Preferences for Oyster Attributes by Consumers in the U.S. Northeast

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In a mail survey of shellfish consumers in the U.S. Northeast, a conjoint experiment was conducted where respondents were asked to rank oyster alternatives that differed on the following attributes: source information, price, and inspection information. Ordered probit analysis of all responses revealed that inspection information was the most important attribute, followed by source information, and price. Respondents most preferred oysters that were farm-raised, priced at $3.49/8 oz, and inspected by the Food and Drug Administration. Individual part-worths were also estimated using ordinary least squares regression. Logit analysis revealed that the probability of inspection information being the most-valued attribute increased when the respondent believed that farm-raised shellfish are harvested in cleaner water than those caught in the wild. The probability of source information being the most important attribute increased when the respondent believed that farm-raised shellfish are safer than wild-caught.

The quality and safety of seafood, shellfish in particular, are of concern to consumers, many of whom had been exposed to magazine articles and television programs questioning the fitness of seafood for human consumption. Economic studies have verified that indeed such concerns exist. For example, Brooks (1992) found that consumers' decision to buy mussels is negatively affected by the perception that there is some health risk associated with eating this product. Similarly, Lin and Milon (1993) conclude that reduced consumption of shellfish results when consumers are exposed to new health risk information. Such worries, though they appear misplaced because the risk from seafood is reported to be lower than from other types of food (Wessells and Anderson 1993), have important implications. When they reduce seafood purchases, consumers forsake a good source of protein, vitamins and minerals and a healthy alternative to beef and pork. Moreover, the reluctance of many consumers to buy seafood negatively affects the seafood production and distribution sectors.

It appears, therefore, that consumers, producers, marketers and other segments of the economy will benefit from efforts to assure consumers about seafood quality and safety. One measure that had been proposed is to institute government inspection of seafood similar to that of meat and poultry (Anderson and Anderson 1991). This approach, when done properly by a credible agency, would signal consumers that seafood that reaches the market is safe and of good quality.

Consumers had also been exposed to information that a major reason for the problem of unsafe seafood, especially shellfish, is pollution in waters where they are harvested (Jarrof 1992). It is possible then that consumers may prefer to buy shellfish grown in aquaculture farms where water quality may be better monitored and controlled. If such preference exists, the aquaculture industry and the seafood distribution sector are then faced with another opportunity to make consumers confident about seafood quality and safety: they can explicitly identify aquaculture products as such through labeling or placement of signs in retail display counters.

A study was conducted to determine the relative importance of these two attributes, government inspection and information that the product was grown in an aquaculture farm, to consumers of oysters. The importance of these two attributes was compared to the product's price, another important factor that determine quantity demanded. Oysters was the product chosen for the study because it is one of the most widely known shellfish. Furthermore, the health

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risks associated with oyster consumption had received a lot of media attention in the recent past.

Methods

The relative importance of the three attributes mentioned above was assessed using conjoint analysis. In this approach, each product is defined as a combination of attributes with each attribute having two or more levels. Respondents are asked to rate or rank stimuli representing alternative combinations of attribute levels. The ranking or rating data are analyzed using any of several methods such as ordinary least-squares regression or logit analysis. The parameter estimates yield a value, called part-worth, for each attribute level. The part-worth indicates the relative importance of that level to the respondents. The measure of the importance of an attribute is then derived from the range of the part-worths over the levels of that attribute (Green and Srinivasan 1978).

Table 1. Attributes and Levels Used in the Conjoint Analysis Study.

Attribute 1: Source Information
Level 1: Farm-Raised
Level 2: Wild-Caught
Level 3: Blank (i.e., no information provided)
Attribute 2: Price
Level 1: $4.49 / 8 oz.
Level 2: $3.99 /8 oz.
Level 3: $3.49 / 8 oz.
Attribute 3: Inspecting Agency Information
Level 1: Food & Drug Administration
Level 2: U.S. Department of Agriculture
Level 3: Blank (i.e., no information provided)

In this study, respondents were asked to assume that they are presented with nine containers of shucked oysters and that the oysters inside the containers are identical in appearance. They were told that the differences among the oysters may be obtained from the information on each container's label. Each label represents a combination of various levels of the three attributes of interest: source information, inspection information, and price. Each attribute has three levels which are shown in Table 1. Respondents were then asked to rank the oysters from one to nine, with the most preferred oyster getting a rank of one and the least preferred oysters getting a rank of nine. The nine combinations used in the study represent a third of all the possible attribute combinations and were selected following a plan developed by Addelman (1962). This subset of combinations, called an orthogonal array, enables the valid estimation of the importance of attributes while not overloading the respondents with the task of evaluating all possible combinations.

Consumer responses were obtained through a mail survey. Data collection for conjoint analysis typically involves face-to-face interviews with respondents, however the use of a mailed questionnaire in a conjoint study had been done in the past with good results (Currim *et. al.* 1981). This experience as well as the researchers' desire to get as large a sample as possible with their limited budget resulted in their choosing a mail survey as their data collection method. A copy of the page containing the conjoint analysis question is shown in Figure 1. In addition, consumers were also asked questions about their perceptions and purchasing behavior related to fresh oysters, attitudes toward farm-raised shellfish, attitudes toward shellfish safety and related issues, exposure to media reports about shellfish, and demographic characteristics. The attitudes and demographic characteristics of the respondents were used in a model designed to explain the relative importance they attach to the attributes of interest in this study.

The questionnaire was mailed to a sample of 5,000 households in the states of the Northeast region. The states included were: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Maryland, New Jersey, Delaware, and West Virginia, plus the District of Columbia. The households in the sample were distributed across states according to each state's share of the region's total population. The sample was purchased from a commercial vendor. Surveying began in April 1993 with a letter sent to each household announcing the impending arrival and stating the importance of the survey. This was followed a few days later by the survey instrument and an explanatory letter. After a week, a postcard was sent to remind households to complete and return the questionnaire. Two weeks later another survey instrument and cover letter were sent, followed

Figure 1. The Conjoint Analysis Question Included in the Survey of Shellfish Consumers in the U.S. Northeast.

12. Assume that you are presented with 9 containers (8 ounces each) of shucked oysters that are for sale. The oysters inside the containers are identical in appearance. The differences among the oysters may be determined by examining their labels which are shown below. Indicate your preference by ranking the oysters from 1 to 9. Please give a rank of 1 to the most preferred oysters, a rank of 2 to the next most-preferred, and so on. The least preferred oysters should have a rank of 9. Please make sure to give each of the oysters a rank.

Farm-raised SHUCKED OYSTERS $4.49 / 8 oz.	*Wild-caught* SHUCKED OYSTERS $3.99 / 8 oz.	SHUCKED OYSTERS $3.99 / 8 oz. Inspected by the U.S. Food & Drug Administration
Rank: ________	Rank: ________	Rank: ________
Wild-caught SHUCKED OYSTERS $3.49 / 8 oz. Inspected by the U.S. Department of Agriculture	SHUCKED OYSTERS $4.49 / 8 oz. Inspected by the U.S. Department of Agriculture	*Wild-caught* SHUCKED OYSTERS $4.49 / 8 oz. Inspected by the U.S. Food & Drug Administration
Rank: ________	Rank: ________	Rank: ________
SHUCKED OYSTERS $3.49 / 8 oz.	*Farm-raised* SHUCKED OYSTERS $3.49 / 8 oz. Inspected by the U.S. Food & Drug Administration	*Farm-raised* SHUCKED OYSTERS $3.99 / 8 oz. Inspected by the U.S. Department of Agriculture
Rank: ________	Rank: ________	Rank: ________

again after a week by a reminder postcard. All returns were received by August 1993. This approach resulted in a return of 1,557 questionnaires for a response rate of 31 percent.

One thousand forty-three respondents answered the conjoint analysis question. The ordered probit procedure was used to analyze the ranks the respondents provided and the relative importance of the three attributes to all the respondents was computed from the estimated coefficients. In essence, this approach, *i.e.*, aggregate-level analysis, involves pooling the ranking data from all the respondents. The model estimated using ordered probit is as follows:

[Model 1] $Y_{in} = b_0 + b_1X_{1in} + b_2X_{2in} + b_3X_{3in} + b_4X_{4in} + b_5X_{5in} + b_6X_{6in} + e_{in}$

for $i = 1, 2, ..., 9$ and $n = 1, 2, . . . , 1043$,

where Y_{in} is the rank assigned by the nth respondent to the ith attribute combination included in the conjoint study; b_0 is the intercept term; $b_1, b_2, . . . , b_6$ are the regression coefficients; X_{1in} and X_{2in} represent the level of the source information attribute, X_{3in} and X_{4in} denote the level of the price attribute, and X_{5in} and X_{6in} represent the level of the inspection information attribute; and e_{in} is a random error term. The Xs are expressed as dummy variables which, following effects coding (Cohen and Cohen 1975), were coded as (1, 0) for the first level, (0, 1) for the second level, and (-1, -1) for the third level. For example, the independent variables for the first oyster label shown in Figure 1 were specified as follows: $X_1 =1, X_2 = 0, X_3 = 1, X_4 = 0, X_5 = -1, X_6 = -1$. The coefficients obtained with the use of effects coding are identical to the results of conventional dummy-variable coding, however effects coding allows for easier computation of the part-worths.

It is also interesting and potentially useful to know how the respondents' attitudes, experience and characteristics influence their ranking of the attributes. Such knowledge may be used, for example, to design and target information or promotional campaigns to increase consumer awareness about shellfish safety. The effects of consumers' attitudes and characteristics on the importance to them of oyster attributes cannot be obtained from the above procedure where data from all respondents are pooled together, so another method was followed.

First, the relative importance of each attribute to each individual was estimated. The estimation model is as follows:

[Model 2] $Y_{in} = b_0 + b_1X_{1i} + b_2X_{2in} + b_3X_{3i} + b_4X_{4i} + b_5X_{5i} + b_6X_{6i} + e_i$

for $i = 1, 2, ..., 9$

where the variables are as defined for Model 1. Model 2 is similar to Model 1 except that, instead of using aggregate data from all respondents, Model 2 was estimated and the part-worths computed for each respondent. Estimation of individual part-worths is common in conjoint analysis (Moore 1980) and in many cases ordinary least squares (OLS) regression is used (Wittink and Cattin 1989). Because there are only nine observations for each individual, it was decided to use the widely accepted OLS regression instead of ordered probit, the results of which, in this particular case, may be difficult to interpret.

After determining the part-worths for each individual, the respondents were grouped according to the attribute that was most important to them: group 1 included those who most valued inspection information; those whose rankings implied that source information was the most important attribute were placed in group 2; and those who considered price most important comprised group 3. Logistic regression was then employed to estimate the effects of respondents' attitudes and characteristics on the probability of being a member of a certain group. The equation for the model was

[Model 3] $\ln (p/1\text{-}p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + b_{13}X_{13} + b_{14}X_{14} + e$

where p is the probability of a respondent belonging to group n (n = 1, 2, 3) and the definition of the explanatory variables are as follows, with all variables equal to 0 if otherwise:

X_1 = 1 if the respondent agrees that farm-raised shellfish are of higher quality than wild-harvested shellfish;

X_2 = if the respondent agrees that farm-raised shellfish are harvested in cleaner water than wild-harvested shellfish;

X_3 = 1 if the respondent agrees that there is no quality difference between farm-raised and wild-harvested shellfish;

X_4 = 1 if the respondent agrees that wild-harvested shellfish are more likely to suffer from improper handling and storage after harvest than farm-raised;

X_5 = 1 if the respondent agrees that farm-raised shellfish contain less grit than wild-harvested;

X_6 = 1 if the respondent was confident that shellfish sold in the U.S. contain nothing harmful to human health;

X_7 = 1 if the respondent had read positive stories in the news media about shellfish in the past year;

X_8 = 1 if the respondent agrees that water pollution is a primary cause of unsafe shellfish;

X_9 = 1 if the respondent agrees that improper handling and storage in the marketplace is a primary cause of unsafe shellfish;

X_{10} = 1 if the respondent agrees that all shellfish currently in the marketplace are harvested from government certified clean water;

X_{11} = 1 if the respondent agrees that farm-raised shellfish are safer than wild-harvested;

X_{12} = 1 if the respondent agrees that water pollution is more likely to create a problem for wild shellfish than farm-raised;

X_{13} = 1 if the respondent's educational level is high school graduate or less; and

X_{14} = 1 if the respondent's annual household income is below $25,000.

Four hundred seventy-three respondents completed the conjoint analysis question and provided information related to the above variables.

Results and Discussion

Aggregate-Level Analysis

The estimated coefficients are presented in Table 2. The part worth for each attribute level was estimated by adding the intercept and the appropriate regression coefficients. For example, the part worth for the level "farm-raised" of the attribute "source information" is equal to 1.10 which was obtained by adding $b_0 + b_1X_1 + b_2X_2$, *i.e.*, 1.726 + (-0.626) (1) + (0.237) (0) = 1.10. The estimated part worths are shown in Table 3. Because respondents were asked to rank the combinations from one to nine, with one indicating the most preferred combination, the part-worth that has the lowest value denotes the most important attribute level to the consumer. To make interpretation of the values more intuitively appealing, the estimated part-worths were adjusted so that the least-desired level has a part-worth equal to zero, and the most-preferred level has the highest adjusted part-worth. This was done by obtaining the difference between the part-worth of the least-desired level and the part-worth for each level. For example, for the price attribute, the adjusted part-worths for the $4.49, $3.99 and $3.49 levels were derived, respectively, as follows: 1.97−1.97 = 0; 1.97−1.69 = 0.28; and 1.97−1.52 = 0.45.

Table 2. Estimated Coefficients from the Ordered Probit Analysis.

Variable	Estimate	Standard Error	t-ratio
Intercept	1.726	0.019	90.99
X_1	- 0.626	0.015	- 41.89
X_2	0.237	0.016	15.16
X_3	0.243	0.015	15.68
X_4	- 0.037	0.016	- 02.28
X_5	- 0.687	0.016	- 43.10
X_6	- 0.549	0.016	- 33.83

All the estimates are different from zero at the $\alpha = 0.05$ statistical significance level.

Table 3. Attribute Level Part-Worths.

Attributes and Levels	Estimated Part-Worths	Adjusted Part-Worths
Source Information		
Farm-raised	1.10	1.02
Wild-caught	1.96	0.16
No information	2.12	0.00
Price		
$4.49/8 oz.	1.97	0.00
$3.99/8 oz.	1.69	0.28
$3.49/8 oz.	1.52	0.45
Inspecting Agency Information		
FDA	1.04	1.92
USDA	1.18	1.78
No information	2.96	0.00

For the inspection information attribute, the most preferred level was inspection by the Food and Drug Administration; respondents least preferred the level where there is no inspecting agency information. For the source information attribute, the "farm-raised" level was valued most by the respondents; they had the least preference for the level where there is no source information. The order of preference for the three levels of the price attribute was consistent with economic theory: consumers preferred most the lowest price ($3.49) and preferred least the highest price ($4.49). Considering only the three attributes in this study, the oysters that had the most appeal to the consumers surveyed were farm-raised, inspected by the FDA, and priced at $3.49/8 oz. The total worth of this product (i.e., the sum of the adjusted part-worths) is 1.02 + 0.45 + 1.92 = 3.39.

In conjoint analysis the importance of each attribute is derived by obtaining the difference between the part-worth of the most desired level and the part-worth of the least desired level. This value or importance weight is then compared with those for other attributes (Table 4). The greater the importance weight, the more important the attribute. To make comparisons easier the importance weights were converted to percent. The conjoint analysis results show that given the three attributes and the levels specified in this conjoint experiment, inspection information was the most important to consumers, followed by source information, and price was the least important.

Table 4. Relative Importance of Attributes.

Attribute	Relative Importance	Percent
Source Information	1.02	30
Price	0.45	13
Inspecting Agency Information	1.92	57
Total	3.39	100

The part-worths indicate that the respondents were willing to pay a higher price for oysters that had been inspected. Ignoring the source information attribute, oysters that were priced at $4.49 and FDA inspected had a total worth of 0.00 + 1.92 = 1.92, and oysters priced at the same level but inspected by the USDA had a total worth of 0.00 + 1.78=1.78. The total worth of oysters that were priced at $3.49 but did not include inspection information was 0.45 + 0.00 = 0.45. Similarly, the consumers surveyed were willing to pay a higher price for farm-raised oysters. Ignoring the inspection attribute, the combination of "farm-raised" and $4.49 price was worth 1.02; oysters that were labeled as wild-caught and with a $3.49 price tag had a total worth of 0.61, and oysters priced at the lowest level but without source information had a total worth of 0.45.

Individual-Level Analysis.

Results of the estimation of part-worths and attribute importance at the individual level confirm the results using aggregate data. Inspection information was the most important attribute for 69 percent of the 473 respondents included in this analysis. Source information and price were the most important attributes for 21 percent and 10 percent of the respondents, respectively.

Logit Analyses Results.

When Model 3 was estimated with the probability of a respondent belonging to Group 1 (those who most valued the inspection information) as dependent variable, the results revealed that two of the fourteen explanatory variables had statistically significant effects. The probability of the inspection information attribute being the most important to a respondent increased when the respondent had the attitude that farm-raised shellfish are harvested in cleaner water than wild-caught shellfish. It is likely that these consumers believed that most of the oysters sold in the market are caught in the wild in waters that may be polluted and hence they strongly wanted the product to be inspected. The odds of being in Group 1 decreased when the respondent believed that farm-raised shellfish are safer than wild-harvested. Respondents who possessed this attitude, as the results of the second logit analysis indicate, tended to belong to Group 2, *i.e.*, those who most valued the source attribute (Table 6). It appears that these consumers considered source information as an indicator of oyster safety. The odds of being in Group 2 also increased when the respondent's educational attainment is a high school education or less. The explanation for this particular result is not clear. The effects of the other explanatory variables were not statistically significant.

The results of the third logit analysis are shown in Table 7. None of the independent variables had a significant effect on the probability of a respondent valuing price as the most important attribute. This implies that the respondents that belonged to Group 3 had widely varying attitudes and demographic characteristics.

Conclusions

This study found that safety was indeed a major concern for oyster consumers, and that safety assurances in the form of inspection information and source information were relatively more important to consumers than price. This result, however, is valid only given the price levels included in the conjoint experiment in this study.

Of the three attributes specified in this study, inspection information was the most important to consumers, especially those who believed that farm-raised shellfish are harvested in cleaner water that wild-caught shellfish. Most of the respondents would like to know that the shellfish they buy and consume had been inspected and found safe preferably by the Food and Drug Administration. There was only a small loss in total worth or utility when inspection was supposed to have been done by the USDA; the loss in utility was much greater when inspection information was not provided. Consumers were willing to pay a higher price for oysters that had been inspected.

Likewise, consumers were willing to pay a higher price in exchange for source information. Many consumers, particularly those who believed that farm-raised shellfish are safer than wild-caught, valued source information the most. They had the strongest preference for farm-raised oysters because, they, it appeared, associated aquaculture with safe products.

These results have significant implications for the firms that produce and distribute oysters and shellfish in general. They should support initiatives that will broaden shellfish inspection because consumers consider it as an important indicator of shellfish safety. Although it is not certain that expanded inspection will increase demand, it may prevent current but wary consumers from reducing their shellfish consumption.

Producers and marketers of farm-raised shellfish are faced with a promising opportunity as well. Labels identifying aquaculturally-grown products as such at retail outlets would appeal to a large segment of shellfish consumers. To many, aquaculture represents a source of safe shellfish. It is important that the shellfish aquaculture industry reinforce this perception by adopting practices that ensure shellfish safety.

Table 5. Parameter Estimates for the Model with the Probability of Belonging to Group 1 (Those who Indicated Inspection Information as the Most Important Attribute) as the Dependent Variable.

Parameter	Estimate	Standard Error	Chi-Square	P-value	Odds Ratio
Intercept	1.308*	0.461	8.062	0.005	
X_1	-0.066	0.261	0.063	0.802	0.937
X_2	0.499**	0.291	2.936	0.087	1.647
X_3	-0.125	0.347	0.129	0.719	0.883
X_4	0.075	0.245	0.095	0.758	1:078
X_5	0.072	0.240	0.090	0.764	1.075
X_6	0.321	0.212	2.289	0.130	1.379
X_7	0.188	0.545	0.118	0.731	1.206
X_8	-0.450	0.434	1.073	0.300	0.638
X_9	0.001	0.254	0.000	0.998	1.001
X_{10}	0.118	0.384	0.095	0.758	1.126
X_{11}	-0.725*	0.267	7.377	0.007	0.484
X_{12}	-0.197	0.256	0.592	0.442	0.821
X_{13}	-0.292	0.258	1.278	0.258	0.747
X_{14}	-0.278	0.284	0.957	0.328	0.757

* Statistically significant from zero at $\alpha = 0.01$ level.
** Statistically significant from zero at $\alpha = 0.10$ level.

Table 6. Parameter Estimates for the Model with the Probability of Belonging to Group 2 (Those who Indicated Source Information as the Most Important Attribute) as the Dependent Variable.

Parameter	Estimate	Standard Error	Chi-Square	P-value	Odds Ratio
Intercept	-2.520*	0.657	14.720	0.000	
X_1	0.454	0.294	2.384	0.123	1.575
X_2	-0.357	0.345	1.072	0.301	0.700
X_3	-0.257	0.415	0.382	0.536	0.774
X_4	-0.046	0.278	0.027	0.870	0.956
X_5	-0.102	0.269	0.144	0.704	0.903
X_6	-0.215	0.245	0.771	0.380	0.806
X_7	-0.865	0.780	1.230	0.267	0.421
X_8	0.958	0.634	2.287	0.130	2.608
X_9	-0.082	0.292	0.080	0.778	0.921
X_{10}	0.063	0.426	0.022	0.882	0.939
X_{11}	0.983*	0.312	9.895	0.002	2.673
X_{12}	-0.067	0.298	0.051	0.822	0.935
X_{13}	0.548**	0.281	3.794	0.051	1.730
X_{14}	-0.004	0.328	0.000	0.990	0.996

* Statistically significant from zero at $\alpha = 0.01$ level.
** Statistically significant from zero at $\alpha = 0.10$ level.

Table 7. Parameter Estimates for the Model with theProbability of Belonging to Group 3 (Those who Indicated Price as the Most Important Attribute) as the Dependent Variable.

Parameter	Estimate	Standard Error	Chi-Square	P-value	Odds Ratio
Intercept	-1.795	0.602	8.892	0.003	
X_1	-0.724	0.455	2.527	0.112	0.485
X_2	-0.596	0.436	1.866	0.172	0.551
X_3	0.609	0.497	1.500	0.221	1.838
X_4	-0.002	0.401	0.000	0.997	0.998
X_5	0.120	0.408	0.087	0.768	1.128
X_6	-0.286	0.337	0.717	0.397	0.752
X_7	0.149	0.805	0.034	0.853	1.161
X_8	-0.324	0.544	0.356	0.551	0.723
X_9	0.021	0.395	0.003	0.959	1.021
X_{10}	-0.610	0.770	0.628	0.428	0.543
X_{11}	-0.073	0.408	0.032	0.858	0.929
X_{12}	0.570	0.414	1.890	0.169	1.768
X_{13}	-0.474	0.471	1.011	0.315	0.623
X_{14}	0.648	0.418	2.400	0.121	1.911

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