NOAA Technical Memorandum NMFS OF 4

COST ANALYSES OF FISH PRICE MARGINS, 1972-77, AT DIFFERENT PRODUCTION AND DISTRIBUTION LEVELS

Erwin Penn

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Office of Policy and Planning
Washington, D.C.
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ABSTRACT

Each price margin of a fish product comprises cost and profits that are analyzed to estimate value added for the purpose of comparing economic contributions and productivities between sectors of each fishery and among fisheries. Costs are also regrouped to distinguish fixed from variable to assess the effect on profit, price, and production as a result of the alteration of cost structures.

PURPOSE OF THE STUDY

This paper provides information that will benefit the fishing industry at different functional levels in its policy decisions on production scale and price levels in a competitive market, and helps fishery authorities to analyze the economic impact of a fishery after management control or a development program is implemented.

PRICE MARGINS OF FISHERY PRODUCTS

For a fishery product, the price spread is the difference between the price paid for the final product by the consumer and the dockside value of an equivalent weight of the product. (If the final product is in fillet form, the exvessel price should be converted to a comparable value on a fillet-weight basis.) This difference includes payments received by all agents performing services in landing and moving fishery products from dockside to consumers. These agents are distinguished to form the four functional levels, namely, harvesting, processing, wholesaling, and retailing. Each fishery product handled at any of these levels has a selling price and a purchase price (or the cost of merchandise). Their difference is the price margin or gross earnings of the product at the particular level.

To find the margins of a price spread, prices are collected for 13 major fishery products at the four functional levels (fig. 1). More than 60 percent of fishery products consumed in this country are imported, and they are mostly frozen and processed, and priced differently from comparable domestic fresh products. To prevent an undistorted measurement of price margins of domestic products, this study concerns prices of only fresh fish and canned fish, except for a few instances where domestic products are also processed in frozen forms, such as halibut steaks and ocean perch fillets.

For the period 1972-77 covered by this study, labor costs increased more rapidly during the later part; costs of paper products and packing materials were just the reverse. Cost of energy almost doubled in the early years and more than tripled at the end of the period compared with 1972. The increased charges of these major items of expense affected the cost and profit structures of most fisheries at the harvesting and processing levels more adversely than those at the two marketing levels.

Price control during the early period stabilized fishery prices somewhat at the processing and distributing levels. Prices at the harvesting sector, which is considered one of the primary food production industries were not subject to controls. As a result, exvessel prices went up more actively during 1972-73 than previous years. After a period of readjustment, many fisheries held their exvessel prices in line and others eased their prices in 1974 with increased landings.

Two devaluations of the U.S. dollar in 1973 caused price rises of imported fishery products, which have continued to decline in volume since 1974. Domestic landings kept up their pace, but exvessel prices of most fisheries continued to rise

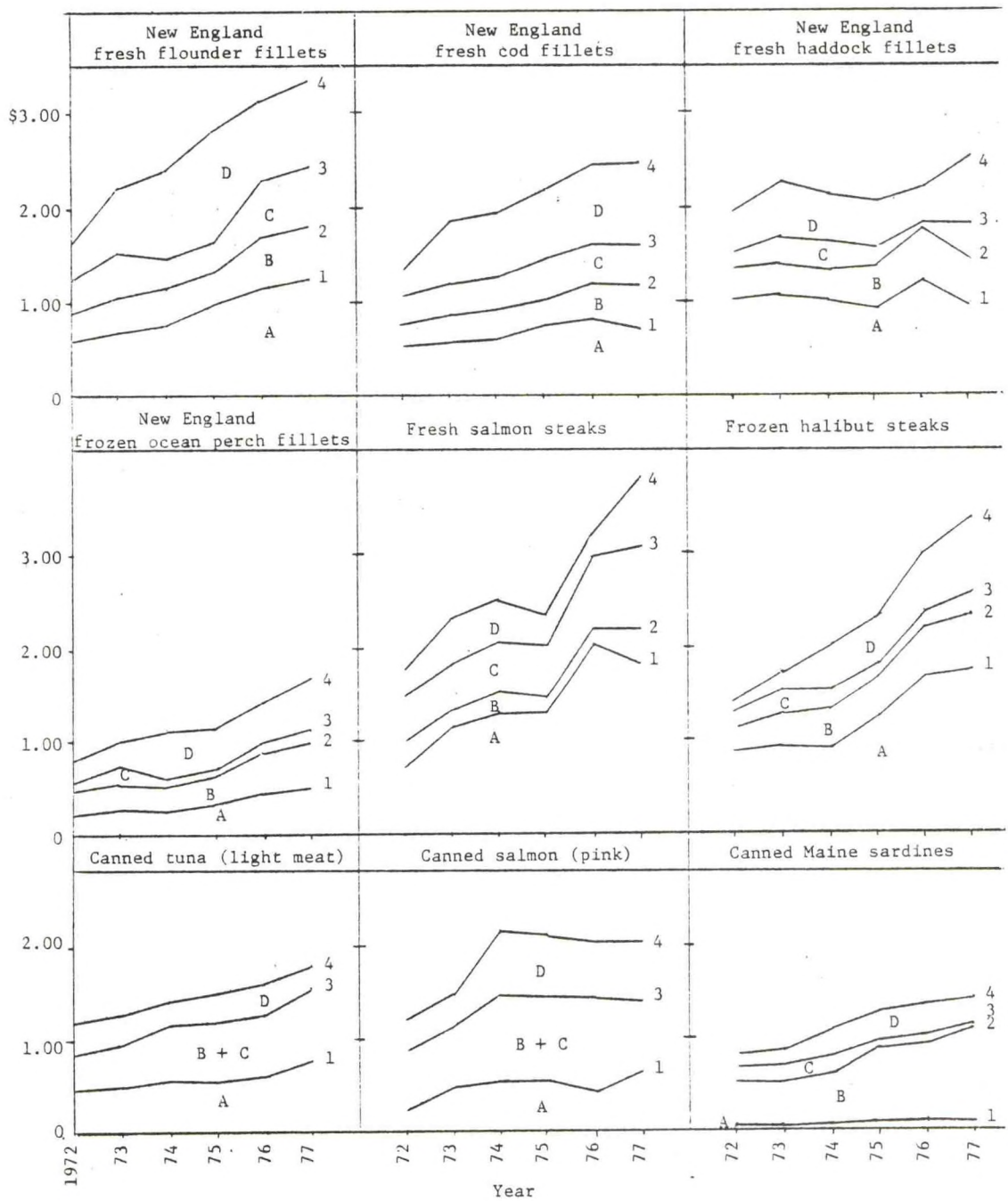

Figure 1.--U.S. fish prices and market margins at different marketing levels, 1972-77 (to be continued).

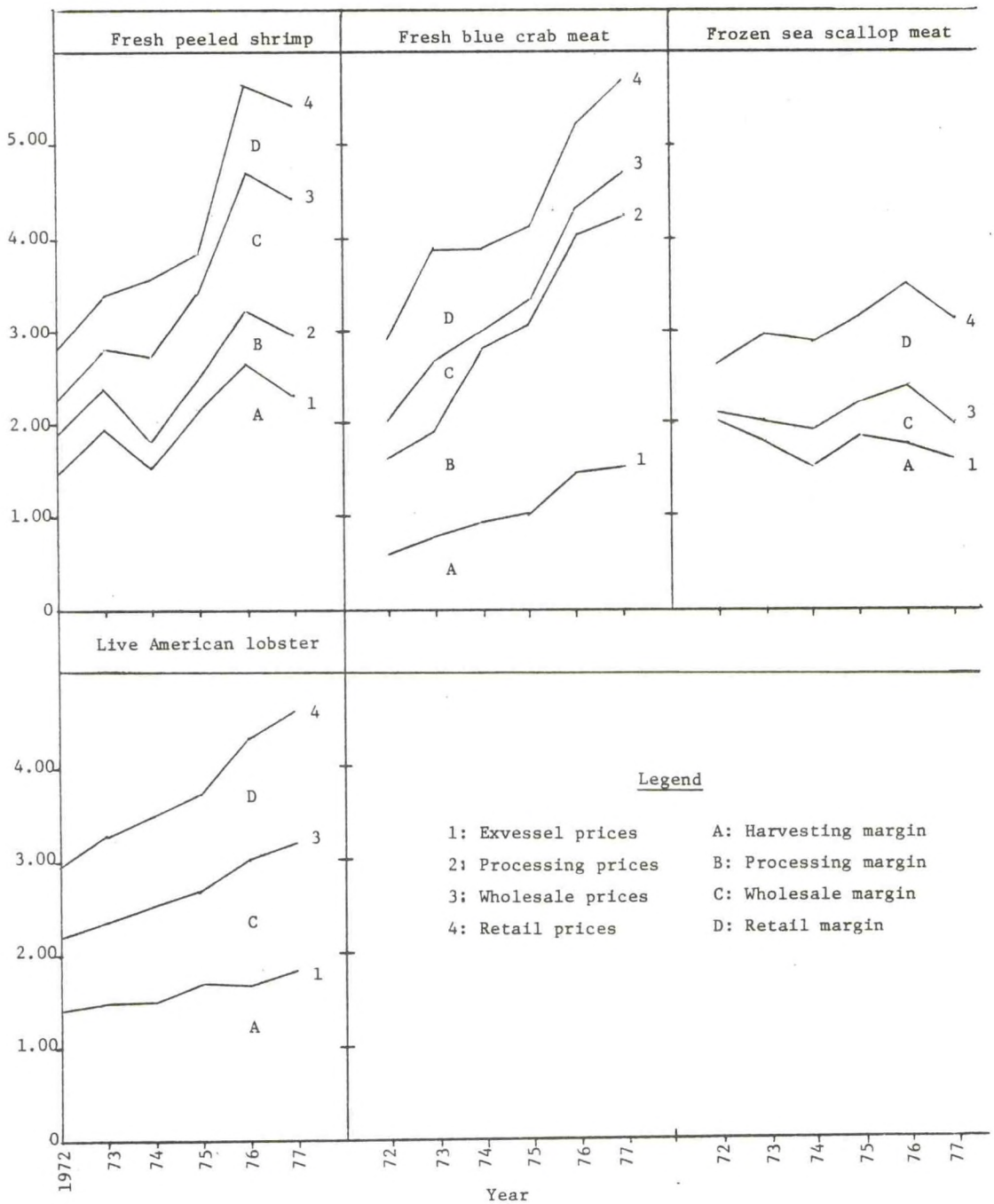

Figure 1.--U.S. fish prices and market margins at different marketing levels, 1972-77 (continued).

after 1974. However, prices at dockside of Atlantic cod, haddock, trolled salmon, Gulf shrimp, and Atlantic sea scallop were off in 1977. Prices of these fishery products at other levels thus are lowered to some extent.

COST ANALYSES OF PRICE MARGINS

A host of cost items together with profit or loss constitute the price margin of each functional (production or distribution) level. Each cost item represents one kind of materials purchased or services hired at each level. A variety of costs are involved in getting fish products from dockside to the retail market. Costs at any functional level can be analyzed by grouping them in different ways to suit the purposes of different studies--(1) to trace the distribution of a consumer's dollar spent for any fish product, (2) to measure the contribution to the economy by each fishery at each level, and (3) to assist management on policy decisions in production (or sales) and pricing.

Our cost data for different fisheries at the four functional levels were compiled on a nationwide basis from public and private sources in 1972; some data are from 1974. They are presented and rearranged in tables 1 to 3; value-added items are separated from material and service costs. The footnotes for each table detail the sources of data separately. From these basic cost tables, detailed cost items are derived for different fisheries at different functional levels, adjusted by regional data from Census.

To bring the collected cost data up to 1977 (annual data for 1978 are not available during the writing of this report), a composite cost index is needed at each functional level for each fishery for such an adjustment. In fact, with the composite cost index we can calculate the costs for any particular year we desire for comparison purposes. With 1 year's actual data a complete set of cost data is derived for every year from 1972 to 1977 for 13 major fisheries including 18 fishery products for four functional levels. (Price indices and wage rates of fishery cost inputs, and calculated composite cost indices for different fisheries, 1972-77, are shown in tables 4-6. Detailed cost rates for all fisheries at different production and marketing levels for the same period are shown in 96 tables in the appendix.)

Tables 1.--Cost rates as percentages of gross earnings for different fishing vessels, 1977
(to be continued)

	Otter trawls				Salmon trollers	Pacific halibut longliners	Tuna purse seiners
	Atlantic flounder	Atlantic cod	Atlantic haddock	Atlantic ocean perch			
	Percent						
Gross earnings (=margin)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Materials & supplies:	11.68	18.65	26.95	12.32	12.96	12.72	18.12
Fuel	6.52	10.41	15.47	4.57	8.82	7.11	12.54
Food	1.96	3.14	4.67	4.74	1.94	2.39	1.92
Ice	1.99	3.17	4.72	1.76	---	---	2.90
Bait	---	---	---	---	1.08	1.80	---
Nets & accessories	---	---	---	---	---	---	---
Other (admin.)	1.21	1.93	2.09	1.25	1.12	1.42	.76
Services purchased:	14.63	24.00	26.02	14.79	11.86	6.70	11.58
Insurance	4.44	7.08	7.53	4.47	3.35	1.45	4.16
Repair & maintenance	9.39	14.99	15.96	9.49	7.77	4.83	6.92
Other (admin.)	.80	1.93	2.53	.83	.74	.42	.50
Value added:	73.69	57.35	47.03	72.89	75.18	80.58	70.30
Payroll	52.26	52.26	52.26	52.26	41.97	57.79	39.60
Crew share	(47.02)	(47.02)	---	(47.04)	---	---	---
Captain's comm.	(2.37)	(2.37)	---	(2.37)	---	---	---
Employee tax	(2.87)	(2.87)	---	(2.85)	---	---	---
Capital costs	6.71	10.72	9.71	6.85	8.42	3.57	13.48
Interest	(1.52)	(2.43)	(2.58)	(1.59)	(1.84)	(.46)	(2.99)
Depreciation	(5.19	(8.29)	(7.13)	(5.26)	(6.58)	(3.11)	(10.49
Rent	.34	.54	.45	.35	.32	.18	.22
Tax & license	2.06	.13	.41	2.42	4.42	3.02	2.64
Net profit	12.32	-6.30	-15.80	11.01	20.05	16.02	14.36

Source: Cost data for New England flounder and sea scallop vessels and Pacific halibut vessels were collected in 1972 from field trip surveys by colleagues in the Economic Research Division. Salmon vessel operating costs are obtained from a study made by the School of Business and Technology (Oregon State University, 1979) and cost analysis of American lobster fishing boats are from a study conducted by the University of Rhode Island (Holmsen, 1969). Vessel cost data for all the other fisheries were provided by vessel operators participating in various programs of the National Marine Fisheries Service. (cont.).

Tables 1. -- Cost rates as percentages of gross earnings for different fishing vessels, 1977 (cont.)

Cost items	Pacific salmon gillnetters	Atlantic sea herring purse seiners	Gulf shrimp otter trawls	Chesapeake blue crab boats	Atlantic sea scallop dredges	Maine American lobster boats
	Percent					
Gross earnings (=margin)	100.00	100.00	100.00	100.00	100.00	100.00
Materials & supplies:	11.72	33.46	27.76	6.69	28.49	29.85
Fuel	3.75	5.25	13.89	2.48	15.50	12.17
Food	4.89	---	3.15	.70	8.23	---
Ice	.29	6.48	1.80	---	-----	---
Bait	---	---	---	3.42	2.39	9.58
Nets & accessories	---	---	4.64	---	---	---
Packing	---	5.70	2.40	---	---	---
Other (admin.)	2.79	16.03	1.88	.09	2.36	8.10
Services purchased:	16.24	24.54	15.33	18.92	27.53	11.94
Insurance	3.22	3.60	5.16	----	8.28	1.18
Repair & maintenance	11.18	10.24	9.61	18.86	27.03	6.83
Other (admin.)	1.84	10.70	.56	.06	2.22	3.93
Value added:	72.04	42.00	56.91	74.39	33.98	58.21
Payroll	33.17	26.24	38.69	40.47	45.57	43.01
Crew share	---	(24.59)	(36.47)	---	---	---
Captain's comm.	---	---	---	---	---	---
Employee tax	---	(1.65)	(2.22)	---	---	---
Capital costs	12.60	4.49	13.00	6.75	9.71	10.26
Interest	(1.59)	(.08)	(3.09)	---	(3.59)	(4.29)
Depreciation	(11.01)	(4.41)	(9.91)	(6.75)	(6.12)	(5.97)
Rent	.80	4.63	.41	.02	.95	.07
Tax & license	5.45	.62	.83	3.08	.75	.22
Net profit	20.02	6.02	3.98	24.07	-23.00	4.65

Source (cont.) They were submitted to the Financial Assistance Division in 1974 and 1975. Cost data are gathered in different years; costs for the years other than the data collecting year are arrived at by using composite cost indices (1972 = 100) compiled by the Economic Research Division to complete a series of cost tables from 1972 to 1977 for each fishery.

Table 2. ---Cost rates, as percentages of gross earnings (margin), at processing and wholesale levels, 1972

Cost items	Fish packaging 1/	Fish canning 1/	Wholesalers for groceries and related products 2/
	Percent		
Gross earnings	100.00	100.00	100.00
Materials & supplies:	27.15	28.20	11.18
a. Paper & paper board	4.05	2.06	--
b. Metal containers	.76	7.56	--
c. Ingredients & containers	11.96	10.52	--
d. Misc. materials	8.93	6.29	7.10
e. Electricity	.95	.78	--
f. Fuel oil	.50	.99	--
g. Office supplies	--	--	4.08
Services hired:	15.10	10.71	36.65
a. Transportation	--	--	19.74
b. Other services	15.10	10.71	16.91
Value added:	57.75	61.10	52.17
a. Wages	19.00	21.90	11.32
b. Salaries	7.03	7.23	5.13
c. Capital costs	17.23	16.50	5.66
d. Rent	3.27	3.43	2.24
e. Taxes	3.74	4.23	3.36
f. Net profit	7.47	7.81	24.47

1/ Statistical data from 1972 Census of Manufactures : Miscellaneous Foods & Kindred Products, Department of Commerce, published in April 1975.

2/ From income & expense data for proprietorship wholesalers, Statistics of Income, 1972, Internal Revenue Service, published October 1974.

Note: Costs and returns at the processing level are detailed nationwide averages from the Census of Manufactures. Those for different fisheries are based on the national averages and adjusted by data of the census from geographic areas (by State) which provide some important cost figures. For example, fish canning cost census from Alaska would be mostly for salmon; that from California, for tuna; that from Maine, for sardines; etc. A complete series of cost tables for different fisheries for the period 1972-77 is prepared by using fishery composite cost indices. They are available in the Economic Analysis Group, NMFS.

Table 3 ---Cost rates, as percentages of gross earnings, at the retail level, 1973 and 1974

Cost items	Super food 1/ markets	Super-markets 2/	Grocery stores 3/ (partner-ships)	Retail food 4/ stores	Meat markets 5/	Meat markets 6/	Fish markets 7/
	Percent						
Gross earnings (=margin)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Materials & supplies:	6.22	7.89	7.06	5.27	7.11	12.75	11.24
a. Energy (electricity) 8/	--	--	--	--	--	3.82	4.40
b. Office supplies	1.58	2.33	2.04	1.63	1.87	8.93	2.30
c. Misc. materials	4.64	5.56	5.02	3.64	5.24		4.54
Services hired: 9/	12.83	16.33	16.06	15.59	11.58	16.52	14.34
Value added:	80.95	75.78	76.88	79.14	87.31	70.72	74.42
a. Wages	.98	50.66	3.64	1.30	.68	13.91*	14.49*
b. Salaries	46.12		29.17	32.86	37.10	39.57**	38.95**
c. Interest	.33	.67	1.82	.54	.41	.82	.85
d. Depreciation	4.09	5.00	4.97	4.07	3.19	2.80	2.90
e. Rent	5.40	7.78	5.68	6.26	7.29	4.06	3.05
f. Taxes	3.55	3.78	8.77	4.40	3.91	3.86	4.00
g. Net profit	20.47	7.89	22.83	29.71	28.72	5.70	10.18

1/ National average of small-size supermarkets with annual sales of $500,000 to $100,000 from the Barometer of Small Business, published by the Accounting Corporation of America, 1973.

2/ Financial statements of supermarkets with multiple stores with annual sales of $20 million to $100 million from the Operations Review, published by the Super Market Institute, Chicago, 1973.

3/ Business Income Tax Returns, Statistics of Income, 1972, Internal Revenue Service, Oct. 1974.

4/ National average of combined food stores from the Barometer of Small Business, 1973.

5/ National average of meat markets with annual sales of $50,000 to $100,000 from the Barometer of Small Business, 1973.

6/ Developed by Case & Co. under contract to the National Association of Food Chains. Figures are re-arranged and presented in percentage form. See Marketing and Transportation Situation, published by Economic Research Service, Department of Agriculture, 1974, p. 27.

7/ Derived from meat market cost-earnings data used by Department of Agriculture by adjusting figures for materials and supplies, wages, and rent.

8/ Electricity for refrigeration to preserve fresh & frozen fish products.

9/ Includes insurance, legal fees, transportation, repairing, telephone, telegraph, postage, store cleaning, etc.

* Direct labor.

** General and departmental labor.

NOTE: Cost rates of different fish products at the retail level for a complete series from 1972 to 77 are shown in Appendix tables 71-83 for value added clasification, and 84-96 for variable/fixed costs.

Table 4. --Price indices and wage rates of inputs used by fish production and marketing firms, 1972-77 (1972 = 100)

	1973	1974	1975	1976	1977
	---------- Percent ----------				
Wholesale price indices[1]:					
Animal fats and oils	180.8	257.2	166.0	165.0	209.6
Misc. processed foods	107.4	138.2	159.1	157.2	165.6
Crude petroleum	110.1	186.1	215.9	222.8	240.9
Electric power	106.4	134.2	159.2	170.9	191.7
Gas fuels	111.0	142.2	189.9	251.4	340.0
Oil--lubricant	109.1	237.0	228.2	228.9	305.9
Tires and tubes	102.0	122.2	135.9	147.9	155.4
Paper	104.0	127.8	148.7	156.7	167.1
Paper board	109.1	144.3	161.4	167.1	167.3
Metal containers	104.5	127.8	149.1	156.9	169.3
General purpose machinery & equipment	103.8	123.5	145.8	155.0	164.8
Household appliances	100.8	109.6	122.9	129.3	134.7
Motor vehicles & equipment	101.0	109.5	122.5	130.3	138.7
Misc. products	104.5	116.1	128.9	160.3	143.5
Consumer price indices[2]:					
Rent	104.3	109.2	115.2	121.4	128.8
Services less rent[3]	104.3	114.9	126.5	132.7	148.3
Interest rate (short-term bank loans[4]	142.6	193.8	148.6	129.9	132.8
Wage rates (hourly)[5]:					
Food processing labor	106.4	115.6	127.3	138.2	148.8
Food wholesaling labor	106.3	115.8	128.7	137.1	151.9
Meat & vegetable retailing labor	105.7	116.8	128.2	141.3	152.1
Service industry labor	108.4	117.2	127.3	136.7	147.6
Eating places labor	105.9	118.8	123.7	129.7	143.6

1/ Bureau of Labor Statistics (BLS) wholesale price index.
2/ BLS consumer price index serie.
3/ Services include insurance, traveling, telephone, telegraph, postage, office cleaning, medical care, etc.
4/ Federal Reserve Board.
5/ BLS employment and earning reports.

Table 5. --Composite cost indices for U.S. fish canning plants for 1975-79 with 1972 as the base year

Costs	1972	1975		1976		1977	
	Cost rate	Price index	Cost rates	Price index	Cost rates	Price index	Cost rates
	%		%		%		%
Value of shipment	100.00						
Raw materials purchased (fish)	-43.68						
Gross earnings	56.32						
Materials & supplies:	15.88		25.05		25.96		28.98
Fats & oil	.89	1.660	1.48	1.650	1.47	2.096	1.87
Paper & paperboard	1.15	1.551	1.78	1.619	1.86	1.672	1.92
Metal containers	4.26	1.491	6.35	1.569	6.68	1.693	7.21
Ingredients & other materials	5.04	1.591	8.02	1.521	7.67	1.656	8.35
Misc. supplies	3.54	1.600	5.66	1.728	6.12	1.947	6.89
Electricity	.44	1.592	.70	1.709	.75	1.917	.84
Fuel oil	.56	1.899	1.06	2.514	1.41	3.400	1.90
Services hired:	6.03	1.265	7.63	1.327	8.00	1.483	8.94
Value added:	34.41		36.78		38.25		40.73
Wages	12.34	1.273	15.71	1.382	17.05	1.488	18.36
Salaries	4.07	1.273	5.18	1.382	5.62	1.488	6.06
Capital costs (depreciation)	9.29	1.472	13.67	1.425	13.24	1.488	13.82
Rent	1.93	1.152	2.22	1.214	2.34	1.288	2.49
Taxes	2.38						
Net profit	4.40						
Total without tax & profit	49.54		69.46		72.21		78.65
Composite index	100.00		140.21		145.76		158.76

NOTE: This table is an illustration of the calculation procedure of cost rates of different inputs of a fishery for the years other than the base year (1972), and also the method of compiling a composite index for the expenses incurred in a fishery at the processing level (canning).

Table 6. --Composite cost indices for U.S. fisheries at the harvesting, processing, and marketing levels, 1972-77 (1972 = 100)

	1973	1974	1975	1976	1977
	---------- Percent ----------				
Harvesting level:					
Atlantic groundfish otter trawls	108.58	118.32	127.54	132.94	135.02
Pacific salmon trollers	109.00	123.67	130.06	136.28	139.72
Pacific halibut longliners	107.48	1/106.67	115.06	125.80	129.25
Tropical Pacific tuna purse seiners	107.78	2/129.13	135.30	138.27	147.70
Pacific salmon gillnetters	106.89	124.75	131.69	132.01	139.22
Atlantic sea herring purse seiners	1/99.33	123.32	128.96	140.25	149.36
Gulf shrimp otter trawls	113.09	2/128.59	139.76	147.73	153.33
Chesapeake Bay blue crab boats	107.24	1/119.82	132.36	141.35	147.81
Atlantic sea scallop dredgers	1/99.87	1/112.33	120.99	123.26	130.11
Maine inshore American lobster boats	108.90	125.22	131.71	137.38	143.50
Processing level:					
Fish canning	107.06	122.35	140.21	145.76	158.76
Fish packaging	105.48	119.16	133.81	139.14	147.33
Marketing level:					
Wholesale	105.71	120.63	135.43	150.08	152.96
Retail	105.40	118.80	131.04	142.76	154.61
Eating places	107.00	123.56	135.87	148.06	161.24
Institutions	106.89	125.90	138.94	151.56	162.64

1/ Crewmen's share reduced as exvessel prices dropped that year.
2/ Indices increased, abruptly because of high fuel prices.

Value Added as a Measurement of Economic Contributions

In an economic system of increasing specialization in marketing, the real contribution of the distribution functionaries such as wholesalers and retailers to the economy is becoming better understood. The elimination of such middlemen may not eliminate the economic functions that are essential nor necessarily reduce associated costs. The contribution of such middlemen could be measured in terms of "value added" by the distributor of each level, the same way the manufacturer's contributions are measured.

The value of a product is created by the four factors of production: land, labor, capital, and management. Each carries a price tag. The total price paid to these factors adds value to the product according to the functions and services they performed. The distributors as well as the manufacturers pay rent for land and buildings, pay wages and salaries for labor, pay interest and write off depreciation as capital expenses, and pay taxes to the government for protection and dividends to the stockholders or owners as reward for investment. These contributions to the economy are derived or created by the four production factors at each level of production and distribution and summed up under the title "value added." That is, each level from extracting or harvesting through retailing has added some value to the product.

The value added of a product by one producer or distributor is, therefore, the difference between the selling price and the costs of raw materials, indirect materials, and purchased services. The total of the last three groups of cost items is the value created by and purchased from other sectors. These purchased materials and services are "value transferred" from other industries or sectors to be distinguished from "value added" created by its own sector in order to avoid duplications. Value added is, therefore, a measure of what each functional level of an industry contributes to the economy by its production factors in the form of gross national product (GNP), or gross regional product (GRP) if the study is confined to a local economy.

The estimate of value added at each functional level provides a yardstick to compare the economic contributions of any industry with those of another and those among different levels within the same industry on a nonduplicative basis.

In the cost analysis of this study, one of the methods of classification is based on the concept of value added. For the convenience of application of the original data collected for each fishery at each functional level, the components of value added are converted to relative values as percentages of sales. The total of these percentages is the value-added rate of a fishery at a particular level. Sales values of the 18 major fisheries

at seven functional levels are calculated in a report on marketing bill studies (Penn, 1980). The sales value of a fish product at each of the seven levels times the value-added rate of the product at that level is the contribution to the national economy by the fishery expressed as the gross national product (GNP) (tables 7-12).

In 1977, at the harvesting level, the shrimp fishery contributed the most to the national economy in terms of gross national product ($207 million) followed by the salmon fishery ($164 million), the tuna fishery ($95 million), and the groundfish fishery ($64 million) (table 7).

When the annual contributions of all the domestically produced and imported fishery products in 1975-77 are added for each functional level, eating places provided 42.86 percent; processing and processing/wholesale, 25.10 percent; harvesting, 16.21 percent; retail, 9.86 percent; wholesale, 4.03 percent; and institutions, 1.94 percent of the total contribution toward the GNP (table 13). An individual fishery product may not follow that order, because different pricing and profitmaking strategies are practiced by management at different functional levels of a fishery under nonidentical supply and demand situations and varying competitive positions.

Although the sales values at the processing and the processing/wholesale levels were much higher than those at the harvesting level in past years, fish harvesting contributed more to the national economy than the other two levels. Apparently more services were performed by labor and capital on the vessel in getting fish to the shore than the services performed in processing the products (table 13).

At the consumer market level, the food service industry sold more fishery products than retail stores in 1977 by 7 to 3 and contributed about four times as much to GNP (table 13). This is conceivable, because greater quantities of fish were handled by the food service industry and more labor, capital, and management were required to transform fish to edible form and taste as well as serve them in proper premises than the limited space needed and simple services performed by retailers.

Table 7.--Contribution to the gross national product by the U.S. fishing industry at the harvesting level, 1975-77

Fishery	1975			1976			1977		
	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP
	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars
Flounder	43,233	71.29	31,101	52,007	76.58	39,622	59,477	73.69	43,829
Cod	14,446	64.64	9,423	15,877	72.31	11,422	18,876	57.35	10,826
Haddock	5,283	54.63	2,886	5,551	50.80	2,806	9,270	47.03	4,360
Ocean perch	4,028	69.67	2,912	5,114	73.88	3,759	6,136	72.89	4,472
Salmon steak	4,738	68.76	3,288	7,686	73.97	5,656	3,244	75.18	2,439
Salmon, canned	38,944	73.45	28,864	62,681	65.99	41,150	89,286	72.04	64,322
Salmon, misc. products	72,616	68.76	50,384	126,129	73.97	93,818	129,333	75.18	97,232
Halibut steaks	14,549	75.44	11,076	19,418	80.26	15,505	17,340	80.58	13,972
Tuna, canned	108,377	63.51	69,445	149,765	64.76	96,489	135,785	70.30	95,457
Sardines, canned	2,656	37.71	1,011	1,695	40.18	677	2,038	42.00	856
Other finfish	113,877	69.67	80,059	136,404	73.88	100,257	140,915	72.89	102,713
Shrimp, canned	12,692	63.51	8,134	23,843	64.76	15,362	36,309	70.30	25,525
Shrimp, peeled	70,898	58.93	42,159	103,281	61.35	63,037	106,450	56.91	60,581
Shrimp, other products	142,650	58.93	84,827	204,251	61.35	125,684	212,399	56.91	120,876
Blue crab meat	18,739	67.11	12,727	22,966	69.06	15,778	27,454	74.39	20,423
Sea scallop meat	18,009	41.81	7,598	35,061	38.31	13,363	40,584	33.98	13,790
American lobster, live	49,090	58.76	29,107	52,684	53.52	28,051	57,715	58.21	33,596
Other shellfish	160,320	67.11	108,518	247,905	69.06	170,323	316,639	74.39	235,548
Totals	895,199	65.18	583,529	1,272,318	66.08	840,739	1,409,250	67.47	950,817

Source: Sales figures in this table and following tables are from the study conducted in a ready-to-be published report: Marketing Bill of U.S. Fish Food Products and Its Components, by Penn, Economic Analysis Group, NMFS. Value-added rates are from Appendix cost tables, 1972-77.

Table 8.--Contribution to the gross national product by the U.S. fishing industry at the processing level, 1975-77

Fishery	1975			1976			1977		
	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP
	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars
Flounder	57,975	12.17	7,056	78,343	21.66	16,969	84,832	18.87	16,088
Cod	20,311	12.80	2,600	23,991	19.00	4,558	31,796	24.74	7,866
Haddock	7,861	18.65	1,466	7,964	18.86	1,502	14,679	21.51	3,157
Ocean perch	7,859	22.95	1,804	10,668	29.35	3,131	13,177	34.96	4,607
Salmon steak	5,506	3.03	167	8,950	5.70	510	3,952	9.56	378
Salmon, canned 1/	102,645	36.47	37,435	205,819	42.18	86,814	202,947	26.05	52,868
Salmon, misc. products	68,333	12.50	8,542	200,454	26.13	52,379	98,224	34.20	33,593
Halibut steaks	20,310	19.39	3,398	25,888	17.62	4,651	22,781	16.42	3,741
Tuna, canned 1/	232,685	32.73	76,158	315,300	32.10	101,211	267,849	31.11	83,328
Sardines, canned	24,426	54.89	13,407	22,681	55.67	12,627	30,804	58.26	17,946
Other finfish	214,562	22.95	49,242	258,264	29.35	75,800	348,940	34.96	121,989
Shrimp, canned 1/	27,250	32.73	8,919	50,197	32.10	16,113	71,623	31.11	22,282
Shrimp, peeled	81,462	5.91	4,814	124,836	9.26	11,560	138,161	13.66	18,873
Shrimp, other products	163,905	5.91	9,687	246,878	9.26	22,861	275,673	13.66	37,657
Blue crab meat	56,229	46.34	26,057	63,896	47.39	30,280	76,385	47.46	36,252
Sea scallop meat	-	-	-	-	-	-	-	-	-
American lobster, live	-	-	-	-	-	-	-	-	-
Other shellfish	452,836	46.34	207,844	638,511	47.39	302,590	881,135	47.46	418,187
Totals	1,544,155	29.73	459,136	2,282,640	32.55	743,466	2,562,958	34.29	878,732

1/ Processing and wholesale combined.

Table 9.--Contribution to the gross national product by the U.S. fishing industry at the wholesale level, 1975-77

Fishery	1975			1976			1977		
	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP
	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars
Flounder	72,932	8.84	6,447	105,614	15.16	16,011	115,363	17.63	20,338
Cod	29,390	16.05	4,717	32,790	15.75	5,164	43,996	16.71	7,352
Haddock	9,048	4.60	416	8,273	-5.20	-430	18,009	9.96	1,794
Ocean perch	8,763	-.77	-67	12,183	3.60	439	15,406	8.25	1,271
Salmon steak	7,538	10.14	764	12,043	10.78	1,298	5,579	14.91	832
Salmon, canned 1/	-	-	-	-	-	-	-	-	-
Salmon, misc. products	93,548	10.14	9,486	269,731	10.78	29,077	138,653	14.91	20,673
Halibut steaks	22,016	2.50	550	28,269	3.96	1,119	25,633	6.97	1,787
Tuna, canned 1/	-	-	-	-	-	-	-	-	-
Sardines, canned	26,746	.12	32	23,719	-4.66	-1,105	32,192	-1.55	-499
Other finfish	239,219	-.77	-1,842	294,857	3.60	10,115	387,798	8.25	31,993
Shrimp, canned 1/	-	-	-	-	-	-	-	-	-
Shrimp, peeled	114,128	22.31	25,462	181,998	26.48	48,193	206,178	28.37	58,493
Shrimp, other products	153,907	22.31	34,337	273,847	26.48	72,515	320,758	28.37	90,999
Blue crab meat	60,727	.80	486	68,203	.18	123	84,573	4.48	3,789
Sea scallop meat	21,647	11.85	2,565	47,199	20.31	9,586	49,751	12.19	6,065
American lobster, live	77,857	15.08	11,741	95,247	21.13	20,126	101,041	22.33	22,562
Other shellfish	489,140	.80	3,913	681,589	.18	1,227	858,807	4.48	38,475
Totals	1,426,606	6.94	99,007	2,135,562	10.02	213,958	2,403,737	12.73	305,924

1/ Processing and wholesale combined. (See processing table.)

Table 10--Contribution to the gross national product by the U.S. fishing industry at the retail level, 1975-77

Fishery	1975			1976			1977		
	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP	Sales	Value-added rate	Contrib. to GNP
	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars	Thousand dollars	%	Thousand dollars
Flounder	44,634	33.66	15,024	51,840	22.14	11,477	56,951	22.40	12,757
Cod	15,807	27.56	4,356	17,507	27.50	4,814	23,722	28.19	6,687
Haddock	4,228	17.87	756	3,725	14.99	558	9,111	21.43	1,952
Ocean perch	6,593	32.82	2,164	7,894	24.02	1,896	10,343	26.94	2,786
Salmon steak	3,099	8.06	250	4,650	3.24	151	2,454	14.90	366
Salmon, canned	81,242	27.06	21,644	200,984	25.10	50,447	201,049	27.39	55,067
Salmon, misc. products	38,459	8.06	3,100	104,153	3.24	3,375	60,996	14.90	9,088
Halibut steaks	12,741	16.71	2,129	15,774	14.52	2,291	15,011	19.16	2,876
Tuna, canned	239,265	16.22	38,809	320,959	15.22	48,850	256,622	10.52	26,997
Sardines, canned	29,542	23.95	7,075	25,725	22.51	5,789	32,038	15.69	5,027
Other finfish	179,988	32.82	59,072	191,127	24.02	45,909	260,384	26.94	70,147
Shrimp, canned	17,467	16.22	2,833	36,149	15.22	5,502	51,312	10.52	5,398
Shrimp, peeled	48,183	5.11	2,462	82,783	12.15	10,058	95,984	14.10	13,534
Shrimp, other products	64,976	5.11	3,320	124,574	12.15	15,136	149,325	14.10	21,055
Blue crab meat	7,542	12.06	910	8,250	10.68	881	10,313	11.40	1,176
Sea scallop meat	3,070	24.26	745	6,983	27.27	1,895	7,807	29.79	2,326
American lobster, live	10,744	20.51	2,204	13,619	22.77	3,101	14,549	23.60	3,434
Other shellfish	60,765	12.06	7,328	82,450	10.68	8,806	104,732	11.40	11,939
Totals	868,345	20.06	174,181	1,299,146	17.01	220,936	1,362,703	18.54	252,612

Table 11.--Contribution to the gross national product by the U.S. fishing industry at the food service levels, 1975-77

	1975			1976			1977		
	Sales	VA rate 1/	GNP 2/	Sales	VA rate	GNP	Sales	VA rate	GNP
	Million dollars	%	Million dollars		%	Million dollars		%	Million dollars
Eating places	2,276.7	35.35	804.81	3,377.1	34.62	1,169.15	3,698.3	32.89	1,216.37
Institutions	149.8	20.76	31.10	236.7	20.35	48.17	237.9	19.99	47.56
Total	2,426.5	34.45	835.91	3,613.8	33.68	1,217.32	3,936.2	32.11	1,263.93

Table 12.--Contribution to the gross national product by all levels from processing/wholesale to food service industries that market imported fish products, 1975-77

	1975			1976			1977		
	Sales	VA rate	GNP	Sales	VA rate	GNP	Sales	VA rate	GNP
	Million dollars	%	Million dollars		%	Million dollars		%	Million dollars
Processing/wholesale	1,962.2	18.34	359.86	2,741.5	21.29	583.66	2,993.2	23.51	703.71
Retail	1,105.5	20.06	221.76	1,472.7	17.01	250.51	1,636.4	18.54	303.39
Eating places	2,305.8	35.35	815.10	3,207.5	34.62	1,110.44	3,380.7	32.89	1,111.91
Institutions	196.5	20.76	40.49	274.7	20.35	55.90	295.8	19.99	59.13
Total	5,570.0	25.81	1,437.51	7,696.4	25.99	2,000.51	8,306.1	26.22	2,178.14

1/ Value-added rate.
2/ Contribution to gross national product.

Table 13.--Total contribution to the economy in terms of gross national product (GNP) from all domestic and imported edible fish products by functional levels, 1975-77

Functional levels	1975				1976				1977				Average percentage of 3 years
	Sales	Average VA* rate	GNP#	% of total	Sales	Average VA* rate	GNP#	% of total	Sales	Average VA* rate	GNP#	% of total	
	Million dollars	%	Million dollars	%	Million dollars	%	Million dollars	%	Million dollars	%	Million dollars	%	%
Harvesting	895.2	65.18	583.5	16.26	1,272.3	66.07	840.7	16.05	1,409.3	67.46	950.8	16.31	16.21
Processing	1,181.6	28.46	336.6	9.38	1,711.3	31.51	539.3	10.30	2,020.5	35.64	720.3	12.35	10.68
Processing/ wholesale**	2,324.8	20.74	482.4	13.44	3,312.8	23.78	787.8	15.04	3,535.7	24.38	862.2	14.79	14.42
Wholesale	1,426.6	6.94	99.0	2.76	2,135.6	10.01	214.0	4.08	2,403.7	12.73	305.9	5.25	4.03
Retail	1,973.8	20.06	395.9	11.03	2,771.8	17.00	471.4	9.00	2,999.1	18.54	556.0	9.54	9.86
Eating places	4,582.5	35.34	1,619.9	45.13	6,584.6	34.62	2,279.6	43.53	7,079.0	32.88	2,328.3	39.93	42.86
Institutions	346.3	20.76	71.9	2.00	511.4	20.35	104.1	2.00	533.7	19.99	106.7	1.83	1.94
Total	12,730.2	28.20	3,589.3	100.00	18,299.9	28.62	5,236.9	100.00	19,981.0	29.18	5,830.2	100.00	100.00

* Value added.

\# Contribution to gross national product.

** This is a special level for canned tuna, canned salmon, and canned shrimp, the wholesale prices of which are quoted at the doors of their canneries. Therefore, their processing and wholesale levels are combined.

Value Added as A Measurement of Productivity

The various costs under the value-added category can also be used to analyze the effectiveness of industrial management among different fisheries or among various functional levels within the same fishery. Effectiveness of management is better known as productivity that measures the efficiency of using the facilities of production or production factors. Therefore, productivity is the output per unit of productive effort. This report deals with the value of output instead of physical units. The value of production or sales is not the true value of output, since part of this value is transferred from other sectors as discussed before. Value added is the real creation of an industry and, therefore, is considered as the true value of output (Buzzel, 1959). Inputs include the functions and services performed by labor, capital, land, and management. The costs of these services are listed in this study as wages, salaries, interest, depreciation, rent, taxes, and profit.

Although the four production factors are all considered as inputs, productivity is usually related to two of the factors--labor and capital--expressed as output/labor and output/capital ratios. By using value added as the real output, the input of labor should also be expressed in value terms, wages, instead of physical units, worker-hours, in order to be comparable. Industrial wages are paid on a hourly or weekly basis, but fishermen are paid on a sharing basis according to their catch. Therefore, idle time and unproductive hours are ruled out. When the output or value added at a certain functional level of a fishery is expressed as a ratio of the input of labor in wages within the same period, productivity of labor in value terms at that level can be estimated. In value terms, it can be interpreted as the real value of output per dollar of productive wages spent. The productivity indices so calculated can be used to compare productivities among fisheries at the same functional level and between functional levels within each fishery. They can be used to compare the same with other industries if the productivity estimates of the latter are also calculated from the value-added approach in value terms.

The input of capital in this study is not investment, accurate information of which is not available, but capital costs in terms of interest and depreciation. Interest and depreciation are related to the size of investment. They can be used not to measure productivity of capital, but to compare the degree of capital intensiveness among different fisheries and functional levels. Such comparisons may not be made between distant periods unless inputs and outputs are carefully adjusted to constant values and no technological changes are envisioned. Capital intensity of a fishery at certain functional levels is calculated by expressing capital costs as a ratio of value added at that

level. The result of such calculation is an alternative interpretation of capital-output relations if we want to make the best use out of a set of limited available data.

Tables 14 to 17 show capital intensity and labor productivity indices for each functional level of different fish products. Capital intensity appears to be highest in processing and lowest in retailing for all fisheries. Compared with other fisheries at the harvesting level, New England sea scallop, California tuna, and Gulf shrimp fishing ranked high and Pacific halibut fishing ranked low in capital expenditures. Apparently it is more expensive to operate purse seiners and trawlers than longliners.

Higher labor productivity for processing than for harvesting indicates that processing plants use comparatively more automation. Low labor productivity in retail stores implies that many workers handle small quantities of products, whereas in wholesale stores fewer workers handle big quantities. Labor productivity at retail is exceptionally high for canned products, because they are shelved and not attended by salesmen. By the same token, higher labor productivity is indicated for frozen than for fresh products (tables 14-17).

COST-PRICE-VOLUME RELATION

Production Level

Both harvesting and processing (of fishery products) are performing the functions of production. The processor is chosen here as an example to study the cost-price-volume relationship. The same procedure will apply to the study of harvesting. Volume in this case means the quantity of production. Costs will vary with the volume of production in gradual proportion only when the variable costs are sorted out from the fixed. Fixed costs usually don't change as volume changes. Volume multiplied by price will give total revenue, which will eventually be affected by the change in variable costs over time with the change in the size of a firm.

During expansion, as inputs (costs) increase, revenue will increase at a faster rate at first and continue to increase but at a slower rate till it reaches the point of diminishing returns. During contraction, total revenue will decline faster than the decline in total costs after a certain point is reached, because fixed costs will not change when production and revenue continue to drop. There are break-even points at the upper and lower ends of a revenue curve and a maximum profit point in between.

Table 14.--Productivity indices for different fish products derived from average value-added, labor, and capital costs in 1975-77 at the harvesting level

Product	Value-added rate (1)	Labor cost rate (2)	Capital cost rate (3)	Labor productivity (1÷2)	Capital intensity (3÷1)
	Percent 1/				
New England fresh flounder fillets	73.85	52.26	8.61	1.4131	0.1166
New England fresh cod fillets	64.77	52.26	10.05	1.2394	.1552
New England fresh haddock fillets	50.82	52.26	10.37	.9724	.2041
New England fresh ocean perch fil.	72.15	52.26	8.37	1.3806	.1160
Puget Sound fresh salmon steaks	72.64	41.97	10.03	1.7308	.1381
Pacific frozen halibut steaks	78.65	57.79	4.27	1.3610	.0543
California canned tuna-lgt. meat	66.19	39.60	15.80	1.6715	.2387
Alaska canned pink salmon	70.49	33.17	13.52	2.1251	.1918
Maine canned sardines	39.86	26.24	4.53	1.5191	.1136
Gulf raw peeled shrimp	59.06	38.69	12.51	1.5265	.2118
Chesapeake blue crab meat	70.19	40.47	8.43	1.7344	.1215
New England sea scallop meats	38.03	52.24	9.59	.7280	.2522
Maine live Amer. lobster	56.79	43.01	10.62	1.3204	.1870

1/ Percentage of sales.

SOURCE: Value-added items from the U.S. fishery cost table series, tables 1-13 (Penn, 1978).

Table 15.--Productivity indices for different fish products derived from average value-added, labor, and capital costs in 1975-77 at the processing level

Product	Value-added rate (1)	Labor cost rate (2)	Capital cost rate (3)	Labor productivity (1÷2)	Capital intensity (3÷1)
	Percent 1/				
New England fresh flounder fillets	17.57	6.57	4.65	2.6743	0.2647
New England fresh cod fillets	18.85	8.50	5.53	2.2176	.2934
New England fresh haddock fillets	19.67	7.23	5.22	2.7206	.2654
New England fresh ocean perch fil.	29.09	11.71	8.77	2.4842	.3015
Puget Sound fresh salmon steaks	6.10	5.17	3.82	1.1799	.6262
Pacific frozen halibut steaks	17.81	4.31	4.49	4.1323	.2521
California canned tuna-lgt. meat 2/	31.98	11.41	6.95	2.8028	.2173
Alaska canned pink salmon 2/	34.90	15.97	8.42	2.1853	.2413
Maine canned sardines	56.27	23.81	14.34	2.3633	.2548
Gulf raw peeled shrimp	9.61	4.43	2.68	2.1693	.2788
Chesapeake blue crab meat	47.06	12.87	2.72	3.6566	.0578
New England sea scallop meats	-	-	-	-	-
Maine live Amer. lobster	-	-	-	-	-

1/ Percentage of sales.
2/ Processing and wholesale combined.
NOTE: Value-added rates are from appendix cost tables 27-37.

Table 16.--Productivity indices for different fish products derived from average value-added, labor, and capital costs in 1975-77 at the wholesale level

Product	Value-added rate (1)	Labor cost rate (2)	Capital cost rate (3)	Labor productivity (1÷2)	Capital intensity (3÷1)
	Percent 1/				
New England fresh flounder fillets	13.88	4.32	1.64	3.2130	0.1182
New England fresh cod fillets	16.17	4.87	2.20	3.3203	.1361
New England fresh haddock fillets	3.12	2.99	3.25	1.0435	1.0417
New England fresh ocean perch fil.	3.69	2.24	.85	1.2341	.2304
Puget Sound fresh salmon steaks	11.94	7.69	1.40	1.5527	.1173
Pacific frozen halibut steaks	4.48	1.86	.71	2.4086	.1585
California canned tuna-lgt. meat 2/	-	-	-	-	-
Alaska canned pink salmon 2/	-	-	-	-	-
Maine canned sardines	-2.03	4.31	1.53	-	-
Gulf raw peeled shrimp	21.72	3.52	1.33	6.1704	.0612
Chesapeake blue crab meat	1.82	2.63	1.00	0.6920	.5495
New England sea scallop meats	14.78	2.13	.78	6.9390	.0528
Maine live Amer. lobster	19.51	7.20	2.73	2.7097	.1399

1/ Percentage of sales.
2/ Processing and wholesale combined. (See processing table.)
NOTE: Value-added rates are from appendix cost tables 49-59.

Table 17.--Productivity indices for different fish products derived from average value-added, labor, and capital costs in 1975-77 at the retail level

Product	Value-added rate (1)	Labor cost rate (2)	Capital cost rate (3)	Labor productivity (1÷2)	Capital intensity (3÷1)
	Percent 1/				
New England fresh flounder fillets	26.07	9.19	1.71	2.8368	0.0656
New England fresh cod fillets	27.75	9.78	.72	2.8374	.0259
New England fresh haddock fillets	18.10	10.91	.91	1.6590	.0503
New England fresh ocean perch fil.	27.93	12.78	1.04	2.1854	.0372
Puget Sound fresh salmon steaks	8.73	6.96	.58	.2543	.0064
Pacific frozen halibut steaks	16.80	8.99	.76	1.8687	.0452
California canned tuna-lgt. meat	13.73	9.92	.83	1.3841	.0605
Alaska canned pink salmon	26.52	9.11	.70	2.9111	.0264
Maine canned sardines	20.72	4.60	.38	4.5043	.0183
Gulf raw peeled shrimp	10.45	8.32	.71	1.2560	.0679
Chesapeake blue crab meat	11.38	12.89	1.08	.8829	.0949
New England sea scallop meats	27.11	10.57	.88	2.5648	.0325
Maine live Amer. lobster	22.29	13.27	1.11	1.6797	.0498

1/ Percentage of sales.

NOTE: Value-added rates are from appendix cost tables 71-83.

To determine the maximum profit and the upper end break-even point requires historical data of prices and costs, which assume different rates of change during the course of expansion for an individual firm. Because of lack of historical data of cost changes of an individual firm, it is impossible to demonstrate the procedure of profit maximization in a static situation. However, we still can avail ourselves to put data of limited time series to use for current estimates, such as the determination of the lowest limit of production below which a firm will not be able to make profit at the present cost and demand situation, and the decision of its pricing policy if everything else is unchanged. Such estimates are not for long-range projections but useful for near-term policy decisions.

a. Break-even Point -- The break-even point is the production (or sales) level where the total revenue equals total costs with no return in the form of profit (Slavin et al., 1968). In a situation where no change in the size of a firm is expected and variable costs maintain the same ratio with production or sales, it is possible to determine the break-even point at the lower end of the revenue curve under existing conditions. Let's take as an example the processing of fresh flounder fillets. Given a New Bedford plant with a 1977 production of 2 million pounds (Q_F) of fresh flounder fillets and other information as follows:

Processor's price (1977) = 177.80 ¢/lb = P_F 1

Variable costs were 81.03% of sales (from appendix table 38).
0.08103 x 177.8 = 144.67 ¢/lb = average variable costs = AVC. . . . 2

Fixed costs were 12.77% of sales (same table mentioned above)
0.1277 x 177.8 = 22.71 ¢/lb = average fixed costs = AFC. . . . 3

Profit rates was 6.19% of sales (same table mentioned above)
0.0619 x 177.8 = 11.01 ¢/lb = r 4

When the above average values are multiplied by the quantity (Q_F) of production (2 million lb), the following total values are obtained:

Total revenue (TR = P_F x Q_F = $3,556,000

Variable costs (VC) = AVC x Q_F = $2,881,400

Fixed costs (FC) = AFC x Q_F = $ 454,200

Profit (II) = r x Q_F = $ 220,200

To find the break-even point we have to equate TR = TC = FC + VC.

To find the right production level, let P_F' = new price, Q_F'' = the production level, then

$$P_F' \cdot Q_F'' = FC + AVC \cdot Q_F'' + r$$

$$1.678\ Q_F'' = 454{,}200 + 1.4407\ Q_F'' + 220{,}200$$

$$Q_F'' = \frac{674{,}400}{.2373} = 2{,}841{,}972 \text{ lb}$$

The processor has to increase his production by 842,000 pounds to maintain the same profit.

$$\text{Marginal revenue} = \frac{\text{Additional revenue}}{\text{Additional units}} = \frac{4{,}768{,}829 - 3{,}556{,}000}{2{,}841{,}972 - 2{,}000{,}000} = \frac{1{,}212{,}829}{841{,}972}$$

$$= 1.4406, \text{ the same value for the marginal cost.}$$

When MR = MC, the same profit will remain.

Management's pricing actions have a direct effect on profits, but this may not necessarily result in favorable terms if other conditions are not carefully considered at the same time. It is especially difficult and risky for small businesses to initiate intelligent price changes as a form of competition. Competition today takes the form of better customer service, effective promotion, and product quality improvement (Management Services Technical Study, 1965).

Distribution Level

Wholesalers and retailers perform distribution functions. Certain operating costs at the distribution level are intended to stimulate product demand. Demand-creating costs include expenses like salesmen's salaries, advertising, promotions, and entertainment. They are classified under the fixed cost category. Other expenses such as commissions, premiums, trading stamps, samples, and discount allowances are classified as variable costs.

a. Change in Fixed Costs -- To increase fixed marketing costs may affect the quantity of sales. How could this be achieved to increase profit without changing the price? One way would be to increase advertising expenditures with the prospect that the increase in sales volume could compensate more than the additional costs involved.

To use canned sardines for an illustration, let's assume that a supermarket has sold 40,000 cans of sardines in 1977 with the following given information:

$$P_F Q_F' = FC + AVC \times Q_F'$$

Substituting:

$$1.778\ Q_F' = 454{,}200 + 1.4407\ Q_F'$$

$$0.3373\ Q_F' = 454{,}200$$

$$Q_F' = 1{,}346{,}576 \text{ lb}$$

The lowest quantity to be produced without loss to the processor is 1.35 million pounds. This is the break-even point. Knowledge of this point can help management foresee the lower limit of production and consider ahead of time the alternative action of lowering variable costs at the expense of fixed costs, or preventing the occurrence of a possible loss.

Break-even analysis is, however, a static measure of a dynamic process. It presents a picture of the cost and price structure of a firm at a given point in time, but may not be true for future projection. It is also difficult to determine for a firm with multiple products.

b. Price-Volume Relation -- In a competitive market any race to reduce the price so as to sell more and still be able to keep the same profit will be a healthy sign to the economy. In the above example of fresh flounder fillets, let's reduce the processor's price by 10 cents to $1.678 a pound. How much should the processor increase his production to maintain the same $220,200 level of profit? First, let's make a trial and error attempt to see whether an increase of 600,000 pounds will serve the purpose. A marginal analysis will test whether the same profit could be retained, i.e., if the new marginal revenue (MR) will equal the marginal cost (MC).

With a new price and a new production level, the additional revenue will be $806,800:

Old revenue = 1.778 x 2,000,000	=	$3,556,000
New revenue = 1.678 x 2,600,000	=	4,362,800
Additional revenue	=	806,800

The new marginal revenue will be $\frac{806{,}800}{600{,}000} = \$1.3447$, which is smaller than the marginal cost (=AVC) of $1.4407. The increase in revenue per unit will not cover the increase in cost per unit. Therefore, the increase in sales of 600,000 pounds, or 30 percent, will not be big enough to make the same profit.

Retail price per can of 1-lb size = 138.40 ¢/can in 1977
Variable costs were 86.37% of sales. (See appendix table 92)
$1.384 x 0.8637 = $1.1954/can = AVC
Fixed costs were 7.04% of sales (" " ")
$1.384 x 0.0704 = 0.974/can = AFC
Profit rate was 6.59% of sales (" " ")
$1.384 x 0.0659 = 0.09121/can = r

We get

VC = 1.1954 x 40,000 = 47,816
FC = 0.0974 x 40,000 = 3,896
TC = 51,712
r = 0.0912 x 40,000 = 3,648

Suppose this store spent $1,200 for advertising ($C_A$, a fixed cost) that resulted in expanded sales of sardines (Q_s') at regular price of 138.40 ¢/can (P_s). To solve for Q_s':

$$TR = TC + C_A + r = FC + C_A + AVC \times Q_s' + r$$
$$1.384Q_s' = 3.896 + 1,200 + 1.1954Q_s' + 3,648$$
$$Q_s' = \frac{8744}{0.1886} = 46,362.7$$

This store would have to sell 6,363 cans more to recover the cost spent in the advertising campaign. Additional sales over this quantity will result in higher profit earned. To increase profit by 5 percent (1.05 x 3,648 = 3,830.4), the retailer would have to be able to sell 967 cans more in addition ($\frac{892.6}{0.1886}$ = 47,329.8). Management should not initiate such a campaign unless it is sure that the extra sales can be generated.

The estimation of the break-even point would be more reliable if no abrupt changes are expected in the intermediate term of the market outlook. The break-even point after the increase of such a fixed cost (advertising) would be at a sales level as low as 27,020 cans, calculated from the equation: $1.384Q_s' = 3,896 + 1,200 + 1.194Q_s'$

b. Change in Variable Cost -- A proposal to give the customers trading stamps at 2 percent of sales will increase the variable costs rate from 86.37 percent to 88.09 percent or $1.2191/can instead of $1.1954/can assuming there is no change in price. To find how much the increase in the volume of sales ($Q_{,s}$) would be to assure the same profit,

$$1.384Q_s' = 3,896 = 1.2191Q_s'' + 3,648$$
$$Q_s'' = 7,544 / 0.1649 = 45,749 \text{ cans}$$

If it were to make the same profit, this store should have sold 5,749 more cans in 1977, to offset the cost of the trading stamps. The cost of this program appears to be about the same as that of the advertising campaign, because the value of trading stamps offered would be about $1,240 if sales reached 45,000 cans. But the effect came out much differently. By offering trading stamps, it is possible to reduce the break-even point to below that engendered by the advertising program. The former involves less risks, because it increases the variable costs rather than the fixed costs (Wright, 1962). On the other hand, the store would have to sell less in quantity under the trading stamp program to make the same profit as it had before the initiation of the program.

Trade-offs of Fixed and Variable Costs

Another way of improving the efficiency of demand-creating expenditures is to change the functions of fixed and variable costs to assume different forms of expenditures. For instance, the plant processing flounder fillets in New Bedford may consider the advisability of establishing a branch office in New York City as a sales office instead of selling its products through wholesale distributors. Let's assume that running a branch office would cost an annual fixed cost of $80,000 and an additional variable cost of 23.25 cents/pound sold (based on cost ratios at the wholesale level: VC = 80.52 percent, FC = 10.13 percent, and profit = 9.35 percent of sales, and the given wholesale price of $2.41751/lb and processing price of $1.778/lb). Also assume that the plant's branch office sells its products at $2.078 a pound -- 30 cents higher than the price at the door of the processing plant, but 33.95 cents a pound cheaper than the wholesale price quoted at New York. What would be the price-volume changes involved in this tradeoff deal?

Using the data provided in equations 1-4 on p. 27 (except that the quantity to be sold in New York will be 1 million pounds Q_F^1, half the presumed quantity produced in its New Bedford plant), we get: AVC = 144.07¢/lb, AFC = 22.71¢/lb, profit rate (r) = 11.01¢/lb. Now we have a new price (P_F^1) 207.80¢/lb; and to the total fixed cost of $210,500 ($FC_1$) in the handling of 1 million pounds of flounder fillets in New York, we should add an extra fixed cost $80,000 ($FC_2$). Let's find out the actual quantity (Q_F^1) needed to be sold to maintain the same profit.

$$P_F^1 \, Q_F^1 = FC_1 + AVC. \, Q_F^1 + r$$

$$2.078 \, Q_F^1 = 210,500 + 80,000 + 1.6732 \, Q_F^1 + 194,000$$

$$Q_F^1 = \frac{484,800}{0.4048} = 1,197,628 \text{ lb}$$

To make the same profit, this branch office has to sell almost 200,000 pounds more than 1 million pounds. If the branch office chooses to sell 1 million pounds as planned, it will make $80,000 less in profit than it would if the processing plant were to continue to sell to New York through wholesalers, as evidenced by the following equation:

$$P_F Q_F = FC_1 + FC_2 + AVC.Q_F + r \quad \text{where } Q_F = 1 \text{ million pounds}$$

$$2{,}078{,}000 = 210{,}500 + 80{,}000 + 1{,}673{,}200 + r$$

$$r = 114{,}300 \quad (194{,}300 - 114{,}300 = 80{,}000)$$

The branch office should figure out ahead of time what would be the lowest possible sales before profit disappears. Without profit,

$$2{,}078\ Q_F'' = 290{,}500 + 1{,}6732\ Q_F''$$

$$Q_F'' = \frac{290{,}500}{0.4048} = 717{,}638 \text{ lb}$$

720,000 pounds of flounder fillets would be the break-even point of sales for this branch office below which there will be no profit.

The efficient use of expenditures intended to stimulate product demand is a subject of increasing importance for management. The separation of cost elements within the price margin into fixed and variable will help management better understand how the change of any one will affect price, production, and profit differently. While direct pricing action is one form of competition, improvement of efficiency, and the reduction and rearrangement of costs are even more important in their effects on the size of profit, volume of production, and the size of price margin of one level and possibly that of the next level. The hypothetical examples given in this study illustrate the interrelations of the above factors and the effects of the restructure of their combination.

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