters of the wholesale demand function for canned pink salmon. The specific objectives of the study are as follows:

1. To develop a model which describes the demand and supply conditions at the wholesale level and their relationships to those conditions prevailing at the retail level.

2. To estimate the parameters of the postulated relationships.

3. To estimate the direct and cross price elasticities and the income elasticity of demand for canned pink salmon.

II THE ECONOMIC MODEL

Description of the Industry

The Pacific Coast salmon industry is a regional industry. "Production" in the United States is confined to a fairly definite geographical area. Canneries are located in the States of Oregon, Washington and Alaska. The value of the annual canned salmon pack exceeds the combined total of all other edible canned fishery products. In the past 15 years, the value of the salmon pack has varied between 108 million dollars in 1951 and 122 million dollars in 1965. The annual salmon pack has fluctuated between 222 million pounds or 4 million cases, and 118 million pounds or 2 million cases annually, since 1951.

There are five species of salmon found on the Pacific Coast that are important in supplying the quantity of salmon available for consumption. The common names for these five are (1) chinook or king, (2) chum or dog, (3) coho or silver, (4) pink or humpback, and (b) sockeye or red. Each species exhibits different characteristics in appearance. For example, sockeye salmon is red in flesh color, rich in oil, firm in texture, and pleasing in flavor. It comprises the most valuable single species. Pink salmon is perhaps more abundant than sockeye, but is not valued as highly because its color is paler, and the flesh is not as rich in oil or as high in flavor. Salmon runs are notably variable as to years, and seasons within years, regions and rivers within regions, and species within years and regions.

Fishing for salmon is carried on with many different kinds of fishing apparatus, the type used depending on the nature of the river, bay or estuary. Cobb (Bureau of Fisheries Document 1092, p. 477-493) describes 11 different methods used in commercial fishing operations in the salmon industry. The use of gill net, haul seines, trap purse seines, fish wheels and trolling is common throughout most of the industry (except in instances where a specific device is prohibited by law). In the operation of the salmon fishery, drift gill nets are more generally used than any other fishing device. The larger part of the annual salmon catch, however, is made by means of purse seines. Trolls and traps are the other methods in common usage. Troll-caught salmon generally reach the final consumer in a fresh or frozen form.

Most salmon are caught when they come to their native rivers in the fullness of their maturity. In general, the five species of Pacific salmon die immediately after spawning. When they come to the Coast seeking their native rivers, the fish are at the peak of their maturity and at the perfection of quality. Salmon head in from the ocean toward spawning grounds from May through October, reaching greatest intensity in July and August. The differences in size, color, and spawning patterns have a substantial effect on the economics of the industry. The table lists the five species of Pacific salmon and their characteristics (Table 1).

Table 1. Characteristics of Salmon.

Species	Aver. weight [a/]	Color of canned meat [a/]	Life cycle [a/]	Aver. price paid to fishermen [b/]	Aver. wholesale price after processing [b/]
	(pounds)		(years)	(¢/pound)	(¢/pound)
King or chinook	24	Deep red or white	4-6	34.1	80.9
Red or sockeye	7	Right red	3-6	21.6	83.2
Coho or silver	9	Light red	3	17.1	55.5
Pink or humpback	4	Pale pink	2	11.6	44.6
Chum or dog	10	Light yellow	3-5	8.5	41.2

Source: a/ Rubinstein (8), Table 1, p. 15.
b/ University of Alaska, Monthly Review, January 1965.
Note: Both prices are average prices in Alaska in 1963.

The salmon canning season starts from June to December. Canned salmon has a unique characteristic. It is a natural product in which nothing is added to the fish except salt for seasoning. The highly seasonal nature of salmon migration, when coupled with the high perishability of fresh salmon (the Alaska Fisheries law of 1906 as amended in 1929, requires that salmon be processed within 48 hours after being killed) forms another environmental constraint which has an important influence on the costs of production and subsequent marketing procedures.

Imports of canned salmon increased from 0.3 percent of the total supply in 1951 to nearly 20.8 percent in 1959. This increase was due to a decline in domestic packing. However, domestic packing has increased since 1960 thus making imports less significant. Exports have been limited, but this situation appears to be changing. Due to the increasing demand in foreign markets, exports have been increasing. For example, exports increased from 0.9 percent of the total supply in 1951 to 14.1 percent in the year 1965 (Table 2).

The per capita consumption of canned salmon in the United States has averaged about 1.19 pounds for the years 1951-1958 and less than 1.0 pound for the years 1959 through 1965. This decrease appears to be the result of a decline in the natural supply of salmon and an increase in the population (Table 3).

This study will focus specifically on pink salmon because pink salmon are generally the most abundant of the five species and comprise a large part of the salmon that is used for canning. The annual average pack of pink salmon for the period from the year

Table 2. Supply of Canned Salmon.

Year	U.S. pack	Percent of total supply	Imports	Percent of total supply	Export	Percent of total supply	Total supply
	(thousand pounds)		(thousand pounds)		(thousand pounds)		(thousand pounds)
1951	222,987	99.8	568	0.3	2,060	0.9	223,555
1952	214,289	95.7	9,544	4.3	1,427	0.6	223,833
1953	187,769	93.9	12,165	6.1	2,277	1.1	199,934
1954	199,810	94.6	11,371	5.4	7,227	3.4	211,181
1955	157,855	91.4	14,644	8.6	10,429	6.0	172,499
1956	168,250	85.4	28,802	14.6	5,213	2.6	197,052
1957	153,917	86.3	24,401	13.7	6,688	3.7	178,318
1958	179,134	86.0	29,226	14.0	9,227	4.4	208,360
1959	118,330	79.2	31,154	20.8	13,826	9.2	149,484
1960	136,049	87.7	19,113	12.3	11,924	7.7	155,162
1961	177,443	96.1	7,167	3.9	7,186	3.9	184,610
1962	184,177	96.4	6,844	3.6	8,978	4.7	191,021
1963	158,153	99.2	1,250	0.8	10,228	6.4	159,403
1964	180,442	99.9	236	0.1	20,924	11.2	180,678
1965	176,277	99.9	101	0.1	24,892	14.1	176,378

Source: Bureau of Foreign and Domestic Commerce, Department of Commerce.

Table 3. Landing, Pack and Per Capita Consumption of Canned Salmon.

Year	Total quantity[a] of landing	Total pack[b] available for U.S. consumption	Per capita[a] consumption	Population[c]
	(pounds)	(thousand pounds)	(pounds)	(thousand)
1951	364,223,012	221,495	1.40	154,878
1952	380,601,799	222,406	1.43	157,553
1953	312,934,191	197,657	1.30	160,184
1954	324,713,030	203,954	1.11	163,026
1955	289,879,983	162,070	1.04	165,931
1956	324,248,525	191,839	1.11	168,903
1957	265,153,106	171,630	1.03	171,984
1958	307,454,045	199,133	1.07	174,882
1959	201,684,452	135,658	0.94	177,830
1960	235,446,560	143,238	0.72	180,684
1961	310,871,300	177,424	0.79	183,756
1962	312,474,720	182,043	0.95	186,656
1963	294,177,200	149,175	0.77	189,417
1964	352,226,200	159,754	0.72	192,120
1965	326,806,000	151,486	0.90	194,592

Source: a/ Bureau of Commercial Fisheries, U.S. Department of the Interior.

b/ Bureau of Foreign and Domestic Commerce, Department of Commerce.

c/ Bureau of Census.

Note: Number of population as of July 1, includes armed forces abroad.

1951 to 1965 is 38 percent of the total salmon pack, and the value is 32 percent of the total value of all canned salmon products. The catch of the pinks which spawn at the age of two years, is large only in odd years, while in even years very few of them are caught. For example, the pink salmon catch in 1960 was almost negligible, compared to catches of several million fish in odd years. But sometimes the pink salmon run does not follow the cycle. For example, in odd year 1965 the total catch was only 79 million pounds when compared with another odd year 1963, in which the catch was 156 million pounds (Table 4). This effect might be caused by physical changes in the spawning and nursery areas (due to pollution of water, sliming of river beds, building of power dams) and over-fishing. Almost all pink salmon is canned.

The principal market for canned pink salmon is in the southern part of the United States, due to the income level of the people. The price range for canned salmon varies considerably between the higher and lower quality merchandise.

1. Market channels

The commercial fishing industry is composed of a series of vertically related activities, including harvesting, processing, transportation and distribution. The functional breakdown in the industry is not always distinct. At some ports, fishermen own their vessels and sell fish to processors who in turn sell to wholesale or retail outlets. In other cases, processors own the vessels and also perform certain distribution functions. For canned salmon, the market participants may be classified into five groups. These are: (1) the producers (fishermen and boat owners), (2) the

Table 4. Quantity of landing, canned and value of pink salmon.

Year	Quantity of Landing: Pounds	Quantity of Landing: Percent of Total Quantity of Landing	Quantity of Landing: Value	Amount of Canned[a/]: Cases[b/]	Amount of Canned[a/]: Percent of Total Canned	Amount of Canned[a/]: Value	Percent of Total Value	Total Canned Salmon: Cases	Total Canned Salmon: Value
			(dols)			(dols)			(dols)
1951	147,644,196	40.56	18,233,833	2,001,352	43.08	41,924,381	38.59	4,645,570	108,625,869
1952	113,488,548	29.82	12,598,692	1,176,879	26.36	21,798,794	22.18	4,464,347	98,263,789
1953	97,170,168	31.05	9,194,522	1,396,635	35.70	24,916,063	30.30	3,911,859	82,240,468
1954	88,691,169	27.31	7,907,836	1,151,126	27.65	22,554,084	24.44	4,163,147	92,280,544
1955	128,179,256	44.22	13,167,186	1,674,162	50.90	36,017,839	44.26	3,288,961	81,376,693
1956	102,156,200	31.50	9,256,678	1,129,346	32.90	25,219,778	26.98	3,432,658	93,472,748
1957	71,652,384	27.02	8,359,748	943,564	29.63	22,049,570	25.69	3,184,897	85,809,580
1958	120,721,143	39.26	11,059,170	1,550,025	41.83	32,181,240	34.89	3,705,293	92,244,046
1959	61,740,000	30.61	7,027,000	819,825	33.25	19,423,486	27.03	2,465,538	71,852,280
1960	52,588,964	22.33	6,817,295	685,504	24.18	17,227,477	19.53	2,834,353	88,196,930
1961	108,452,500	34.89	10,950,800	1,361,874	36.84	37,322,168	31.63	3,696,726	118,010,275
1962	143,309,700	45.86	20,302,300	1,949,328	50.80	45,914,977	40.30	3,837,031	106,031,028
1963	156,603,400	53.23	18,289,380	1,956,482	59.47	43,346,555	49.46	3,289,579	87,638,369
1964	162,325,500	46.08	17,131,960	1,939,613	51.79	39,302,133	41.43	3,745,307	94,857,397
1965	79,655,000	24.37	8,299,000	949,917	77.39	26,130,327	21.29	3,633,614	122,744,087
Total	1,634,378,128	100.00	178,595,400	20,685,636	100.00	455,328,872	100.00	54,298,878	1,423,644,097
Mean	108,958,000	35.51	11,906,300	1,379,040	38.09	30,355,200	31.98	3,619,920	94,909,000

Source: Pacific Fisherman

[a/] The pack figures refer to the ownership of the salmon after processing, not to the number of cases actually packed by a firm.

[b/] Standard cases represent the various sized cases converted to the equivalent of 48 one-pound cans to the case.

processors (canners), (3) the distributors, sales agents, or brokers (who handle sales to retailers of the smaller processing firms, while the larger processors generally sell directly to retail outlets), (4) the retailer, and (5) the consumer. Since the concern of this thesis is the demand faced by processors, retailers and the aforementioned sales agents will be referred to collectively as "distributors". The fishermen deliver fish to the processors on the basis of a seasonal contract which sets the price of fresh fish in advance. Prices set at the processor-distributor level are generally determined through bargaining. The price at which the processors sell is the "wholesale price" and the price at which the retailer sells is called the "retail price". These prices will fluctuate over the season depending upon the quantity of landing, imports, exports, inventory and demand. This study will estimate the parameters of the demand function facing processors.

(2) Price determination at the various levels

a. Opening price (between processors (canners) and distributors): The opening price is defined as the earliest price in each season at which a large percentage of the pack has been sold.[10/] The announcement of the opening price does not occur

---

10/ Pacific Fisherman yearbook 1948. p. 133.

ordinarily until late August or early September, when the greater part of the packing is over and a good estimate of the total pack has been obtained. Small packers generally fall in line after the larger concerns have issued their price quotation. The price is presumably fixed at an amount that would move the available supply of canned salmon from the market during canning season. To accomplish the desired end, packers have to consider, among other factors, the size of the pack, the size of the carryover plus their expectations of the price of competing products and of consumers' purchasing power.

b. Seasonal fluctuation: Seasonal price variability is largely due to the amount of pack which in turn is partly dependent upon the quantity of landing, length of season, the availability of the other canned foods and seasonal demand shifts as, for example, during the Lenten season.

c. Substitutes in demand: The differentiation between the five species are important as the salmon are distinguished on the basis of certain characteristics such as appearance, color of flesh, texture and nutritive qualities. The composition of the flesh of the various species of canned salmon and the relative food value of each species is illustrated in Table 5.

The difference in quality affects the price of each species. The differences in consumer preference between pink and red, for example, is sufficient to justify regarding the marketing problems of

Table 5. Composition of Canned Salmon.[a]

Species	Total solids	Fat	Protein	Ash	Food value per pound
	percent				
Sockeye	35.22	11.22	20.80	1.23	860
Chinook	36.83	15.72	17.67	1.22	991
Coho	32.51	8.49	21.08	1.21	750
Pink	30.20	6.99	21.40	0.76	696
Chum	29.96	6.69	20.67	1.02	514

a/ No appreciable difference is found between canned and fresh salmon, so the composition of canned salmon is used here.

Source: DeLoach, Daniel B. The salmon canning industry. Oregon State College, Corvallis, Oregon. 1939. p. 21.

the two species as distinctly separate. However, their interrelationships must be recognized. When the price of red salmon goes up, pink salmon may be substituted. Besides this substitution among the five species of salmon, other seafood products--tuna, for example--and some meat and poultry products may also be substituted.

General Form of Model

The essential effects of three factors have an important bearing on per capita fish consumption: price, income, and price of competing products. On a more technical level, measures of these effects are called the price, income, and cross elasticity of demand for commodities, respectively. On the supply side, the price of canned pink salmon can be regarded as depending on the cost of production (labor, capital, transportation and storage) and the price of the commodity in the preceding year. This study will classify the supply of and demand for canned pink salmon in the domestic market by the consumer, the distributor (including the retailer), the processor, and the fisherman. In the discussion that follows, the following symbols are used:

$\bar{P}$ = annual average price of canned pink salmon

Q = quantity demanded

S = beginning stock of canned salmon

Y = disposable income per capita

T = price of competing good (canned tuna)

X = cost of production

The subscripts c, d, p and f are used for the consumer, the distributor, the processor and the fisherman, respectively. The present year is t, the preceding year is t-1.

(1) Demand for canned pink salmon:

P^c, Q^c: S^c, Y, T (by consumer)

P^d, Q^d: P^c, S^d, X^d (by distributor)

P^p, Q^p: $P^d; S^p, X^p$ (by processor)

(2) Supply of canned pink salmon:

P^f, Q^f (catch): No. of fishermen; X^f (by fishermen)

P^p, Q^p (pack and beginning stock):

Q^f, $\bar{P}^p_{t-1}$; X^p (by processor)

P^d, Q^d: Q^P, $\bar{P}^d_{t-1}$; X^d (by distributor) 11/

Specification of Economic Relationships to be Used in Estimating the Wholesale Demand (i.e., demand by distributors)

The focus of this study will be on the processor-distributor level and will treat the price-determination process as one in which the processor fixes the opening price at which he sells his products to the distributor or retailer. In setting this price he will consider the beginning stock of all canned salmon, quantity of landing of pink and quantity of landing of all other salmon, the preceding year's average price of canned pink salmon and the preceding year's average price of all other canned salmon, in addition

---

11/ Colon may be read "depends on"; comma may be read "and"; semicolon may be read "appear in relation with". The variables to the left of the colon or semicolon are current endogenous variables and those to the right are regarded as predetermined within the particular model.

to variables affecting imports and exports. Thus the first step of this analysis will be to specify an equation which can be used to predict or to estimate the opening price of canned pink salmon as set by processors.

The quantity demanded by distributors is dependent on several variables, including factors affecting final consumption: i.e., on the predicted opening price of the processor, beginning stock of canned pink salmon held by distributors, disposable income per capita and the price of canned tuna, the latter two variables being important in the consumer's demand function and, hence, appearing importantly in the derived demand function facing processors. Since population is also an important determinant of "consumption" (by consumers and, hence, by distributors) demand will be on a per capita basis at this level. Since the difference between the opening price and annual average price is very slight, the equation used to predict the opening price will be used to predict the annual average price and the resulting prediction will be compared.

There are two equations in this study:

$$(1) \quad P^*_t : S_t, L^p_t, L^a_t, \overline{P}^p_{t-1}, \overline{P}^a_{t-1}, E'_t, E''_t$$

This equation will be used to predict the opening price. It is also used to predict annual average price.

(2) $Q_t: \hat{\bar{P}}_t, Y_t, T_t$

This equation is used to describe the demand function whence Q is a function of the predicted annual average price and other variables.

Where

P^* = price of canned pink salmon

$\bar{P}$ = annual average price of canned salmon (based on the calendar year 12/)

S = beginning stock of canned salmon

L = quantity of landings

E' = exports of canned salmon

E'' = net exports of canned salmon (exports less imports)

$\hat{\bar{P}}$ = predicted annual average price of canned pink salmon

Y = disposable income per capita

T = price of canned tuna

The subscripts p, a are used for pink salmon and all other salmon, respectively; t is the present year and t-1 is the preceding year.

The equations, as described, include the following list of assumptions:

12/ The "calendar year" is not the same as the "fishing year". The fishing year for pink salmon starts from the beginning of May.

(1) The opening price of canned pink salmon is independent of current actual sales to distributors. It is dependent upon the preceding year's price, the quantity of landing, the beginning stock and imports and exports. (In the estimation procedure, actual imports and exports are used to approximate their magnitudes as expected at the beginning of the season.)

(2) The processor, the distributor and the consumer demands are not uniform throughout the year. The demand for canned fish is not always ready to follow smoothly the fluctuations of supply resulting in a surplus or shortage of the processor's inventory. The suppliers of the stored commodities are manufacturers holding title to the goods "with a view to their future sale either in their present or in a modified form". The length of the storage period is determined by the price of the canned salmon on the market. The quantity demanded for canned pink salmon fluctuates within the season, so the annual average price is not equal to the opening price. While supply varies between seasons, demand need not vary accordingly.

(3) The price of pink salmon continues on an upward trend because of the increase in the foreign markets demand.

(4) The monopolistic conditions are considered to be of some importance in establishing the price of canned salmon.

(5) The conditions during the years 1951-1965 are assumed

to have been sufficiently homogenous to permit their inclusion in a single analysis because of normal circumstances that influenced supply and demand in this period.

(6) The technology remains unchanged throughout the period of analysis.

III THE STATISTICAL MODEL

Form of Relationship

The statistical model of the canned pink salmon market has been developed from the economic model discussed in Chapter II. Thus opening price-predicting (or "supply") and demand equations have the general form:

$$\text{Supply: } P^* = \beta_0 + \beta_1 S_t + \beta_2 L_t^p + \beta_3 L_t^a + \beta_4 \bar{P}_{t-1}^a + \beta_5 \bar{P}_{t-1}^p + \beta_6 E_t' + \beta_7 E_t'' + u \quad (1)$$

$$\text{Demand: } Q = \alpha_0 + \alpha_1 \hat{\bar{P}}_t + \alpha_2 Y_t + \alpha_3 T_t + v \quad (2)$$

where

Endogenous variables [13/]

P^* = opening price of canned pink salmon

Q = per capita consumption of canned pink salmon

Exogenous or predetermined variables [14/]

S = beginning stock of canned salmon

L = quantity of landings of salmon

13/ Endogenous variables are logically dependent upon the exogenous variables and must be explained by them.

14/ Exogenous variables are treated as logically independent variables which do not have to be explained inside

$\bar{P}$ = annual average of canned salmon

E' = exports of canned salmon

E'' = net exports of canned salmon (exports less imports)

$\hat{\bar{P}}$ = predicted annual average price of canned pink salmon

Y = disposable income per capita

T = price of canned tuna

The subscripts p and a are used for pink salmon and all other salmon, respectively. The present year and the preceding year are t and t-1.

β_0, α_0 = constant term in the equations. $\beta_1 \ldots \beta_7$, $\alpha_1 \ldots \alpha_3$ = coefficients of the statistical analysis that apply to the exogenous or predetermined variables. u, v = random error term.

The estimation consists of two steps. In the first step P^* is an endogenous variable, and is dependent upon the exogenous or predetermined variables in equation (1). The result, P^* is the estimate of the predicted opening price. This predicted opening price will be the predetermined variable in equation (2). In the

---

of the equation model. The lagged value of endogenous variables and the exogenous variables frequently are grouped together and referred to as predetermined variables.

second step Q is an endogenous variable and is dependent upon the exogenous or predetermined variables in equation (2).

A statistical model comprises a system of equations in which the endogenous variables are functions of the predetermined variables plus random error terms. The values of exogenous or predetermined variables are constant and known from the period of study in the year 1951 to 1965. The error terms are assumed to be independent and are normally distributed (mean equal zero, variance constant). In this study, it is assumed that the relationship between the endogenous variable and the exogenous or predetermined variables is linear. The method of least squares can be applied when the conditions of the above assumptions are met. The least squares estimation yields an unbiased and consistent estimate of the parameters.

In an economic time series, the original observations frequently show strong trends and cycles. For the variables expressed in dollar terms, it is useful to remove the influence of trends in the general price level, so the price and income variables are deflated by the Bureau of Labor Statistics Consumers' Price Index. Per capita and annual data on quantities and price are used to avoid the population and the seasonal influences.

It could be argued that, since the opening price does not prevail consistently throughout the season, the "supply" equation should be expressed in terms of quantities of canned pink salmon and season average prices. In this case, the structure would contain two equations, each containing two endogenous variables and a simultaneous equations-estimating procedure would be called for. In view of the importance of the opening price in determining prices during the season it was decided, instead, to use a model which would predict the opening price, test its success in predicting the season's average price, and use the average price so predicted as an independent (and "predetermined") variable in the demand equation.

The Estimated Results

A. Supply Relation

The results of the supply equation when the opening price of canned pink salmon during a given time period (1951-1965) is a function of the beginning stock, the quantity of landing of pink salmon, the quantity of landing of all other salmon, the preceding year's average price of canned pink salmon, the preceding year's average of all other canned salmon, exports and net exports, is as follows:

$$P^*_t = 7.576 + \underset{(0.3195)}{0.000000867}\, S_t - \underset{(-1.9369)}{0.0000000459}\, L^p_t$$

$$- \underset{(-0.0508)}{0.000000000811}\, L^a_t + \underset{(1.6543)}{1.283}\, \bar{P}^p_{t-1}$$

$$- \underset{(0.7451)}{0.409}\, \bar{P}^a_{t-1} + \underset{(1.2686)}{0.000261}\, E'_t + \underset{(0.8476)}{0.0000187}\, E''_t \quad (1)$$

$$R^2 = 0.71$$

When the annual average price is substituted for the opening price and is a function of the all variables as previously defined, the result is:

$$\bar{P}_t = 6.122 + \underset{(0.3244)}{0.000000904}\, S_t - \underset{(-2.1132)}{0.0000000515}\, L^p_t$$

$$+ \underset{(0.2671)}{0.00000000437}\, L^a_t + \underset{(1.5715)}{1.252}\, \bar{P}^p_{t-1} - \underset{(0.6399)}{0.360}\, \bar{P}^a_{t-1}$$

$$+ \underset{(1.2307)}{0.000260}\, E'_t + \underset{(0.7899)}{0.0000179}\, E''_t \quad (2)$$

15/

$$R^2 = 0.72$$

The correlation coefficients in both equations are quite the same so the opening price and the annual average price, as predicted by this model, vary only slightly. This conclusion can be

---

15/ In both equations (1 and 2), the values of t are given in the parenthesis below the coefficients of independent variables. The t-values are significant at the 90% level with 7 degrees of freedom if t-values are greater than 1.895.

further tested by use of the paired t-test and the coefficient of determination (r^2) between the two variables (Appendix B). The same set of independent variables was used to predict both the annual average price and opening price. Since there was no statistically significant difference between the two predicted series at the 90 percent level and since the computed r^2 value was .9998, it was felt that one could justify the use of the predicted opening price as the average price to which the demand quantities correspond in the demand equation.

B. Demand Relation

The estimated result of the demand function where quantity is specified as a function of the predicted annual average price, disposable income per capita and price of canned tuna is as follows:

$$\begin{aligned} Q_t = 0.0809 - &\ 0.0203\ \hat{\bar{P}}_t + 0.248\ Y_t + 0.0179\ T_t \qquad (3) \\ &(-1.533) \quad\ (1.514) \quad\ (0.653) \\ &-1.220 \qquad\ 1.399 \qquad\ .592 \end{aligned}$$

$R^2 = 0.31$

The correlation coefficient is quite low and the t-values are not significant. When the predicted opening price is substituted, the result is not improved as shown below:

$$Q = 0.0948 \quad -0.0197 \hat{P}^*_t + 0.235 Y_t + 0.183 T_t \quad \underline{16/} \qquad (4)$$
$$\qquad (-1.309) \qquad (1.372) \qquad (0.632)$$
$$\qquad -1.170 \qquad 1.326 \qquad .606$$

$$R^2 = 0.27$$

Generally, the total available supply in a given time period is not equal to the quantities of consumption in that period. The canned salmon is not highly perishable and can be easily stored. Thus, it was decided that the inventory variable should be included in the demand equation. If the demand curve shifted, a negative sign would be expected, on the assumption that the larger the beginning inventories in the hands of distributors, the smaller the quantity of current output they would purchase at given prices. So in the following equation, the quantity demanded is a function of the predicted opening price, the beginning stock of canned pink salmon, disposable income per capita and price of canned tuna. The result is as follows:

$$Q = 0.927 \quad -0.00256 \hat{P}^*_t + 0.000000298 S^p_t -0.353 Y_t$$
$$\qquad (-0.1907) \qquad (2.7605) \qquad (1.4837)$$
$$\qquad -0.496 \qquad 0.513 \qquad -1.383$$

$$+ 0.0105 T_t \qquad (5)$$
$$(0.4563)$$
$$0.731$$

$$R^2 = .59$$

16/ The values of t are given in the parenthesis below the coefficients of the independent variables. The t-values in equations (3) and (4) are significant at 90% level with 11 degrees of freedom of t-value is greater than 1.796. The coefficient of elasticities are beneath the t-value.

When the stock of all canned salmon is substituted for the stock of canned pink salmon the result is improved. The correlation coefficient is high.

$$\hat{Q} = 1.095 \underset{\substack{(-1.0912) \\ -0.739}}{-0.0124 P^*_t} + \underset{\substack{(3.1713) \\ 1.371}}{0.000000264 S^a_t} \underset{\substack{(-1.6349) \\ -2.185}}{-0.379 Y_t}$$

$$\underset{\substack{(-0.3592) \\ -0.0415}}{-0.00828 T} \quad \underline{17/} \qquad (6)$$

$R^2 = 0.64$

Data Limitations

This study relies on secondary data. Most of the data were obtained from publications printed by the Bureau of Commercial Fisheries, Bureau of Commerce, and Pacific Fisherman Yearbook. This study must accept the limitations imposed by the availability of data. Some figures do not agree with information published previously, as revisions have been made where earlier data were found to be in error. The appropriate data are often not readily available. The available data must be interpolated; for example, the data on the stock of individual species. The carryover figures were not given since July 1, 1942, because of war conditions

---

17/ The values of t are given in the parenthesis below the coefficients of independent variables. The t-values in equations (5) and (6) are significant at 90% level with 10 degrees of freedom if t-values are greater than 1.812.

under which the greatest part of the salmon pack has been delivered to the government. Data on stocks is again recorded as of 1964 so to estimate inventory data for the intervening years one has to work backwards, based on the stock in the year 1964.[18/] The other difficulty with the available data arises from the difference in basis. For example, data on the annual pack are based on annual marketing years data which begin at the beginning of June. The inventory data, on the other hand, are based on annual calendar years. Accurate figures of canned pink salmon are still scarce. The economic data on fisheries are not adequate and the quantitative information is not reliable. So research cannot forecast as accurately as it could,were better data available.

18/ For example, the beginning stock in 1963 equals the beginning stock in 1964 plus the total consumption in 1963 less the total available supply in 1963 (total available supply equals total pack salmon plus imports less exports). The stock of canned pink salmon is determined by multiplying the total pack of canned pink salmon by the stock of all canned salmon and dividing the product by the total pack of all canned salmon. This is ending stock in the year of computation. The beginning stock in the present year is the ending stock in the preceding year.

IV ANALYSIS OF RESULTS AND INTERPRETATION

Supply Equations

Equations 1 and 2 predict the opening prices and annual average prices of canned pink salmon at the processor level for the years 1951 to 1965. Data for all variables except the beginning stock of all canned salmon were available from secondary sources. The stock data have not been available since 1942.

The coefficient of determination resulting from the analysis of equation (1) was .71. This means that 71 percent of the variation in the dependent variable was explained by the independent variables used in that equation. The analysis also indicated that the only significant independent variable at the 10 percent level was the quantity of landing of pink salmon (L_t^p).

Also important in analyzing the results were the signs associated with the respective coefficients. The sign indicates the nature of the relationship between the respective independent variables and the dependent variable. Positive and negative signs indicate a positive and negative relationship, respectively.

From economic theory, a negative relationship would be expected between the dependent variable and all the independent variables except P_{t-1}^p, P_{t-1}^a, $E_t^{'}$ and $E_t^{''}$. However, in the results of the analysis, the signs on the coefficients of two independent variables, S_t and P^a_{t-1} were different than expected. It should be pointed out that both these variables were found not to be significantly different from zero at the 10 percent level. This means that their impact on the model was not considerable.

The significant independent variable, L^p_t, having a negative coefficient suggests that as landings of pink salmon increase, opening prices will decrease.

Inventories

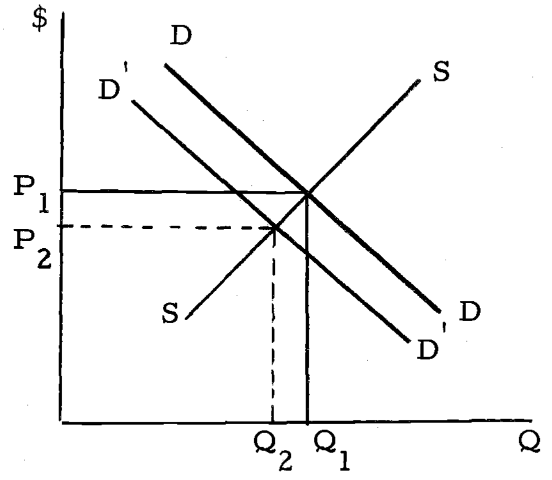
The "price predicting" equation:

$$P^*_t = \underset{}{7.576} + \underset{(0.3195)}{0.000000867S_t} - \underset{(-1.9369)}{0.0000000459L^p_t}$$

$$- \underset{(-0.0508)}{0.000000000811L^a_t} + \underset{(1.6543)}{1.283\bar{P}^p_{t-1}} - \underset{(0.7451)}{0.409\bar{P}^a_{t-1}}$$

$$+ \underset{(1.2686)}{0.000261E'_t} + \underset{(0.8476)}{0.0000187E''_t}$$

Suppose we represent the demand (by distributors) and the supply (by processors) as DD and SS, respectively, in the following diagram:



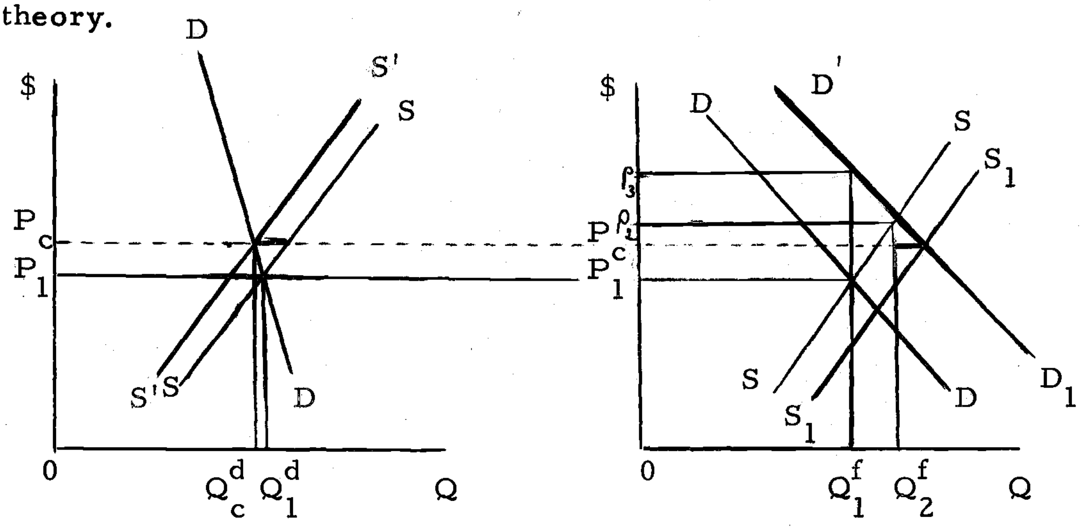
In this case the equilibrium price would be P_1 and the equilibrium quantity would be Q_1. Now suppose that the demand curve is <u>not</u> DD but, rather, is D'D' because of large inventories in the hands of distributors. In this latter case, the equilibrium price would be P_2 ($< P_1$) and the equilibrium sales would be Q_2. Thus, it is hypothesized that the larger the beginning inventory in the hands of distributors, the lower the equilibrium price. While the canned pink salmon market is not a perfect market (so that marginal revenue and marginal cost curves should be used instead of demand and supply curves) and while the equation deals with opening price rather than equilibrium prices, the same forces should be at work. Hence, a negative sign was expected on the "stocks" variable.

The Preceding Years' Price of All Other Canned Salmon

The coefficients of the variable $\overline{P}^{p}_{t-1}$ and $\overline{P}^{a}_{t-1}$ are expected to be positively related to the dependent variable P^{*}_{t} because the processors would look at the last years' price as an indication of what price to ask this year.

Exports and Net Exports

From the analysis, the sign on the coefficient of the variable pertaining to exports was as would be expected from the economic theory.



Assume an equilibrium price P_1 prevails in both domestic and foreign markets, and assume that the quantities demanded in the foreign markets increase. When the demand curve shifts from DD to D'D', the price will be P_2 and quantities demanded OQ_2^f. If the amount supplied is only OQ_1^f, the price will rise to P_3.

The price in the foreign markets will be greater than the price in the domestic market. The result will be a shift in the quantities supplied from the domestic market to the foreign market which will cause the price to increase in the domestic market and the foreign market to P_c. Thus, a positive sign was expected on the coefficient of the "exports" variable. (This analysis abstracts from transportation costs, etc.)

Another analysis was made with the annual average price ($\bar{P}_t$) as the dependent variable and the independent variables identical to those used in equation (1). The results of the analysis of equation (2) show little difference from that of equation (1). The signs were identical and the same independent variable (L_t^p) was significant in both cases at the 10 percent level. The t-values for corresponding pairs of independent variables in both equations were very close, and the coefficient of determination was .72 in equation (2) as compared to .71 in equation (1). This leads to the conclusion that there was no significant difference detected between the opening price (P_t^*) and the annual average price ($\bar{P}_t$).

Demand Equations

Equations (3) through (6) show the results of the statistical analysis of quantities demanded of canned pink salmon. Of the variables in these equations only disposable income and price of canned tuna data have appeared in printed sources. The coefficients of determination in both equations (3) and (4) were rather low. The signs on the coefficients of the independent variables were identical as between the two equations and the t-values were not statistically significant at the 10 percent level in both equations. The price, income and cross-elasticities of demand (calculated at the mean values of the respective variables) were similar as between the two formulations. From the analysis results, the signs on the coefficients of the independent variables were as expected from the economic theory.

Prices of Canned Pink Salmon

The coefficient associated with the price of canned pink salmon had a negative sign. This suggests that the quantities consumed and price of canned pink salmon are inversely related. When the price goes up, the quantities consumed go down and as the price goes down, the quantities consumed go up. The price elasticity of demand was found to be elastic. This means that the percentage change in quantities purchased is greater than the percentage change in price. A decline in price will increase total revenue because quantity demanded increases proportionately more than price declines and a rise in price will decrease total revenue because quantity demanded falls proportionately more than price increases.

Disposable Income Per Capita

Engel's law states that, for all food, as income increases, consumption increases but by relatively less than the increase in income. It was expected that the coefficient on income would have a positive sign. From the analysis result, the income elasticity was greater than one. This means that the quantities consumed increase relatively faster than income. Canned pink salmon is an individual canned product, as opposed to "all food", to which Engel's law has reference. This result merits further study.

Prices of Canned Tuna

The equations show the price of canned tuna and the quantities demanded of canned pink salmon were related in the same direction, as the coefficient of the independent variable had a positive sign. The cross elasticity was less than one. This means that a given percentage change in prices of canned tuna would lead to a smaller percentage change in quantities demanded of canned pink salmon. Thus the tendency of substitution of canned tuna for canned pink salmon was inelastic.

Equations (5) and (6) show that the inventories variable had affected the quantities demanded of canned pink salmon, due to the statistically significant coefficients on the "inventories" variable at the 10 percent level. The coefficient of determination was .59 when the equation used as an independent variable the beginning stock of canned pink salmon, and was .64 when the beginning stock of all canned salmon replaced the beginning stock of canned pink salmon. This means that 59 percent in equation (5) and 64 percent in equation (6) of the variation in the dependent variable was explained by the independent variables. The signs on the coefficients of independent variables, except the price of canned tuna, were identical as between equations and the same independent variable (S_t) was significant. It was expected that including beginning inventories as an independent variable in the demand equation would increase the explanatory power of the equation. This, in fact, happened. However, the sign on the inventory variable was opposite to that expected. This may be because of failure to identify who holds the inventory. It was hypothesized that distributors were the holders and that, therefore, the coefficient would be negative. It may be, however, that processors were the larger holders of inventories, thereby accounting for the resulting positive sign on the estimated coefficient. The method used to compute inventories may also have been seriously inappropriate. It should be noted that the previously discussed elasticity figures were seriously affected by the inclusion of the inventory variable. It seems clear that additional work is necessary to investigate the role of this variable.

V CONCLUSION AND RECOMMENDATION

Barriers to a reasonable explanation of industry behavior in the canned pink salmon market have been imposed by the scarcity of relevant, comparable and reliable quantitative data. Nonetheless, this study attempted to estimate the parameters of the demand and supply equations at the processors-distributors level. The least square method was applied to estimate the coefficients of the linear equations. The t-values were used for testing the statistic significance at the 10 percent level. The period of study was from 1951-1965.

In the supply equation the opening price was used as the dependent variable. Factors designated as affecting the price were the beginning stock of canned salmon, the quantity landed of pink salmon, the quantity landed of all other salmon, the preceding years' average price of canned pink salmon, the preceding years' average price of all other canned salmon, exports and net exports. The resulting predicted opening price was used as an independent variable in one formulation of the demand equation, since the predicted opening prices and the predicted annual average prices were so similar.

In another specification of the demand equation, the quantity consumed was a function of the predicted annual <u>average</u> price, disposable income per capita and price of canned tuna. Coefficients for the demand equation were used to calculate elasticity figures, calculated at the mean values of the appropriate variables. Signs of the coefficients indicated the relationship between the dependent variable and the independent variables. The price elasticity indicated what could be expected to happen to the total revenue when the price and the quantity changes. The results of this study suggest that the demand for canned pink salmon at wholesale is price elastic. Income elasticity was also calculated and indicates what happens to quantities purchased of canned pink salmon as income change, other things being equal. This figure was computed to be greater than unity. The cross elasticity indicates the expected change in consumption of wholesale of canned pink salmon as the price of canned tuna changes. This figure was computed to be positive. The inventories were very important in the demand equation since the total available supply was not equal to the quantity consumed and canned pink salmon is easy to store. However, the demand curve, income and cross elasticity were difficult to determine in the fisheries industry because of poor information on inventories.

For further research in this industry, a simultaneous equations model could be used in demand analysis as was suggested by Foote (5), p. 47.

BIBLIOGRAPHY

1. Alaska trade study. A regulatory staff analysis, U.S. federal maritime commission. Washington. 1967.

2. Bell, Frederick W. and Jared E. Hazleton (eds.) Recent developments and research in fisheries economics. New York, Oceana, 1967. 233 p.

3. DeLoach, Daniel B. The salmon canning industry. Corvallis, Oregon State College. 1939. 118 p.

4. The Fisheries of North America. The first North America fisheries conference. Canada, United States, Mexico. Washington, D.C. 1965. 63 p.

5. Foote, Richard J. Analytical tools for studying demand and price structure. Washington, D.C. 1958. 217 p. (U.S. Dept. of Agriculture. Agriculture handbook No. 146).

6. Fox, Karl A. Intermediate economic statistics. New York. John Wiley. 1968. 568 p.

7. Malinvaud, E. Statistical methods of econometrics. Rand McNalley and Company. Chicago. 1966. 629 p.

8. Rubinstein, Mark E. The history of concentration in the canned salmon industry of the United States. Bachelor's thesis. Harvard College. April 1966. No. leaves 126.

9. Pacific fisherman yearbook, Vol. 44 No. 2, Vol. 46, No. 2, 1946, 1948.

10. Price systems in the fishing industries. Organization for economic cooperation and development. Paris, 1966.

11. Snedecor, George W. and William G. Cochrane. Statistical methods. Ames, Iowa. 1967. 585 p.

12. Waugh, Frederick V. and Virgil J. Norton. Some analysis of fish prices. Washington, D.C. 1969. 194 p. (U.S. Bureau of Commercial Fisheries. Working paper No. 22)

13. Wood, William R. A demand analysis of processed salmon from the West Coast. Master's thesis. Corvallis, Oregon State University. June 1970. No. leaves 78.

14. U. S. Fish and Wildlife Service. Current Fisheries Statistics No. 4001-4100 Washington, D. C. March 1966.

APPENDICES

APPENDIX A

Data Pertinent to the Demand and Supply

of Canned Pink Salmon.

Appendix Table 1. Factors that are Instrumental in the Supply Equation.

Year	Beginning stock of canned salmon (S_t)	Quantity of landing of pink salmon (L_t^p)	Quantity of landing of all other salmon (L_t^a)	Annual average price of pink salmon ($\bar{P}_{t-1}^p$)	Annual average price of all other canned salmon ($\bar{P}_{t-1}^a$)	Export of canned salmon (E_t')	Net export of canned salmon (exports less imports) (E_t'')	Opening price of canned pink salmon (P_t^*)	Annual average price of canned pink salmon ($\bar{P}_t$)
	(pounds)	(pounds)	(pounds)	(dol/case)	(dol/case)	(thou lbs)	(thou lbs)	(dol/case)	(dol/case)
1951	1, 339, 740	147, 644, 196	216, 578, 816	21.70	24.15	2, 061	+1, 493	21.69	21.64
1952	1, 436, 940	113, 488, 548	267, 113, 251	21.64	26.05	1, 427	-8, 117	19.17	18.68
1953	1, 584, 970	97, 170, 168	215, 764, 023	18.68	23.46	2, 277	-9, 888	17.46	17.30
1954	1, 364, 510	88, 691, 169	236, 021, 861	17.30	22.10	7, 227	-4, 144	19.53	19.13
1955	1, 843, 570	128, 179, 256	161, 700, 727	19.13	22.60	10, 429	-4, 215	21.22	20.28
1956	1, 624, 860	102, 156, 200	122, 092, 325	20.28	26.49	5, 213	-23, 589	22.16	21.06
1957	1, 715, 620	71, 652, 384	193, 500, 722	21.06	27.94	6, 688	-17, 713	22.52	22.88
1958	1, 600, 760	120, 721, 143	186, 732, 900	22.88	27.85	9, 227	-19, 999	21.61	21.36
1959	1, 850, 950	61, 740, 000	139, 944, 452	21.36	28.68	13, 826	-17, 328	24.30	23.50
1960	1, 194, 660	52, 588, 964	182, 857, 596	23.50	31.60	11, 924	-7, 189	24.50	25.13
1961	1, 468, 520	108, 452, 500	202, 418, 800	25.13	33.03	7, 186	+19	28.20	27.59
1962	2, 138, 400	143, 309, 700	169, 165, 020	27.59	34.80	8, 978	+2, 135	24.79	23.83
1963	2, 236, 700	156, 603, 400	137, 573, 800	23.83	32.23	10, 228	+8, 979	22.24	22.39
1964	2, 306, 000	162, 325, 500	189, 900, 700	22.39	33.58	20, 924	+20, 688	21.21	20.46
1965	2, 752, 400	79, 655, 000	247, 151, 000	20.46	31.28	24, 892	+24,791	28.38	28.91

Note: Price deflated by CPI.

Source: Bureau of Commercial Fisheries, Bureau of Foreign and Domestic Commerce.

Appendix Table 2. Factors that are Instrumental in Demand Equation.

Year	Predicted opening price of canned pink salmon (P^*_t)	Predicted annual average price of canned pink salmon ($\hat{\bar{P}}_t$)	Beginning stock of canned pink salmon (S^p_t)	Real consumer income a/ (Y_t)	Deflated price of canned tuna b/ (T_t)	Consumption of canned pink salmon (Q_t)
	(dol/case)	(dol/case)	(pounds)	(thou dol/capita)	(dol/case)	(pounds)
1951	20.32	19.69	343,615	1.83	12.4	.5328
1952	20.73	20.66	618,418	1.88	13.3	.4195
1953	19.10	18.83	417,792	1.94	14.3	.3974
1954	19.47	19.31	487.427	1.91	14.1	.3322
1955	21.11	20.33	509,949	2.02	13.5	.3926
1956	20.31	19.63	827,036	2.09	12.3	.3955
1957	22.64	22.54	564.673	2.09	11.5	.2885
1958	21.41	21.02	474,613	2.06	11.4	.3432
1959	25.21	24.91	773,462	2.13	11.0	.3254
1960	26.27	26.29	396,795	2.15	11.2	.1929
1961	24.33	24.17	355,091	2.18	12.0	.2428
1962	26.27	25.78	787,163	2.25	12.3	.4113
1963	22.45	21.71	1,136,458	2.30	12.1	.4392
1964	22.82	22.41	1,359,669	2.40	12.2	.4680
1965	26.54	26.84	1,425,615	2.51	12.6	.4401

a/ "Weekly Data for Demand Analysis," U.S. Dept. of Agriculture, October, 1967, Income deflated by population and by BLS Index of Consumer Prices.

b/ Unpublished data of U.S. Bureau of Commercial Fisheries, U.S. Dept. of the Interior. Wholesale price: standard cases, average price of all sizes and varieties. Deflated by BLS Index of Wholesale Prices.

APPENDIX B

The paired t-test and the simple coefficient of determination (r^2) were needed to examine the relationship between the predicted opening price and the predicted annual average price.

1. The formula for the paired t-test is as follows

$$t = \frac{\bar{D}}{s_{\bar{D}}}$$, where D_i = predicted opening price_i - predicted annual average price_i

$$s_{\bar{D}} = \sqrt{\frac{\Sigma D_i^2 - \frac{(\Sigma D_i)^2}{n}}{n-1}}$$

We assume, a normal distribution (mean = 0, variance = σ^2).

The null hypothesis $\mu_D = 0$

$$s_{\bar{D}} = \sqrt{\frac{2.887 - \frac{(4.86)^2}{14}}{14}}$$

$$= .96$$

$$t = \frac{.3240}{.96} = .3375$$

t - value (table) with d. f. 14 = 1.761 at 90% significance level

$\therefore$ do not reject the null hypothesis.

2. $$r^2 = \frac{(\Sigma XY)^2}{\Sigma X^2 \Sigma Y^2}$$

$$= \frac{(7647.2321)^2}{(7752.4574)(7544.9018)}$$

$$= .9998$$

Appendix Table 3. Predicted Opening Price and Predicted Annual Average Price of Canned Pink Salmon.

Year	Predicted opening price ($\hat{P}^*$)	Predicted annual average price ($\hat{P}$)	Difference
	---------------- dollars	----------------------	
1951	20.32	19.69	0.63
1952	20.73	20.66	0.07
1953	19.10	18.83	0.27
1954	19.47	19.31	0.16
1955	21.11	20.33	0.78
1956	20.31	19.63	0.68
1957	22.64	22.54	0.10
1958	21.41	21.02	0.39
1959	25.21	24.91	0.30
1960	26.27	26.29	0.02
1961	24.33	24.17	0.16
1962	26.27	25.78	0.49
1963	22.45	22.71	0.74
1964	22.82	22.41	0.41
1965	26.54	26.84	0.30