ANALYSIS OF SELECTED FRESH AND FRESH FROZEN FINFISH AND SHELLFISH SPECIES IN THE UNITED STATES

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February 1986

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This work was sponsored by National Oceanic and Atmospheric Administration, Office of Sea Grant, Grant/Project No. R/SE-4, from the Virginia Graduate Marine Science Consortium.

AAEA paper presented at its annual meetings,
Reno, NV, July 27-30, 1986

ABSTRACT

As the popularity for seafood in the United States continues to grow, information about consumer patterns of fishery products will be valuable to the seafood industry. This research provides own-price, cross-price, income and household size elasticities of specific fresh and fresh frozen shellfish and finfish products for at-home consumption.

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Introduction

The consumption of seafood in the United States has expanded steadily in recent decades. From 1960 to 1984, the annual per capita consumption of fish and shellfish in terms of edible meat weight trended gradually upward from 10.3 pounds to 13.6 pounds (excluding recreational catches) (U.S. Department of Agriculture). The increased use of fresh and frozen finfish and shellfish products accounts for most of the growth in seafood consumption. Per capita consumption of fresh and frozen seafood has risen 45.6 percent since 1960, while per capita consumption of canned and cured seafood has remained relatively constant over this period. Currently, American consumers spend roughly 15 billion dollars annually on seafood, approximately four percent of total food expenditures. The expenditures on seafood in the United States are roughly three-fourths of those on poultry (Miller). The popularity for seafood in the United States is likely to continue to grow. The National Marine Fisheries Service projects the share of the food dollar for seafood to be roughly 8 percent by the year 2000 (Miller).

Because finfish and shellfish are becoming more prominent parts of household diets in the United States than in the past, information about the demand for these products would be extremely useful to various groups in the seafood industry. Information on consumer behavior with regard to how prices, income, household size, and socio-demographic variates influence consumption is crucial to the success of any production or marketing program.

Historically, product development and work to reduce production and processing costs have dominated research efforts. Studies relating to consumption of finfish and shellfish have been conducted but not with great frequency. Purcell and Raunikar analyzed the demand for both aggregate and disaggregate species of fish and shellfish by households in Atlanta, Georgia during the period from 1958 through 1962. Other research has focused on factors affecting consumption of aggregate species of fish and shellfish at the national level (Perry; Capps). The balance of previous work examining household consumption of disaggregate species of fish and shellfish has been tabular in nature (Nash 1970, 1971; Miller and Nash) and consequently lacks statistical support. Furthermore, previous works have neglected potential interdependencies of finfish and shellfish consumption with various meat products such as beef and poultry.

In this light, the primary objective of this research is to provide quantitative information about consumer behavior relating to specific fresh and fresh frozen finfish and shellfish products. The paper is organized as follows. The model development for this analysis is depicted in the next section. The data and procedures are described in the third section. The empirical results are presented in the fourth section. Concluding comments follow in the fifth section.

Model

In analyzing household expenditure behavior using data from cross-section surveys, emphasis has been placed on expenditure-income (Engel) relationships. Because all households may not face the same prices and, further, preferences for the commodity in question may not be the same

across households, it is necessary to take simultaneous account of the effects of household income, prices, and socioeconomic and demographic factors on expenditure patterns. In empirical analyses of household expenditure behavior, socioeconomic and demographic characteristics are proxies for tastes and preferences.

In empirical analyses of household expenditure behavior using survey data, a commonly encountered problem is that some households report no expenditure on particular items over the survey period. The shorter the survey period and the more narrowly defined the commodity, the greater the proportion of households likely to report zero expenditure of the particular product. The reason for nonpurchases may be due to sufficient household inventory, response to market price, or to nonpreference. Rather than alter or dispose of household records containing zero expenditures, several censored response models have been developed by researchers in the attempt to adequately portray the full range of household behavior (Tobin; Powell; Paarsh; Heckman; Maddala).

Deletion of households reporting zero expenditures from empirical analyses may lead to statistical problems due to sample selection bias. This study employs the Heckman censored response model to circumvent this problem. According to Heckman, the sample selection bias that arises from using least squares is characterized as a specification error or omitted variable problem. When a subsample of the data containing only non-zero observations on household expenditure is used for model estimation, the conditional expectation of the disturbance terms, in the general case, is non-zero. Therefore, parameter estimates derived from the selected sample omit the conditional expectation of the

disturbance term as a regressor. Heckman subsequently proposes an estimator that amounts to estimating the non-zero conditional mean and using least squares including this variable as a regressor.

This procedure entails two stages. The first stage involves the use of probit analysis to determine the inverse of Mill's ratio for each household for the ith expenditure (λ_{ih}) (Heckman, p. 479). The probit analysis employs all available observations; the dependent variable takes on the value of one if the household reports the ith expenditure and zero otherwise. The second stage involves the use of $\hat{\lambda}_{ih}$ as a regressor in the original model specification. The appropriate estimation technique is either ordinary or generalized least squares, but the estimation only involves non-zero observations. The OLS procedure produces consistent estimates, but the GLS procedure, when implementation is possible (see Heckman, pp. 480-483), improves the precision of the estimates. Because of the ability of the Heckman procedure to test for sample selection bias and because the procedure avoids imputation, this technique appears to be the preferred procedure to handle the zero expenditure problem.

Mathematically, the empirical model is given by

$$\begin{aligned}\log EXP_{ih} = {} & b_0+b_1\log PFISH_{ih}+b_2\log PPOULTRY_h+b_3\log PREDMT_h+b_4\log INC_h+ \\ & b_5\log HSIZE_h+b_6 DLV_{ih}+b_7 REG1_h+b_8 REG3_h+b_9 REG4_h+b_{10} URBN1_h+ \\ & b_{11} URBN2_h+b_{12} URBN3_h+b_{13} OC1_h+b_{14} OC2_h+b_{15} EDHH_h+b_{16} EMPHM_h+ \\ & b_{17} AGHM_h+b_{18} CHILD_h+b_{19} RACE_h+b_{20} RELG_h+b_{21} DSP_h+b_{22} DSU_h+ \\ & b_{23} DFA_h+b_{24} OLT_{ih}+b_{25}\hat{\lambda}_{ih}+U_{ih}. \qquad (1)\end{aligned}$$

The variable names and notations are exhibited in Table 1. The parameters $b_1, b_2, \ldots, b_{24}$ are the coefficients that measure the change in

Table 1. List of Variable Names in the Model

Variate	Variable Name	Description
Expenditure	EXP	Household expenditure on finfish and shellfish products
Own price	PFISH	Price of fishery products
Cross prices	PPOULTRY	Price of poultry
	PREDMT	Price of red meat
Household income	HINC	Household income
Household size	HSIZE	Household size
Deal value	DLV	Coupon value
Geographic region	REG1	Northeast and Middle Atlantic
	REG2	South (omitted category)
	REG3	Central states
	REG4	West
Population density	URBN1	Farm
	URBN2	Less than 50,000 population
	URBN3	50,000 to 499,999 population
	URBN4	Over 500,000 population (omitted category)
Occupation of household head	OC1	White collar
	OC2	Blue collar
	OC3	Retired and unemployed (omitted category)
Education of	EDHH	Years of education of household head
Employment status of household manager	EMPHM	Employed household manager
		Unemployed household manager (omitted category)
Age of household manager	AGEHM	Household manager less than 44 years of age
		Household manager with at least 44 years of age (omitted category)
Children	CHILD	Presence of children
		Absence of children (omitted category)
Race	RACE	Black and other
		White (omitted category)
Religion	RELGN	With religious affiliation
		No religious affiliation (omitted category)
Season	DSP	Spring
	DSU	Summer
	DFA	Fall
	DWI	Winter (omitted category)
Seafood outlet	OLT	Supermarket and grocery store
		Other stores (health food, drug, variety, department, discount, house to house, mail order and other outlets (omitted category)

expenditures for a selected fresh and fresh frozen seafood product due to changes in prices, household income, and socioeconomic and demographic variables.

In this analysis, the double logarithmic function constitutes the form of the Engel function. The reasons for this choice are as follows. First, the double-logarithmic form provides a fairly satisfactory description of the curvature found in most commodities (Prais and Houthakker). Second, the double logarithmic function is often preferred to other functions when the income range is sufficiently narrow and when consumption is expressed in terms of expenditure rather than in terms of quantity (Goreux).

The regression coefficients associated with household income, household size, price of poultry, and price of red meat in equation (1) can be interpreted as the income elasticity, household size elasticity, and cross-price elasticities of demand for a particular fresh and fresh frozen seafood commodity. The own-price elasticity of demand implied by (1) is given by $b_1 - 1$. Except for DLV and EDHM, the remaining independent variables are binary or zero-one variables, intercept shifters of the expenditure function. The use of zero-one variables achieves a greater degree of generalization in model formulation.

Data and Procedures

The Seafood Consumption Survey (SCS), conducted by the Market Research Corporation of America for the National Marine Fisheries Service, is the source of data for this research. The Survey provides weekly quantity and expenditure information for various species and product forms of seafood for 9,422 households over the calendar year 1981.

The number of seafood species that are currently marketed in the United States is well in excess of 200 (Mill, p. 20). To make the research manageable, the following species in fresh and fresh frozen form were analyzed: (1) shellfish--crabs, oysters, scallops, and shrimp, and (2) finfish--cod, flounder/sole, haddock, perch, and snapper. The criteria for selection were twofold: (1) the relative importance of the product in the seafood market, and (2) the number of observations available in the survey data. Total fresh and fresh frozen shellfish expenditure and total fresh and fresh frozen finfish expenditures for at-home consumption were also analyzed in this study. The percentage of observations corresponding to zero expenditure levels for the various species was as follows: (1) crabs (96.3), (2) oysters (95.4), (3) scallops (96.8), (4) shrimp (88.2), (5) total shellfish (81.9), (6) cod (92.2), (7) flounder/sole (89.6), (8) haddock (93.7), (9) perch (90.7), (10) snapper (96.5), and (11) total finfish (66.3). For almost all categories of fresh and fresh frozen fishery products included in this research, over 80 percent of the sample households reported zero expenditure levels on the particular products.

Own prices were derived, where possible, from expenditure and quantity data compiled from the 11 censored samples. To avoid imputation of the missing values of the price variables, the aforementioned Heckman sample selection procedure was used. The variable PREDMT constitutes a weighted average of the prices of sirloin steak, round steak, ground beef, and loin chops. Monthly prices of these red meat products together with monthly prices of whole chicken (the variable PPOULTRY) in 10 major cities across the country in 1981

were obtained from the publication Operation Price Watch (U.S. Department of Commerce).

Empirical Results

The statistical results of the probit analyses used in the first stage of estimation and the OLS and GLS estimates of the coefficients obtained in the second stage of the Heckman procedure, although available upon request, are not reported due to space limitations. The goodness-of-fit (R^2) measures for the respective shellfish species ranged from .0924 to .1721, and for the respective finfish species, the goodness-of-fit measures ranged from .0879 to .1598. The effects of the explanatory variables were considered to be statistically significantly different from zero if the coefficient estimates, in absolute value, were equal to or greater than their associated standard errors.

Own-price elasticities and cross-price elasticities are exhibited in Table 2. All own-price elasticities were negative and statistically significant. The respective own-price elasticities ranged from -0.4500 (flounder/sole) to -1.1320 (oysters). The demand for most of the fresh and fresh frozen seafood commodities was inelastic.

Cross-price elasticities for shellfish products were positive but generally statistically insignificant. The effects of the prices of poultry and red meat on household consumption of finfish products were mixed. In cases of statistical significance, poultry was a gross complement for snapper; red meat was a gross complement of perch but a gross substitute for cod and snapper. In general, household expenditures for fresh and fresh frozen fishery products consumed at home were more sensitive to changes in own price than to changes in prices of poultry and red meat.

Table 2. Own-Price, Cross-Price, Household Income, and Household Size Elasticities

Fresh and Fresh Frozen Products	Own-Price Elasticity	Cross-Price Elasticity (Poultry)	Cross-Price Elasticity (Red Meat)	Household Income Elasticity	Household Size Elasticity
Crabs[a]	-0.7713*	.1212	0.0315	0.4610*	-0.0778
Oysters[a]	-1.1320*	0.3105	0.1991*	0.1769*	0.1527*
Scallops[b]	-0.5034*	0.3328	0.0345	-0.1715	0.2411*
Shrimp[b]	-0.6956*	0.3438	0.0257	0.0366	0.0953
Total Shellfish[b]	-0.8850*	0.9643*	0.0266	0.1115*	0.1316*
Cod[b]	-0.5358*	0.6051	0.1710*	0.0633	0.2409*
Flounder/Sole[b]	-0.4500*	-0.5501	-0.0574	0.0369	0.3273*
Haddock[b]	-0.5557*	-0.4033	0.0096	-0.0063	0.0977
Perch[a]	-0.7039*	0.3157	-0.1036*	0.0172	0.1765*
Snapper[b]	-0.9819*	-1.7752*	0.1568*	-0.1088	0.4655*
Total Finfish[b]	-0.6746*	0.0382	0.0185	0.1406*	0.3260*

*The coefficient estimate is considered to be statistically significant if in absolute value, this estimate is equal to or greater than the associated standard error.

[a]OLS estimates (implementation of the Heckman GLS procedure was not possible)

[b]GLS estimates

Household income and household size elasticities for fresh and fresh frozen seafood commodities are also presented in Table 2. Income elasticities were generally statistically insigificant except for crabs, oysters, total shellfish and total finfish. These respective elasticities were positive, indicative of normal goods. With the exception of haddock, crabs, and shrimp, household size elasticities were positive in the interval from 0.1316 to 0.4655, and statistically significant. In general, household expenditures for fresh and fresh frozen fishery products consumed at home were more sensitive to changes in household size than to changes in income.

Households in the South spent significantly more on fresh and fresh frozen seafood commodities than did households located in other regions, ceteris paribus. Urbanizational differences relative to central city areas were evident in household expenditure on crab, shrimp, total shellfish, cod, haddock, perch, and snapper. Significant differences in household expenditure for fresh and fresh frozen seafood commodities due to the occupation of household head were found for crabs, oysters, scallops, flounder/sole, haddock, and perch. Households wherein the household head received higher levels of education generally spent less on fresh and fresh frozen seafood commodities for home consumption than households with lower levels of education. The effect of the employment status and age of the household manager was generally found to be insignificant, all other factors invariant. The presence of children, ceteris paribus, was negatively associated with expenditures for all fresh and fresh frozen fishery products. Households with religious affiliation spent significantly less on oysters, cod, and total finfish

than did households with no religious affiliation. Nonwhite households expended significantly more on most of fresh and fresh frozen fishery products than did white households. Significant differences due to season relative to the winter quarter were evident for expenditures on oysters, shrimp, total shellfish, cod, perch, snapper, and total finfish. The effects due to store outlets were generally not significant, ceteris paribus. Coupon value was found to have significant positive effects on household expenditure for all categories of fresh and fresh frozen seafood products except for oysters.

The coefficient estimates of the variable $\hat{\lambda}_{ih}$ were statistically different from zero for all shellfish species except oysters. However, the coefficient estimates of $\hat{\lambda}_{ih}$ except for perch, were not statistically different from zero for the various finfish species. Consequently, deleting the observations corresponding to zero expenditure levels for most shellfish species would have introduced sample selection bias, but deleting zero expenditure levels for most finfish species would not have biased the parameter estimates, although efficiency losses would have occurred.

Concluding Comments

The findings of this research indicate that own-price and household size were generally the dominant factors in explaining the variation of household expenditures on fresh and fresh frozen seafood commodities for at-home consumption. Other factors, notably coupon (or deal) value, household income, geographic region, race, and seasonality were also important factors. In general, cross-price effects of red meat and poultry on household consumption of fresh and fresh frozen seafood products were not statistically significant.

The estimated Engel functions may be used to make predictions of household expenditures on fresh and fresh frozen fishery products given information on prices, household income, household size, and socioeconomic and demographic characteristics. Various socioeconomic and demographic profiles can be constructed to examine household expenditure behavior. The analysis of expenditure patterns for disaggregate finfish and shellfish species from this research is a fruitful first step. Various producer, processor, and consumer groups of the seafood industry may ascertain key demand factors from this research. However, to provide definitive results to the seafood industry, improvements and/or refinements in data collection and model formulation are necessary. Unequivocally, further research in analyses of seafood commodities merits attention.

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