Marine Resource Economics, Volume 26, pp. 59–74
Printed in the U.S.A.
0738-1360/00 $3.00 + .00

Factors Influencing the Purchase of Live Seafood in the North Central Region of the United States

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Abstract *This study assesses the preferences of shoppers of live seafood products in the North Central Region of the US accounting for heterogeneity in their preferences. The results suggest that quality assurance considerations and high incomes are factors that would increase the probability of higher expenditures on live fish/shellfish. The purchase of saltwater fish and shellfish also increased the probability of higher expenditures. The North Central Region produces freshwater seafood, and maintaining fish quality through the production process is important to this niche market. Shoppers also purchased live seafood frequently, signifying the importance of availability.*

Key words Live fish, preferences, random parameters ordered probit.

JEL Classification Codes Q11, Q21, Q22.

Introduction

Consumer demand is a predominant area of market research where researchers attempt to understand the determinants of consumer purchase behavior given product diversity and consumer heterogeneity. There is an increasing trend in demand for fish products through the non-traditional retail grocery sector, such as ethnic food markets, and fresh and live seafood products feature prominently in the expansion of the sector (Ewart 1996). Chinese and other Asian food stores, restaurants, seafood distributors, and retailers are the principal market outlets for live fish. Shoppers at ethnic stores demand food items that are perceived to be fresh, healthy, nutritious, and safe.

Quality and safety is becoming increasingly important for seafood because fish retailers offer an array of seafood products including fresh, frozen, processed, and canned seafood. Seafood products are widely diverse, with a range of species and product attributes; therefore, quality issues become complex, especially with diversity of production, processing, markets, species, and forms in which seafood is consumed (Allshouse *et al*. 2004). Dochtermann (1996) emphasized the need to maintain quality throughout the growth cycle if fish is meant for the live market.

To our knowledge, little, if any, economic research has been conducted to examine the live fish market. Live fish are a delicacy in Asian cuisine, and fish producers are exploring opportunities in this expanding food market. The sale of live seafood in ethnic

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markets presents a viable channel for fish farmers to obtain price premiums and avoids the need to invest in value-adding activities to compete with imported seafood products. Targeting consumers who purchase live fish presents a good potential for sales growth for fish farmers and for the development of a long-term marketing relationship between fish farmers and ethnic food stores. Shoppers at ethnic food markets have spending patterns, shopping habits, and food preferences that are associated with their ethnic cultural heritage and traditions. These all represent opportunities for the aquaculture industry. Puduri *et al*. (2010), Myers *et al*. (2010), and Ewart (1996) reported that Asians were the main customer base for the live seafood market in the northeastern US, but Caucasians, Hispanics, and Africans also constituted a significant ethnic make-up of their clientele. Degner *et al*. (1994) also arrive at a similar conclusion that Asians consume more live seafood than other ethnic groups.

Studying the ethnic live fish market in the North Central Region of the US is of particular importance to fish farmers there because they are mainly small farmers, and such niche opportunities appear more viable than traditional seafood channels that handle mostly processed seafood products. The region currently accounts for less than 1% of total US aquaculture production with the production of some major food/sport fish and shellfish, such as yellow perch, hybrid striped bass, tilapia, trout, freshwater prawns, catfish, largemouth bass, smallmouth bass, and sunfish/bluegill (USDA-NASS 2007).

The ethnic live fish market offers niche marketing opportunities and income potential for small-scale farmers, but the challenge is to assess consumer preferences for live fish given their diversity. To develop and sustain marketing of farmed fish through ethnic food markets, fish farmers need to identify factors that affect the preferences of shoppers at these food markets. Knowledge of these factors can be utilized to develop marketing strategies that are proactive in terms of targeting shoppers who are likely to purchase live fish.

The purpose of this study is to assess the preferences of shoppers of live fish products in the North Central Region of the US accounting for heterogeneity in their preferences. The influence of various perceived attributes of live fish, as well as the demographic and socioeconomic characteristics of respondents are investigated.

Materials and Methods

Theoretical Framework

Preference analysis is an essential component of studying individual choice behavior and has been applied in consumer demand for seafood. Studies have utilized both real and hypothetical data on seafood attributes to evaluate consumer choice behavior (Johnston *et al*. 2001; Myrland *et al*. 2000; Larkin and Sylvia 1999; Holland and Wessells 1998; Gempesaw *et al*. 1995). The modeling approach usually involves a taxonomy of determinants of consumer choice behavior that can be categorized as related to the seafood product, individual person, and environment. Characteristics of the product, as well as social/cultural and environmental factors jointly shape perceptions of foods.

Wierenga (1983) and Steenkamp (1993) suggest that product attributes can be categorized into three aspects: sensory (consumptive), functional (benefit), and expressive (symbolic). The sensory properties of a product are assumed to be related to feelings in consuming the product, while functional attributes are assumed to perform certain functions relevant to the consumer; *e.g*., health benefits and convenience benefits related to use. The expressive attributes refer to expressions of traditions, exclusiveness, status, etc. Individual attributes are also important in choice analysis. In the case of preferences for live fish, a shopper's preference could be affected by needs, motives, socio-cultural background, and situational elements. Thus, the overall preference for live fish products could be the result of shoppers' perceptions and beliefs about the product coupled with some

underlying socio-economic characteristics, and there is likely to be some unobserved heterogeneity among shoppers given the diverse clientele (Ewart 1996; Degner *et al*. 1994; Myers *et al*. 2010; Puduri *et al*. 2010).

Heterogeneity among consumers in the empirical literature is generally considered by incorporating demographic factors directly in demand functions or through the utility function (*e.g*., Lusk, Roosen, and Fox 2003; Platter *et al*. 2005). Other empirical economic analyses consider preference heterogeneity by clustering or stratifying consumers into various segments and estimating demands separately on each segment (Holland and Wessells 1998; Morey, Rowe, and Watson 1993). For these analyses, economists sometimes use interactions of demographic variables and product attributes to account for heterogeneous preferences. Incorporating heterogeneity into choice analysis requires some knowledge of the elements of heterogeneity. Possible sources of heterogeneity in the demand for live fish include demographics, social/cultural factors, consumer attitudes, and perceptions. Recent flexible choice models account for individual heterogeneity in the estimation of the choice parameters. Examples include the random parameters (mixed) choice models of Revelt and Train (1998), the latent class choice model of McFadden (1986), and the random parameter ordered choice model of Greene (2008) and Greene and Hensher (2008).

Ordered Probit Model

In this study, the concept of demand for live fish is examined with the use of an ordered probit model to analyze shoppers' expenditures on live fish. The ordered choice model assumes that the dependent variable depends on a latent variable, y_i^*, which is observed by y_i. The latent regression is expressed as:

$$y_i^* = \beta' x_i + \varepsilon_i, \quad \varepsilon_i \sim N[0,1], \tag{1}$$

where β is a vector of parameters to be estimated, x_i is vector of covariates, and ε_i is disturbance. The latent variable, y_i^*, is observed in the form of discrete measures through a censoring mechanism expressed as:

$$\begin{aligned} y_i &= 0 \text{ if } y_i^* \le \mu_0, \\ &= 1 \text{ if } \mu_0 < y_i^* \le \mu_1, \\ &= 2 \text{ if } \mu_1 < y_i^* \le \mu_1 \\ &= \ldots \\ &= J \text{ if } \mu_{J-1} < y_i^* \le \mu_J. \end{aligned} \tag{2}$$

The μs are unknown "cut off" or threshold parameters, which separate the adjacent categories and are estimated with the βs. The probabilities associated with the observed categorical outcomes are expressed as:

$$\begin{aligned} \mathrm{P}(y_i = 0 \mid x_i) &= F(\mu_0 - \beta' x_i) \\ \mathrm{P}(y_i = 1 \mid x_i) &= F(\mu_1 - \beta' x_i) - F(\mu_0 - \beta' x_i) \\ &\cdots \\ \mathrm{P}(y_i = 3 \mid x_i) &= 1 - F(\mu_3 - \beta' x_i), \end{aligned} \tag{3}$$

where $F(.)$ is the cumulative distribution function of ε_i. For the ordered probit model, $F(.)$ takes the form of a normal distribution.

The basic ordered probit model outlined above assumes a homogeneous population and thresholds in the observation mechanism; *i.e.*, that the thresholds μ_j are the same for every individual in the sample. This implies fixed parameters in the basic model. Such an assumption may be unrealistic because of individual variation and some underlying heterogeneity among shoppers (Greene 2008; Greene and Hensher 2008; Greene 2007). To account for a possible latent heterogeneity, Greene and Hensher (2008) suggests a random parameters probit (RPOP) model of the form:

$$\begin{aligned} y_i^* &= \beta_i^i x_i + \varepsilon_i \quad ;\text{where} \quad \beta_i = \beta + u_i, \quad u_i \sim N[0,\Omega] \\ &= \beta_i^i x_i + \varepsilon_i + x_i^{'} u_i, \qquad \text{var}[\varepsilon_i + x_i^{'} u_i] = 1 + x_i^{'} \Omega x_i \\ &= \beta_i^i x_i + \mu_i \ . \end{aligned} \tag{4}$$

In terms of probability, equation (4) provides the conditional probability distribution, which can be expressed as:

$$\text{P}(y_i = j \mid x_i, \beta) = F[j, u, (\beta' x_i + \mu_i)], \quad j = 0,1,\ldots,J \ . \tag{5}$$

The probability function is estimated using maximum simulated likelihood estimation procedures. See Greene (2008) and Greene and Hensher (2008) for further computational details.

A framework of shoppers' preferences for live fish is developed based on the RPOP model outlined above. The framework incorporates a latent construct of demand for live fish as observed categories of shoppers' expenditures on live fish/shellfish. Estimation of the μs and βs parameter vectors in equations (3) and (5) was performed via maximum likelihood methods using LIMDEP Version 9 (Greene 2007). The random parameters were assumed to be independently normally distributed in the population. The standard deviations reflect the deviation in individual preferences in the population.

Data

The study covered a five-month period from June through August, and then October/November, 2008, by means of an intercept survey of shoppers at Asian food stores in selected cities in the North Central Region of the US. Seventy eight (78) Asian food stores were identified from city yellow page books, internet searches, and industry contacts. These stores were contacted by phone and email to inquire if they sold live fish. Twenty eight (28) stores that sold live fish and voluntarily agreed to participate in the study were visited. The number of stores visited were Indianapolis (5), West Lafayette (2), Fort Wayne (1), and Evansville (1) in Indiana; Columbus (2), Fairfield (1), Cincinnati (2), and Cleveland (2) in Ohio; and Chicago (12) in Illinois. Permission was obtained from store owners and managers to interview their customers. As an incentive for both shoppers and store managers, a $3 coupon was given to each shopper who completed a survey to be redeemed at the participating store. The stores were reimbursed for the total amount of coupons received at the end of the survey period.

Stores were visited on two different occasions in the summer and early fall, and some shoppers were intercepted on more than one occasion. Therefore, the data set is

an "unbalanced" panel because it includes more than one observation of some shoppers. Data were collected using a questionnaire. Shoppers who indicated English as their first language were given the questionnaire along with an explanation of how to complete it on their own. For shoppers who indicated Chinese as their preferred language, Chinese enumerators assisted them in completing the questionnaire.

Table 1 provides the summary statistics of the data used in the empirical model to assess consumer preferences for live fish products. A total of 461 customers were approached for the survey and 361 participated, giving a response rate of 78%. Of this number, 44% were females and 46% were males. Forty-six percent (46%) of the respondents were between 36 and 50 years of age, 36% from 21 to 35, 13% from 51 to 65, and 5% were over 65. More than half of the shoppers had a household size of three to five persons. Thirty-two percent (32%) had up to two individuals in their household, 9% had six to eight, and less than 1% had more than eight persons. Respondents came from 29 different countries and five major regions of the world. The majority (53%) were from Asia, 31% were from the US, 8% were from Africa, 6% were from Latin America/Caribbean and 1% was from Europe. The household income range of most (62%) respondents was $30,001–$100,000 per year. Those earning $30,000 and below were 15%, and customers earning between $100,001 and $150,000 per year were 14%. Very few people (9%) made more than $150,000 (table 1).

The value of live fish/shellfish purchased per visit varied among shoppers; 23% of shoppers spent up to $10 per visit, 50% of shoppers spent from $11 to $20 per visit, 17% spent from $21 to $30 per visit, and 10% more than $30 on fish/shellfish per visit. Most shoppers indicated they purchased freshwater fish (84%), followed by shellfish (48%), and saltwater fish (38%). Asked about the type of fish they purchased, a total of 56 different species of fish were indicated by respondents. The most popular species purchased were tilapia, catfish, and shrimp. These three species constituted about 40% of the total fish/shellfish species purchases. When asked how they processed the live fish purchased, 63% of respondents indicated the fish was purchased live and processed in the store, while the remaining 37% purchased live fish and processed it at home.

Regarding quantity purchased per visit, almost 80% of the shoppers indicated less than 11 lbs. of fish per visit. About 56% of the shoppers purchased less than 6 lbs., 23% purchased 6 to 10 lbs., 8% purchased 11 to 15 lbs., 6% purchased 16 to 20 lbs., and 5% purchased over 21 lbs. of fish per visit. The smallest quantity of fish purchased was 0.5 lb., and the largest quantity purchased was 50 lbs. per visit. The average quantity purchased per visit was about 8 lbs. (table 1). A number of customers traveled a relatively short distance to purchase live fish. Approximately 62% travelled less than 10 miles. The most frequently indicated distances travelled were 5, 10, 15, and 20 miles, which were 13, 14, 9, and 12%, respectfully.

Regarding frequency of fish purchase, 30% of the shoppers purchased fish/shellfish weekly, 28% purchased fish every two weeks, 18% purchased fish monthly, and 10% purchased fish once every two months and occasionally. Shoppers purchased live fish for a number of reasons. Freshness was the major reason indicated by 60% of respondents; quality assurance, 33%; and tradition, 22%. As to the fish attributes shoppers considered important when purchasing live fish, 87% specified that price was important, and about 76% indicated that size was important.

Table 1
Descriptive Statistics of Model Variables (N = 361)

Variable	Variable Definition	Mean	Std. Dev.	Range
Dependent Variable				
Expenditure on live fish/shellfish per visit	$y0$ = up to $10	0.227	0.420	0–1
	$y1$ = $11– $20	0.499	0.501	0–1
	$y2$ = $21– $30	0.172	0.378	0–1
	$y3$ = more than $30	0.102	0.304	0–1
Monthly quantity per month (lb.)	Quantity of live fish purchased	7.857	7.610	0.5–50
Distance travelled live fish (miles)	Distance travelled to purchase	14.683	19.837	1–180
Seafood Type				
Freshwater finfish	= 1 if respondent purchases freshwater finfish, 0 otherwise	0.837	0.370	0–1
Saltwater finfish	= 1 if respondent purchases saltwater finfish, 0 otherwise	0.382	0.487	0–1
Shellfish	= 1 if respondent purchases shellfish, 0 otherwise	0.482	0.500	0–1
Purchase Frequency				
Weekly	= 1 if respondent purchases live fish up to once a week, 0 otherwise	0.299	0.459	0–1
Biweekly	= 1 if respondent purchases live fish biweekly, 0 otherwise	0.277	0.448	0–1
Monthly	= 1 if respondent purchases live fish monthly, 0 otherwise	0.180	0.385	0–1
Rationale				
Quality assurance	= 1, if the reason for purchasing live fish is quality assurance, 0 otherwise	0.327	0.470	0–1
Freshness	= 1, if the reason for purchasing live fish is freshness, 0 otherwise	0.604	0.490	0–1
Tradition	= 1, if the reason for purchasing live fish is tradition, 0 otherwise	0.222	0.416	0–1
Attributes				
Price is important	= 1, if respondent indicates price is important when purchasing live fish, 0 otherwise	0.870	0.337	0–1
Size is important	= 1, if respondent indicates size is important when purchasing live fish, 0 otherwise	0.759	0.428	0–1
Native Region				
Asian	= 1 if respondent's native region is Asia, 0 otherwise	0.526	0.500	0–1
American	= 1 if respondent's native region is USA, 0 otherwise	0.305	0.461	0–1
Other	= 1 if respondent's native region is not Asia or USA (omitted variable).	0.169	0.375	0–1

Table 1 (continued)
Descriptive Statistics of Model Variables (N = 361)

Socioeconomic Factors				
Household size	The size of respondent's household	3.377	1.446	1–10
Income0	= 1 if household income is $30,000 or below (omitted variable)	0.152	0.359	0–1
Income1	= 1 if household income is $30,001–$100,000, 0 otherwise	0.623	0.485	0–1
Income2	= 1 if household income is $100,001–$150,000, 0 otherwise	0.136	0.343	0–1
Income3	= 1 if household income is above $150,000, 0 otherwise	0.089	0.285	0–1

Application of Ordered Probit Choice

To measure demand for live fish/shellfish, shoppers were asked to indicate their average expenditure on live fish/shellfish per store visit among the following categories: up to $10, $11 to $20, $21 to $30, and more than $30. This information is important because, in the food marketing system, economic decisions by producers and consumers jointly determine market outcomes, and the consumer's food budget is relevant to this process. Fish farmers targeting the live fish market need to know the spending habits of shoppers of live fish/shellfish. Thus, the dependent variable was constructed as four ordered categories from 0 to 3, respectively, for shoppers spending up to $10 per visit on live fish/shellfish, $11 to $20 per visit, $21 to $30 per visit, and more than $30 on fish/shellfish per visit.

Demand for live fish/shellfish may be influenced by a multitude of factors, and by observing those factors, fish producers may make better-informed farming decisions. For example, in the traditional agriculture sector, producers have responded to consumer demand for leaner meats and low-fat dairy products. The independent variables in this study were chosen to best represent five categories of factors: seafood type, frequency of purchase, rationale for purchasing live fish/shellfish, fish/shellfish attributes, native region, and socioeconomic factors. Also included were the quantity of live fish/shellfish purchased per month and distance traveled to purchase live fish/shellfish. These factors are hypothesized to affect how much shoppers spend on live fish/shellfish per visit.

Puduri *et al*. (2010), Myers *et al*. (2010), and Ewart (1996) list several species of seafood that are sold in live fish markets that can be categorized into freshwater finfish, marine finfish, and shellfish. These categories were considered factors affecting expenditures. The supply of a given type of seafood is very important and depends on the price, source, and other economic and environmental factors. Fish farming has the advantage over capture fisheries in that it can better manage supply if the species can be farmed or cultured.

The rationale variables considered are derived from the reasons shoppers indicated for purchasing live fish/shellfish, including assurance of quality, freshness, and tradition. Puduri *et al*. (2010) and Myers *et al*. (2010) found that freshness and quality were more valued for live fish by respondents than price, availability, and other attributes. That study reported that none of the respondents indicated freshness as "Not Important" and concluded that a good physical appearance of fish reflected fish quality and could attract higher premiums because the fish survive longer in the store, have greater meat yields, and may also have better flesh quality (Puduri *et al*. 2010; Myers *et al*. 2010).

The fish/shellfish attributes considered in the study are price and size. Respondents were asked to indicate if these were important factors to them in their purchase deci-

sions for live fish/shellfish. The empirical literature generally supports the significance of price, size, and freshness on seafood demand (*e.g*., Kumar, Quagrainie and Engle 2008; Quagrainie 2006; House *et al*. 2002; House, Hanson and Sureshwaran 2003; Gempesaw *et al*. 1995; Ewart 1996; Dochtermann 1996; Herrmann *et al*. 1994; Engle *et al*. 1990). Shoppers of live fish from ethnic markets are believed to have some traditions relating to preference for live fish (Puduri *et al*. 2010; Myers *et al*. 2010; Degner *et al*. 1994).

The majority of respondents indicated ethnicity as Asian (53%) and American (31%). Asian countries indicated by respondents included Japan, Korea, China, Hong Kong, Taiwan, Vietnam, Burma, Singapore, Philippines, India, and Bangladesh. Consumers from these 11 countries have different preferences because of differences in cultures, tastes, national origin, language habits, level of acculturation, and other differences that affect their food choices (Lowe 1991; Taylor and Stern 1997; Kaufman-Scarborough 2000; Sechena *et al*. 2003; Govindasamy *et al*. 2006). Kaufman-Scarborough (2000), for example, pointed out differences among Asian-American sub-groups and the importance of segmenting them in market analysis. However, the author also pointed out similarities and suggested that grouping Asian-Americans into one consumer segment could be useful for some aspects of consumer behavior, as most Asian-Americans prefer shopping at ethnic markets, oriental food, and specialty stores. Yeh *et al*. (1998) also suggested that Asians could be grouped as one consumer segment because many have lived in the US for numerous years and have blended their habits with people from the US and other cultures. Sensory studies have reported no significant differences in cross-cultural responses to tastes within foods common to different cultures (Prescott 1998; Murray, Easton, and Best 2001).

Respondents were intercepted at Asian stores where live seafood is sold, a common food product purchased by Asians (Degner *et al*. 1994; Myers *et al*. 2010; Puduri *et al*. 2010). Therefore, cross-cultural preferences among them may not be different. Consequently, respondents from the 11 individual Asian countries were not included as separate consumer sub-groups by country, but were grouped as one consumer segment—'Asian.' Nonetheless, the use of the RPOP model allows the testing of a possible latent heterogeneity in preferences for live seafood among the group.

The probability of shoppers' expenditures on live fish/shellfish falling into any of the expenditure categories was specified as:

$$Prob\ (expenditure_i) = F\ (Freshwater\ finfish_i,\ Saltwater\ finfish_i,\ Shellfish_i,\ Quantity\ purchased_i,$$
$$Distance\ travelled_i,\ Weekly\ purchase,\ Biweekly\ purchase,\ Monthly\ purchase,$$
$$Quality\ assurance_i,\ Freshness_i,\ Tradition_i,\ Price\ is\ important_i,\ Size\ is\ important_i,$$
$$Asian_i,\ American_i,\ Household\ size_i,\ Income1_i,\ Income2_i,\ Income3_i).$$ [1]

A negative coefficient on an explanatory variable indicates a higher probability of its effect on shoppers' expenditures being in the lower expenditure categories. However, a positive coefficient indicates a higher probability of the effect of the variable on shoppers' expenditures being in the upper expenditure categories. Thus, a positive coefficient suggests a higher expenditure or demand for live fish/shellfish.

To examine the importance of specific groups of factors in the model, a likelihood ratio (LR) test is used to compare models with restrictions on seafood type (freshwater finfish, saltwater finfish, and shellfish), rationale for purchasing live fish (quality assurance, freshness, and tradition), fish attributes (price is important and size is important), and native region (Asian and American). If the LR-test statistic 2 [LL (unrestricted)–LL (restricted)] is greater than the critical χ^2 value, the null hypothesis that a restriction is supported is rejected, implying that the group of factors jointly has significant influence

[1] The income variables are assumed to be observed without error and are included to assess the variability of preferences and the 'true' expenditure patterns of shoppers.

on live fish/shellfish expenditures. However, if the null hypothesis is not rejected, then that group of factors jointly has no significant influence on live fish/shellfish expenditures.

Results

The empirical analysis proceeded by first estimating an RPOP model with all the variables outlined above. Then separate RPOP models that restricted seafood type (freshwater finfish, saltwater finfish, and shellfish), rationale for purchasing live fish (quality assurance, freshness, and tradition), fish attributes (price is important and size is important), and native region (Asian and American) were estimated. The LR-test statistic value from excluding the seafood type variables was 18.30 with a critical value of 12.59. Similarly, the LR-test from excluding the ethnic region resulted in a test statistic of 13.11 with a critical value of 9.49. This suggests the importance of these categories of factors on live fish expenditures.

Table 2 presents the estimated mean coefficients, standard deviations of the mean parameters, and marginal effects for the full RPOP model. The estimated mean coefficients and corresponding standard deviations are reported in columns 2 and 3, respectively, while the marginal effects are reported in columns 4 to 7. The dependent variable is categorically ordered so that the effects (positive or negative) on the middle expenditure categories are vague (Greene 2007). The coefficients of the RPOP model indicate only the direction of expenditures, *i.e.*, whether the variables generally increase (positive coefficient) or decrease (negative coefficient) the expenditures on live fish/shellfish. The marginal effects, however, describe how the probability of being in each expenditure category changes for a one unit change in a particular variable, or for a discrete jump in a dummy variable.

The monthly quantity of fish purchased and distance travelled both had positive coefficients that were statistically significant at the 1% level. This suggests that the more live fish/shellfish purchased, the more likely expenditures on live fish/shellfish would increase, a result that should be expected, assuming fixed prices. Also, the further a shopper travelled to purchase live fish/shellfish, the more they spent on live fish, which may also be expected. This result can be clearly seen in columns 4 to 7 of table 2, where the marginal effects are reported. The effects of quantity and distance significantly increased (decreased) the probability of shoppers' expenditures falling into the higher (lower) categories, though the extent of the probabilities is very low compared to other estimated marginal effects.

For the seafood type variables, purchase of saltwater finfish and shellfish resulted in increased expenditures on live seafood, as the estimated coefficients had significant positive effects. Saltwater seafood and shellfish are relatively more expensive than freshwater finfish, so the results were expected. The marginal effects suggest that, with the purchase of saltwater fish, the probability of shoppers incurring expenditure within $21–$30 per visit would increase by about 10%, while the probability of shoppers incurring expenditures above $30 per visit would increase by about 1%. If shellfish was purchased, the probability of shoppers incurring expenditure within $21–$30 per visit would increase by about 14%, while the probability of shoppers incurring expenditures above $30 per visit would increase by about 1%. On the other hand, the probability of shoppers incurring expenditure up to $10 per visit would reduce by about 5% if saltwater fish was purchased and by 9% if shoppers purchased shellfish.

Other variables that resulted in increased probability of shoppers incurring higher expenditures on live fish/shellfish per visit to a store were biweekly purchase, quality assurance, and household income above $150,000 (Income3). If quality assurance is the rationale for purchasing live seafood, the probability of expenditures within $21–$30 per visit would increase by as much as 16%, while having household income above $150,000 (Income3) would increase the probability of $21–$30 expenditure per visit by as much as 24%.

Table 2
Estimated Parameters of the Random Parameters Ordered Probit

	Mean Parameter	Std. Dev.	Up to $10[a]	$11–$20[a]	$21–$30[a]	> $30[a]
Monthly quantity	0.043***	0.056***	–0.005***	–0.004	0.009***	0.001***
Distance travelled	0.025***	0.022***	–0.003***	–0.002*	0.005***	0.001***
Seafood Type						
Freshwater finfish	–0.146	0.109	0.017	0.018	–0.031	–0.003
Saltwater finfish	0.444***	0.204*	–0.052***	–0.053	0.095**	0.010**
Shellfish	0.675***	0.753***	–0.085***	–0.069*	0.139***	0.014***
Purchase Frequency						
Weekly	–0.180	1.181***	0.024	0.015	–0.036	–0.003
Biweekly	0.372**	1.054***	–0.041**	–0.050	0.082*	0.009
Monthly	–0.165	0.005	0.022	0.013	–0.032	–0.003
Rationale						
Quality Assurance	0.721***	0.004	–0.076***	–0.106**	0.163***	0.020***
Freshness	–0.035	0.158*	0.004	0.004	–0.007	–0.001
Tradition	–0.150	0.333**	0.020	0.012	–0.029	–0.002
Attributes						
Price is important	0.062	0.268***	–0.008	–0.006	0.012	0.001
Size is important	0.049	0.017	–0.006	–0.005	0.010	0.001
Native Region						
Asian	–1.208***	0.129	0.155***	0.125*	–0.249***	–0.031***
American	–0.710***	0.416***	0.110**	0.026	–0.126***	–0.010***
Socioeconomic Factors						
Household size	0.061	0.011	–0.008	–0.006	0.012	0.001
Income1	0.166		–0.021	–0.015	0.033	0.003
Income2	–0.178		0.024	0.013	–0.034	–0.003
Income3	0.915***		–0.065***	–0.215*	0.236**	0.044

[a] Parameters are the marginal effects.
*** indicates significant at the 1% level; ** 5% level; and * 10% level.

Being an Asian or American had statistically significant negative effects; *i.e.*, decreased the likelihood of shoppers' expenditures falling in the higher categories. Specifically, the marginal effects suggest that the probability of an Asian incurring live seafood expenditures within $21–$30 per visit would decrease by about 25%, but the probability of expenditures of up to $30 per visit would increase by about 16%. Similarly, the probability of an American incurring expenditures of $21–$30 per visit would decrease by about 13%, but the probability of expenditures of up to $30 per visit would increase about 11%.

From the preceding results, factors that would increase the probability of expenditures on live fish/shellfish being in the higher category by at least 10% were the purchase of saltwater fish, purchase of shellfish, quality assurance, and high income. Fish farmers in the North Central Region produce mostly freshwater finfish, so it is important to examine the effects of the variables on shoppers' expenditures associated with seafood type. Consequently, the RPOP model was estimated for data associated with each seafood type. Tables 3, 4, and 5 present the estimated coefficients and marginal effects, respectively, for the freshwater finfish RPOP model, saltwater finfish RPOP model, and shellfish RPOP model.

All three seafood type models showed statistical significant coefficients for quantity purchased, quality assurance, and high income earners, suggesting that these factors are important when it comes to live seafood expenditures. For an additional pound of seafood purchased, the probability of expenditures within $21–$30 per visit would increase by just about 1% depending upon whether the seafood type is freshwater finfish (table 3), saltwater finfish (table 4), or shellfish (table 5). However, when quality assurance is considered, the probability of expenditures within $21–$30 per visit would increase by about 19% for freshwater finfish (table 3), 14% for saltwater finfish (table 4), and 20% for shellfish (table 5). For higher income earners (Income3), the probability of freshwater finfish expenditures within $21–$30 per visit increased by 18% (table 3), saltwater finfish by 29% (table 4), and shellfish by 31% (table 5). This result supports the original result reported in table 2, which shows that the highest probability of larger live seafood expenditures is associated with high income earners, followed by quality assurance.

Distance travelled is important regarding higher live seafood expenditures for freshwater finfish and shellfish. Distance travelled by shoppers was not an important factor in the saltwater finfish model.

Regarding fish attributes, the variable "price is important" is statistically significant in both the freshwater and saltwater finfish models but with opposing effects. If consumers considered price as important, their expenditures on saltwater finfish increased, but their expenditures on freshwater finfish decreased. There is a 16% probability of an increase in expenditures of $21–$30 on saltwater finfish per visit if shoppers considered price as important, compared to 4% probability of increase in expenditures of up to $10 on freshwater finfish per visit.

The estimated standard deviations associated with the parameter means identified significant heterogeneity in attitudes among shoppers in some factors. In the original RPOP model (table 2), statistically significant standard deviations are associated with the mean parameters of quantity purchased, distance travelled, shellfish, weekly purchases, biweekly purchases, tradition, price is considered important, and among Americans. Of particular note are the standard deviations of the mean parameters for the frequency of purchase categories. The relatively high values and the significant standard deviations of weekly purchases and biweekly purchases, but a low value and insignificant standard deviation of monthly purchases, indicate a high degree of variation among shoppers regarding how often they purchase live seafood. The results suggest that shoppers appear to have preferences for more frequent purchases of live seafood, rather than less, with much variability among weekly and biweekly shoppers. Similarly, the standard deviation of the mean parameter for American suggests a large degree of variability around the utility level of live seafood purchase for Americans. However, the statistically insignificant standard deviation on the Asian mean parameter suggests that there is generally homogeneity among Asians when it comes to live seafood purchase.

The results from table 2 indicate heterogeneity among shellfish shoppers, while shoppers of freshwater finfish and saltwater finfish were largely homogenous. For a better comparison among shoppers of the three seafood types, heterogeneity is examined using the estimated standard deviations of the mean parameters reported in tables 3–5. The results consistently suggest that for each seafood type, shoppers are heterogeneous in attitudes relating to quantity of fish purchased and household size. Variation among shoppers regarding monthly purchases is consistent with the findings in table 2, but variation among shoppers relating to household size is not.

There is also some consistency among shoppers regarding heterogeneity in attitudes of shoppers of freshwater finfish with the original results reported in table 2. It could be because 84% of shoppers indicated purchasing freshwater finfish. Statistically significant standard deviations associated with the mean parameters of quantity purchased, distance travelled, biweekly purchases, tradition, price is considered important, household size, and among Americans, are largely similar to those reported in table 2. In the saltwater

finfish model (table 4), statistically significant standard deviations are associated with the mean parameters of quantity purchased, distance travelled, biweekly purchases, freshness, household size, and among Americans. In the shellfish model (table 5), statistically significant standard deviations are associated with the mean parameters of quantity purchased, weekly purchases, freshness, and household size.

Table 3
Estimated Parameters of Freshwater Finfish

	Mean Parameter	Std. Dev.	Up to $10[a]	$11–$20[a]	$21–$30[a]	> $30[a]
Monthly quantity	0.036***	0.039***	–0.004***	–0.003	0.006***	0.000**
Distance travelled	0.031***	0.024***	–0.003***	–0.002	0.005***	0.000***
Weekly	–0.442**	0.142	0.058*	0.014	–0.068**	–0.004**
Biweekly	0.320	0.300**	–0.031*	–0.034	0.061	0.004
Monthly	–0.105	0.136	0.012	0.006	–0.017	–0.001
Quality assurance	0.903***	0.076	–0.078***	–0.130**	0.190***	0.018**
Freshness	0.242	0.054	–0.027	–0.018	0.042	0.003
Tradition	–0.129	0.360**	0.015	0.007	–0.021	–0.001
Price is important	–0.374*	0.255***	0.037*	0.039	–0.071	–0.005
Size is important	–0.068	0.010	0.007	0.005	–0.012	–0.001
Asian	–1.377***	0.031	0.192***	0.047	–0.221***	–0.018***
American	–1.015***	0.806***	0.167***	–0.026	–0.134***	–0.007***
Household size	–0.008	0.069***	0.001	0.001	–0.001	–0.001
Income1	0.079		–0.009	–0.006	0.014	0.001
Income2	–0.310		0.041	0.008	–0.047	–0.002
Income3	0.759**		–0.051***	–0.148	0.178*	0.020

[a] Parameters are the marginal effects.
*** indicates significant at the 1% level; ** 5% level; and * 10% level.

Table 4
Estimated Parameters of Saltwater Finfish

	Mean Parameter	Std. Dev.	Up to $10[a]	$11–$20[a]	$21–$30[a]	> $30a
Monthly quantity	0.045***	0.017*	–0.007***	–0.003	0.009**	0.001**
Distance travelled	0.011	0.017***	–0.002	–0.001	0.002	0.000
Weekly	–0.048	0.094	0.007	0.003	–0.009	–0.001
Biweekly	0.305	0.859***	–0.039	–0.037	0.067	0.009
Monthly	–0.413	0.078	0.079	–0.005	–0.068	–0.006*
Quality assurance	0.595**	0.162	–0.067***	–0.094	0.138*	0.023
Freshness	0.056	0.356**	–0.008	–0.004	0.011	0.001
Tradition	–0.673**	0.315	0.143*	–0.035	–0.100***	–0.008***
Price is important	0.712**	0.160	–0.092**	–0.087	0.155**	0.023
Size is important	–0.025	0.005	0.004	0.002	–0.005	–0.001
Asian	–1.046***	0.299*	0.231**	–0.065	–0.152***	–0.014***
American	0.213	0.704***	–0.028	–0.023	0.045	0.006
Household size	0.031	0.069**	–0.005	–0.002	0.006	0.001
Income1	–0.366		0.062	0.011	–0.067	–0.007
Income2	–0.017		0.003	0.001	–0.003	0.000
Income3	1.160**		–0.083***	–0.299	0.290**	0.092

[a] Parameters are the marginal effects.
*** indicates significant at the 1% level; ** 5% level; and * 10% level.

Table 5
Estimated Parameters of Shellfish

	Mean Parameter	Std. Dev.	Up to $10[a]	$11 – $20[a]	$21 – $30[a]	> $30[a]
Monthly quantity	0.084***	0.052***	–0.009***	–0.007	0.015***	0.001**
Distance travelled	0.016***	0.000	–0.002**	–0.001	0.003**	0.000**
Weekly	–0.504*	1.405***	0.069	0.003	–0.070*	–0.003**
Biweekly	0.534*	0.154	–0.041**	–0.081	0.113	0.008
Monthly	–0.018	0.054	0.002	0.001	–0.003	0.000
Quality assurance	0.853***	0.075	–0.056***	–0.160*	0.196**	0.019
Freshness	–0.112	0.704***	0.012	0.008	–0.019	–0.001
Tradition	–0.200	0.297	0.023	0.010	–0.032	–0.001
Price is important	0.120	0.106	–0.012	–0.010	0.021	0.001
Size is important	0.061	0.012	–0.006	–0.005	0.011	0.001
Asian	–1.052***	0.201	0.167**	–0.026	–0.135***	–0.006**
American	–0.629*	0.151	0.090	–0.001	–0.086**	–0.004**
Household size	0.018	0.064**	–0.002	–0.001	0.003	0.000
Income1	0.005		–0.001	0.000	0.001	0.000
Income2	0.312		–0.026	–0.041	0.063	0.004
Income3	1.190***		–0.054***	–0.302*	0.307**	0.049

[a] Parameters are the marginal effects.
*** indicates significant at the 1% level; ** 5% level; and * 10% level.

Discussion

Shoppers of live seafood showed different attitudes regarding expenditure patterns on live seafood. Factors that would likely ensure higher expenditures on live fish/shellfish were found to be the purchase of saltwater finfish, purchase of shellfish, quality assurance, and high income earners. These factors increase the probability of expenditures in the higher category by at least 10%. It makes economic sense to find that saltwater finfish and shellfish, which are generally more expensive than freshwater finfish, would show positive effects on the higher expenditure categories. The North Central Region has no marine or saltwater resources, and these products need to be shipped over long distances to the ethnic stores.

The finding that high income earners spend more on live seafood reflects the effects of purchasing power and is in line with the Engel curve. High income earners can afford more expensive seafood, so their food spending habits tend to increase with the purchase of shellfish, rather than saltwater finfish, and freshwater finfish.

Saltwater finfish, shellfish, and purchasing power, though important, are factors that fish farmers in the North Central Region have no ability to manage or control. The manageable factor that was found to be highly significant is quality assurance. For freshwater finfish, a shopper has a 19% probability of spending $21–$30 per visit and a 2% probability of spending over $30. This compares well with a 14% probability of spending $21–$30 per visit on saltwater finfish and 20% probability on shellfish. As Dochtermann (1996) pointed out, fish destined for the live market requires that quality be maintained throughout the growing period. Ensuring fish quality through the value chain demands that farmers provide balanced and nutritious diets, prevent or minimize disease occurrence, maintain proper stocking densities, and handle fish appropriately during production and transportation to the market. Healthy-looking fish reflects its quality and attracts higher premiums (Puduri *et al*. 2010; Myers *et al*. 2010).

Regarding fish attributes, shoppers who considered "price is important" in their purchase decisions had a higher likelihood of spending more on saltwater finfish compared to freshwater finfish. The effect of the "price is important" variable does not clearly indicate the price effects on live finfish/shellfish purchases. However, the expenditures (dependent variable) are ordered outcomes, which represent a censoring of an underlying continuously measured preference for live seafood. A negative coefficient on the variable indicates a lower effect on shoppers' utility. Thus, shoppers tend to demand less freshwater finfish and more saltwater finfish as they consider the increasing importance of price.

Generally, shopping frequency appears to be an important determinant of live seafood expenditures. Shopper attitudes showed a high degree of variation, particularly with respect to weekly purchases and biweekly purchases, which suggest significant variability around the utility levels with some shoppers preferring more frequent purchases of live seafood. The insignificant parameter on the standard deviation of monthly purchases indicates that shoppers gain positive utility at that frequency of shopping.

Being an American does have a significant effect, and there is a large degree of variability among this group of shoppers. The heterogeneity of Americans could be a reflection of the diversity among shoppers who considered themselves Americans, many of whom were non-Caucasian but naturalized or born and raised in the US.

Those who identified themselves as Asian were found to be generally homogeneous in their preferences for live fish, except saltwater finfish. Live seafood is a common food product purchased by natives of Asian countries, suggesting that there might not be much difference in cross-cultural preferences for live seafood, particularly freshwater finfish, which is common to the various cultures. Murray, Easton, and Best (2001), for example, found no significant differences in preference between European-origin and Chinese-origin consumers for a "novel" snack product common to both cultures. In a study of fish consumption in Bangladesh, China, India, Indonesia, the Philippines, Thailand, and Vietnam, Dey *et al*. (2005) reported that although preferences for freshwater and marine fish species varied by geographical location, freshwater species were mostly preferred by consumers in all the seven Asian countries studied. Our finding appears to support the observation that the preferences of consumers from diverse cultures tend to be homogeneous for foods common to their cultures.

Conclusions

Shoppers of live seafood showed a greater preference for shellfish and saltwater fish compared to freshwater finfish. Other factors that would likely ensure higher expenditures on live fish/shellfish were found to be quality assurance and high income earners. Fish farmers in the North Central Region generally produce freshwater finfish, and can compete in the live seafood market with its diverse species and product attributes by focusing on producing quality freshwater fish. Shoppers also appear to have preferences for more frequent purchases of live seafood, suggesting the importance of availability. Fish farmers in the North Central Region should ensure that there is year-round supply of freshwater seafood to ethnic stores to meet demand.

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