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Measuring Food Safety Preferences: Identifying Consumer Segments

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Conjoint analysis was used to estimate individual preference functions for food safety attributes. Consumer segments were constructed by using cluster analysis to form groups which were homogeneous with respect to preferences regarding food safety. Although substantial differences existed among the three distinct groups, consumers in all segments were willing to pay a moderate amount to ensure that apples met established safety standards. However, a policy which restricts pesticide use would likely result in substantial consumer dissatisfaction, unless it could be achieved with little impact on price or quality.

Key words: conjoint analysis, food safety, pesticides.

Introduction

In the continuing debate over food safety, policymakers face extremely difficult choices in trying to balance concerns about risk, cost of production, and consumer preferences. The problem is compounded because policymakers, who often base policy decisions on the results of scientific studies, frequently do not understand the seemingly "irrational" concerns held by consumers.

Most research to date has focused on one aspect of the problem, measuring consumer willingness to pay for policy alternatives which decrease risk to consumers. Several studies used contingent valuation to estimate consumer willingness to pay for increased food safety. Van Ravenswaay and Hoehn, using a national sample, surveyed consumers to determine the quantity of apples consumers would buy given various prices, qualities, and labels. They estimated demand equations and calculated willingness to pay for reduced pesticide labels. Their study found consumers were willing to pay an additional 23.6¢ per pound for either "no detectable pesticide residues" or "no pesticide residues above federal limits," and 37.5¢ per pound for "no pesticide residue" labels on fresh apples. Misra, Huang, and Ott conducted a mail survey of Georgia consumers to determine willingness to pay for tested and certified pesticide-free produce. They found consumers were generally unwilling to pay anything extra for such produce, or at most were willing to pay only a small price premium. Ott obtained similar results in a survey of supermarket shoppers in the Atlanta area. There is a substantial difference in estimates of consumer willingness to pay for certified pesticide-free produce between the Van Ravenswaay and Hoehn research and that conducted by Ott and by Misra, Huang, and Ott.

The primary objective of our research was to identify consumer segments based on a detailed analysis of individual consumer preferences for food safety attributes. Blattberg and Neslin argued strongly against aggregating across consumers when they are heterogenous with respect to the variables being studied. Aggregating may smooth out the dif-

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ferences between groups so that the results do not reflect the preferences of any individual or group. Previous studies using the contingent valuation method have estimated average willingness to pay for food safety attributes across all consumers. We identify homogeneous groups of consumers based on their preferences for food safety attributes relative to other characteristics of fresh produce. This has important implications for policymakers. Basing policy decisions on the preferences of consumer segments should lead to policies which better meet consumer needs, compared to policy choices based on average consumer preferences. Our research results also permit the analysis of complex scenarios where several variables are affected by changes in food safety regulations. For example, it is likely that reducing pesticide usage would result in both increased defects and higher prices. The results of our analysis allow for the evaluation of such scenarios.

This research illustrates the use of conjoint analysis to construct consumer segments. Conjoint analysis (CA) has been widely used in the field of marketing to evaluate new products and product attributes (Green and Srinivasan), but to the best of the authors' knowledge, it has not been applied to food policy issues. CA has gained widespread acceptance because of its predictive ability and its value in providing an understanding of the structure of consumers' preferences. A major advantage of CA over the contingent valuation method is that consumers respond to a more realistic market situation. They are asked to evaluate various products, a task similar to an everyday shopping experience. By comparison, contingent valuation typically uses survey data, whereby consumers are asked directly how much they would be willing to pay for a product or product attribute. However, the major advantage of CA is that it allows for the analysis of individual consumer preference functions because of the large number of data points collected for each consumer. By contrast, the very nature of contingent valuation and the limited number of data points per consumer allow only the estimation of aggregate demand functions.

Theoretical Model

One of the earliest studies suggesting that consumers purchase products based on their characteristics was published by Waugh. The first formal models of the economics of product characteristics were published independently by Theil and Houthakker. Lancaster's work on the subject is probably the best known. He formulated the consumer's utility function as a function of the total amount of product characteristics obtained from an array of products. Ladd and Zober extended this model, assuming that buyers consume products by consuming the services they provide. Total utility is determined by the amount of consumptive services provided by consumption of products. Van Ravenswaay and Hoehn further refined the model to focus on a single product. It is their formulation which forms the basis of our model.

Consider a product x_1 offered at price p_1 and a vector of I alternative products, $\mathbf{x} = (x_2, \ldots, x_I)$, offered at prices corresponding to vector $\mathbf{p} = (p_2, \ldots, p_I)$. (Vectors and matrices are denoted in bold.) The product x_1 contains a vector of J quality attributes, $\mathbf{a}_1 = (a_{11}, \ldots, a_{1J})$; products $\mathbf{x}$ contain a matrix of attributes, $\mathbf{a} = \mathbf{a}_{ij}$, $i = 2, \ldots, I$, and $j = 1, \ldots, J$. Consumption services are provided by the products and their attributes. For a food product an attribute may be level of protein, while an example of a service would be nourishment. While each product has the same set of attributes associated with it, the amount of each attribute is dependent on the specific product. For example, some products may possess a relatively high amount of an attribute, whereas that attribute may be absent in other products. Services are determined by

$$s_k = s_k(x_1, \mathbf{a}_1, \mathbf{x}, \mathbf{a}), \qquad k = 1, \ldots, K. \tag{1}$$

The consumer's utility function is represented by

$$U = u(s_1, \ldots, s_k), \tag{2}$$

subject to the budget constraint

$$(3) \qquad p_1x_1 + \boldsymbol{p}'\boldsymbol{x} \leq m.$$

This yields a demand function for x_1 of

$$(4) \qquad x_1 = x_1(p_1, \boldsymbol{a}_1, \boldsymbol{p}, \boldsymbol{a}, m).$$

Substituting for services in the utility function and products in the service function yields the indirect utility function

$$(5) \qquad V = v(p_1, \boldsymbol{a}_1, \boldsymbol{p}, \boldsymbol{a}, m).$$

A consumer's purchase decision for a product is therefore conditioned on attributes the product possesses, product price, attributes and prices of all other products, and level of income.

Previous studies (Misra, Huang, and Ott; Van Ravenswaay and Hoehn) have used the contingent valuation approach to estimate the demand for products as defined by equation (4). CA, the analytical technique used in this research, relies on estimating the effect of price and product attributes on individual consumers' utility, equation (5), to determine trade-offs consumers make between price and quality attributes.

Methodology

In marketing, CA has become one of the most important analytical and empirical tools applied to the study of consumer preference and choice. It has proven to be very robust over a wide range of designs and applications (Carmone, Green, and Jain). For a comprehensive review of the methodology, see Green and Srinivasan. CA decomposes an individual's utility for a product or service into some combination of part-worth utilities defined for the relevant characteristics, or attributes, of the product. That is, for a choice alternative described in terms of a set of characteristics, $z_k = (z_1, \ldots, z_K)$, the utility function for an individual is specified in terms of a combination rule W and a set of functional forms w_k (one for each of the characteristics) as $W(w_1(z_1), \ldots, w_K(z_K))$.

CA is based on the premise that consumers evaluate or value a product by combining the separate amounts of utility provided by each attribute of the product. Researchers construct a set of hypothetical products by combining attributes at various levels. A hypothetical product is defined by the levels of attributes. From an experimental design perspective, product attributes are factors, the hypothetical products are treatments, and the set of hypothetical products is the experimental design. Hypothetical products are presented to consumers who are asked to provide their overall evaluation of the products in the form of preference ratings. Ordinary least squares (OLS) is used to estimate the utility function $W(w_1(z_1), \ldots, w_K(z_K))$ for each individual from these preference ratings.

The selection of product attributes and levels of each attribute affect both the accuracy and the relevance of the results. All product attributes which potentially create or detract from the overall value of the product should be included. From a practical perspective, it is necessary to limit the attributes considered to the attributes being studied and attributes which are most directly affected by changes in those attributes under study. The levels of selected attributes must be believable and meaningful to the respondents. That is, the level descriptions should be as precise as possible and their range should not greatly exceed existing levels.

The combination rule, W, for the utility function is generally a choice between additive and quadratic models. An additive model captures only the main effects of the attributes, while the quadratic form additionally captures two-way interaction effects between attributes. Including interaction effects often does not increase the predictive power of the model for two reasons. First, there is a loss in statistical efficiency as more parameters are estimated. Second, as the number of parameters to be estimated increases, the number of hypothetical products presented to respondents must be increased, which in turn increases the task's complexity and tends to decrease the reliability and validity of responses. On the other hand, not allowing interaction effects means that a variable's impact on utility is independent of the levels of other attributes. In practice, the most common model is the additive model (Hair et al.).

The functional forms for the utility of the individual product characteristics, $w_k(z_k)$, are generally selected from one of three types: linear, quadratic, or part-worth. The linear (vector) model, $w_k(z_k) = bz_k$, where b is the utility per unit of attribute z_k, is the most restrictive choice. The part-worth model, $w_k(z_k) = w_{z_k}$, estimates a particular utility level for each attribute level and is the most flexible choice. The quadratic (ideal point) model, $w_k(z_k) = c(z^* - z_k)^2$, where z^* is the ideal level of the attribute for the consumer and c is a constant of proportionality, allows a curvilinear relationship between attribute levels. The choice of functional form depends on the relationship between a particular attribute's different levels. Often, a mixture of models across a product's attributes is required.

The last step in model estimation is to construct the aggregate preference function based on estimates of individual preference functions. This is accomplished by averaging the coefficients for the individual models.

For all but the smallest of studies, a full factorial design of hypothetical products is impractical. A full factorial design for a study with four attributes with four levels each requires the respondent to rate 256 hypothetical products. For this reason, it is often necessary to limit the number or levels of attributes studied. Typically, a highly fractional design is used which limits the number of hypothetical products to a manageable number of 10 to 25 products. The fractional factorial design must be chosen to minimize confounding the effects of different attributes. Numerous published guides and computer packages are available to aid in this process (for example, Bretton–Clark 1988b; Conner and Zelen).

Hypothetical products are presented to respondents in a manner which describes the products fully in terms of their attribute levels. Most often these are profile description cards, with one card per hypothetical product. Respondents are asked to consider each product description separately and indicate their preference for the product on a rating scale. Typical metric scales are 1 to 11 for a small to medium number of products, and 1 to 21 for studies with larger numbers of products.

OLS is generally used to estimate respondents' individual utility functions on the basis of their preference ratings, assumed combination rule, and attribute utility functional forms. Computer packages are available which automate the tedious individual level analyses (for example, Bretton–Clark 1988a). In most studies, the number of data points does not greatly exceed the number of parameters, and thus traditional measures of a model's "fit" are not appropriate. Alternatively, conjoint studies typically collect a holdout sample of ratings from each respondent (usually two or three hypothetical products) which are not included in the OLS estimation of the utility functions. The predictive ability of the model is then measured by comparing the estimated to the reported utility for the products in the holdout sample (Acito and Jain). Typically, Pearson's correlation coefficient, which is calculated using the predicted and actual preference scores of the holdout sample, is reported as a measure of predictive validity. Furthermore, examining the part-worth functions to determine whether the signs of the coefficients are consistent with prior expectations is a check of the model's face validity (Acito and Jain).

Market Experiment and Model Specification

The market simulation was conducted on two Saturdays in June and July 1992, at two Safeway supermarkets located in metropolitan San Jose, California. These stores were selected because the demographic characteristics of their customers closely matched those of San Jose and the San Francisco Bay Area.

The experiment was conducted by the authors and four trained assistants. Shoppers were approached as they entered the supermarket and asked if they would participate in the experiment in return for a $10 incentive payment. The sample consisted of 160 consumers. Those agreeing to participate were administered a short survey containing questions on gender, marital status, age, education, ethnicity, and fresh fruit and vegetable consumption habits. Information also was obtained about their household, including age composition, labor force participation, weekly grocery bill, income, and home gardening practices. Subjects were seated at a table and read instructions containing descriptions of the product attributes and the evaluation process.

The four attributes (price, damage, certification program, and pesticide regulations) were assumed to be the most salient attributes of fresh apples from the perspective of food safety. Three levels of each attribute were chosen to provide a balance between complexity for the respondent and the amount of information collected. Price levels were 39¢, 79¢, and $1.19 per pound. The damage level was depicted in pictures showing damage of 0%, 1.6%, and 3.4% of the visible surface area, and participants were told that there was no "hidden" damage on the portion of the apple they could not see. The certification programs were termed "no label" to represent the current system of monitoring pesticide residues, "government label" to indicate the government would test and certify that the produce met established safety standards, and "private label" to indicate a private laboratory would test and certify that the produce met established safety standards. Pesticide regulation alternatives were termed "current standards" to represent no change in pesticide regulations, "ban carcinogens" to indicate that pesticides found to be probable carcinogens would be banned, and "35% reduction" to indicate a 35% reduction in the total quantity of pesticides used on fresh apples.

Attribute levels were chosen to realistically represent the range of options consumers face, or might face, should the policy alternatives be implemented. For example, both alternative pesticide regulations have been proposed in California. A ban on carcinogens was included in Proposition 128, more commonly known as "Big Green," which was defeated by voters in 1990. More recently, California's governor and several environmental groups proposed reducing the total quantity of pesticides used in California by 35% over a five-year period. A private laboratory certification program, conducted by NutriClean, an Oakland, California-based laboratory, is actually used by supermarkets in some areas.

We used a fractional factorial design to limit the number of products participants had to evaluate. The Bretton–Clark Conjoint Designer program (Bretton–Clark 1988b) was used to choose 20 product combinations, including a holdout sample of two, since a full factorial design would have resulted in 81 product descriptions. Subjects were given cards describing each of the 20 products. They rated each product on a scale of 1 to 11, with 1 being least preferred and 11 being most preferred.

The model was specified as:

$$W_i = \beta_{i1} + \beta_{i2}PRICE + \beta_{i3}DAMAGE + \beta_{i4}GOVT + \beta_{i5}PRIV + \beta_{i6}BAN + \beta_{i7}REDUCE + \epsilon_i, \quad (6)$$

where W is the utility or preference level for the ith individual; *PRICE* is the price of apples per pound; *DAMAGE* represents damage as a percentage of visible surface area; *GOVT* indicates government certification and labeling (1 if yes, 0 otherwise); *PRIV* indicates private laboratory certification and labeling (1 if yes, 0 otherwise); *BAN* signifies a ban on the application of pesticides classified as probable carcinogens (1 if yes, 0 otherwise); and *REDUCE* indicates a reduction of 35% in the total quantity of pesticides used on fresh apples (1 if yes, 0 otherwise). The model was specified as additive, which would seem to be a reasonable assumption given the range of the variables considered. There was no a priori expectation as to whether *PRICE* and *DAMAGE* should be estimated as linear or part-worth functions; however, preliminary analysis indicated the fit for a linear function was very good.

Comparison of the sample's socioeconomic characteristics (table 1) with those of the Bay Area was complicated because some statistics were not comparable. For example, respondents were asked only to specify a range for some of the more sensitive questions

Table 1. Socioeconomic Characteristics of Experiment Participants

Gender	56.5% female
Marital Status	52.5% married
Average Household Size	3.31 people
Median Age Group	26–35 years
Median Household Income Group	\$40,000–\$59,999
Median Educational Level	Some college
Ethnic Composition:	
White Non-Hispanic	76.9%
Hispanic	10.6%
Asian or Other	8.8%
Black	3.8%
Average Weekly Household Grocery Bill	\$101.42
Home Gardener	43.8%

including income and age. The median household income for the sample fell in the \$40,000 to \$59,999 category, consistent with the median household income for the Bay Area of \$55,331 as reported in the 1990 census. (Census data for the San Francisco Bay Area were obtained from the Center for Continuing Study of the California Economy, *California Population Characteristics, 1991 Edition: What the Census Results Mean.*) The median age group for the sample was 26 to 35 compared to an average age of 33.3 years for residents of the Bay Area. The sample's average household size of 3.31 was larger than that of the Bay Area's 2.61. Minorities were generally underrepresented in the sample; white non-Hispanics comprised 76.9% of the sample as compared to 60.7% for the Bay Area. The sample characteristics, as well as comparisons with census results reported here, must be interpreted with caution. Because the sample was comprised solely of supermarket shoppers, its characteristics would be expected to differ from those of the general population. For example, we would anticipate elderly people to be underrepresented in a sample of shoppers relative to the overall population because they tend to be less mobile.

Results and Discussion

Identifying Consumer Segments

Results of the aggregate model are reported in table 2 and the results by segment are presented in table 3. All coefficients reported in tables 2 and 3 are presented as part-worth coefficients, including those estimated as linear coefficients, to simplify interpretation of the results. Analysis of the holdout sample indicates the predictive accuracy of the model was good, with a correlation coefficient of .72 between the actual and predicted scores. All of the coefficients have the correct sign.

Results indicate the most important factor in determining consumer preference was level of damage. For all consumers in the experiment, level of damage accounted for approximately 40% of the difference in preference scores (this is a measure of the relative variation in utility explained by this factor; see Bretton–Clark 1988a), as compared to roughly 20% for each of the other factors. These results could be interpreted further, although the real power of conjoint analysis is not in generating aggregate results, but rather in understanding individual preferences and identifying consumer segments.

Individual respondents have their own preference function, represented by their own estimated coefficients. Cluster analysis was used to group the respondents into relatively homogeneous groups on the basis of the similarity of their preference functions. The similarity between individuals was measured as the Euclidean distance between the individuals in the preference function coefficient space (the space formed by the model's

Table 2. Conjoint Analysis Experiment Results for All Participants (N = 160)

Variable	Part-Worth Estimates (Relative Importance of Factors)
Price:	(17.64%)
$ .39	−.691
$. 79	−1.400
$1.19	−2.109
Damage:	(39.36%)
0%	0
1.6%	−1.488
3.4%	−3.162
Certification/Label:	(19.31%)
None	−.982
Government	.570
Private	.412
Pesticide Regulation:	(23.68%)
Current Standards	−1.042
Ban Carcinogens	.861
35% Reduction	.182
Predictive Accuracy, Correlation Coefficient:	.72

coefficients). Ward's method, which minimizes the sum of squared distances between individuals within clusters while maximizing squared distance between the clusters, was used progressively to join individuals into distinct clusters. This method generally results in clusters which are "tight"—that is, comprised of individuals whose preference functions are relatively similar to the average preference function for that cluster. Many other amalgamation rules exist and no one method is statistically superior. Moreover, it is difficult to statistically defend the clusters formed by any method. What is of interest is the stability of the clusters observed across different methods and when the sample is split into subsamples (Hair et al.). We observed similar clusters (in the sense that the average preference functions for the clusters are very similar although individuals may be assigned to different clusters) to those we report using several different methods and when the sample was randomly split in half.

Using the cluster analysis procedure described above, we identified three stable clusters; the average preference functions for the clusters are given in table 3. The analysis was performed using the StatSoft statistical package (StatSoft, Inc.). The correlation coefficients between the predicted and actual preference scores for the holdout samples for the three segments range from .87 to .61. All of the coefficients in the preference functions have the expected sign.

Examination of preference functions for each segment indicates that consumers in each segment value product characteristics very differently. Segment 1 consumers, representing 16% of the participants, are most concerned with pesticide usage; this factor has a relative importance of 68%. It is also clear from their part-worth scores that they would much prefer pesticide regulations which ban carcinogens to those which would limit pesticide usage in general. They are relatively unconcerned with the produce's appearance, place little value on certification and labeling programs, and are not price sensitive.

Segment 2 consumers, comprised of the majority of the respondents (55%), value the level of damage most highly. This factor has a relative importance of 54%. They also have a relatively strong preference for certification and labeling programs over changes in pesticide regulations. This indicates they believe that existing regulations are sound, but they want to ensure that produce is in compliance with established food safety reg-

Table 3. Conjoint Analysis Experiment Results by Segment

Variable	Part-Worth Estimates (Relative Importance of Factors)		
	Segment 1 (N = 26)	Segment 2 (N = 88)	Segment 3 (N = 46)
Price:	(5.75%)	(5.42%)	(43.09%)
$ .39	−.250	−.196	−1.888
$ .79	−.506	−.397	−3.824
$1.19	−.763	−.597	−5.761
Damage:	(15.77%)	(53.51%)	(29.26%)
0%	0	0	0
1.6%	−.662	−1.864	−1.238
3.4%	−1.408	−3.961	−2.632
Certification/Label:	(10.49%)	(26.71%)	(13.18%)
None	−.577	−1.219	−.753
Government	.359	.758	.330
Private	.217	.461	.428
Pesticide Regulation:	(68.00%)	(14.36%)	(14.47%)
Current Standards	−2.961	−.592	−.819
Ban Carcinogens	3.108	.470	.333
35% Reduction	−.147	.122	.482
Predictive Accuracy, Correlation Coefficient:	.87	.65	.61

ulations. Like consumers in segment 1, they are unresponsive to price changes over the experimental range.

Consumers in segment 3 are price sensitive and quality conscious (43% and 29% relative factor importance scores, respectively). The 29% of the respondents in segment 3 represent those consumers who are most likely to be satisfied with the current situation because the characteristics which they value most highly (price and quality) are currently reflected in the marketplace.

A comparison of the aggregate preference function (table 2) and the preference functions of the three segments described above indicates that the level of aggregation is very important in terms of the interpretation of consumers' preferences. The aggregate results for all respondents could be interpreted to indicate that consumers are primarily concerned with damage and that price, certification, and pesticide regulations are secondary factors. On the other hand, an examination of the individual consumer segments indicates that this description is not consistent with the preferences of any of the three segments described in table 3. Rather, the "typical" consumer described in table 2 represents a blend of the sharp differences between the preferences of the consumers in the three segments.

To determine whether consumers in the three segments differed by socioeconomic characteristics, we calculated chi-square statistics based on the distribution of consumers with various socioeconomic characteristics. Frequency tables were constructed to contrast consumers in one cluster versus all other respondents. Results are reported in table 4.

While it is difficult to generalize, these results yielded some interesting information. For example, segment 1, the group most concerned with pesticides, consisted of more women and high-income consumers than would be expected by chance. Home gardeners tended to fall into segments 2 and 3, representing consumers who were most concerned with price and quality characteristics. A possible explanation for home gardeners' apparent lack of concern about pesticides is that home gardeners are more familiar with agricultural pesticides and understand their importance in fighting agricultural pests. It was surprising to find that segment 3, the segment most concerned with price, consisted of more high-income consumers than would be expected by chance.

The above results have several important implications. Although several of the chi-

Table 4. Chi-Square Analysis of Socioeconomic Differences Between Segments

Variable	Relationship[a]		
	Segment 1	Segment 2	Segment 3
Gender: Female	+**		−***
Marital Status: Married			
Age			
Education			
Income	+*	−**	+**
Household Size			
Ethnicity: White		−**	
Home Gardener		+**	+**

Notes: Single, double, and triple asterisks (*) indicate significance at the 10%, 5%, and 1% level of probability, respectively.
[a] The sign indicates the direction of the relationship.

square statistics are significant, many are not. This would make any attempt to classify consumers according to a priori expectations difficult. This finding is consistent with many studies which have found that psychographic and behavioral variables are more appropriate bases for segmentation than demographic variables. Moreover, these psychographic and behavioral variables can vary widely within demographic groups (Kotler). Thus, it is often more fruitful to obtain a deeper understanding of *what* consumers value in addressing important issues such as food safety rather than to search for differences between consumer groups with different demographic characteristics. Furthermore, information concerning differences between consumer segments is only valuable if products (or policies) have been properly defined based on a clear understanding of consumers' desires.

Using Conjoint Analysis Results to Evaluate Policy Changes

The results of the conjoint and cluster analyses can be used to analyze a segment's response to policy alternatives. For example, we can determine how much consumers in segment 3 are willing to pay for reducing pesticide usage by 35%. The reduction in utility per 1¢ increase in price is calculated as the difference in utility between the prices of 39¢ and $1.19 (see table 3) divided by the price change of 80¢. Therefore, the decrease in utility score per 1¢ price increase is calculated as follows: $[-1.888 - (-5.761)]/(.80 \times 100) = .04841$. A similar calculation is performed to estimate the increase in utility generated by reducing pesticide usage by 35% relative to current standards of 1.301: $[.482 - (-.819)]$. Thus, consumers in segment 3 would be willing to pay for the policy change up to the point that the gain in utility from the reduction in pesticides (1.301) is completely offset by the loss in utility from the price increase, or 27¢ (1.301 divided by .04841).

It is important that values outside the range of the factor levels studied are not considered. For example, it is incorrect to conclude that a similar policy analysis for segment 1 consumers reveals that they would be willing to pay an additional $4.39 per pound of apples to reduce pesticide usage by 35%. Such a statement is not supported by the analysis since prices in the experiment ranged only from 39¢ to $1.19 per pound. More correctly, we can conclude that given an average apple price of 39¢ per pound, segment 1 consumers would be willing to pay at least an additional 80¢ per pound to reduce pesticide usage by 35%. Because the cost of such a change is unlikely to exceed 80¢, the actual amount consumers would be willing to pay is irrelevant. The variable ranges used in the study were limited to what was considered reasonable.

The CA technique also allows for analysis of complex realistic scenarios. For example, it is likely that any policy that drastically reduces or eliminates pesticides would result in some increase in damage. We can answer the following question: How much damage would be acceptable to consumers in segment 1 if a program to ban carcinogens was implemented costing an additional 20¢ per pound? The additional utility generated by banning carcinogens relative to current standards is 6.069. The disutility from a 20¢ price increase is −.128, leaving a total change in utility of 5.941 as a result of changes in price and pesticide regulations. Since damage decreases the utility score at a rate of .414 for every 1% increase in damage, the damage level could not exceed 14% (5.941 divided by .414). This level of damage is well out of the range we studied, but the result does indicate that consumers in segment 1 are willing to pay a price premium of 20¢ per pound as well as accept a reasonably high amount of damage in return for banning the application of probable carcinogens. However, similar analyses of consumers in segments 2 and 3 indicate they would accept less than a 1% increase in damage in addition to paying an increase of 20¢ per pound to ban carcinogens.

Concluding Remarks

This research has presented an individual level approach to studying how consumers value food safety product attributes. Conjoint analysis was used to develop individual consumer preference functions for fresh apple products in an experimental market setting in the San Francisco Bay Area. Cluster analysis was used to group participants into relatively homogeneous consumer segments based on the structure of their individual preference functions. The analysis yielded three distinct consumer segments. The study has also provided insight into the use of conjoint analysis and consumer segmentation for evaluating policy alternatives.

The results of our analyses have important policy implications. They imply that in developing policy, it may be more appropriate to address the needs of distinct consumer groups as opposed to the needs of the "typical" consumer as defined by aggregate models. While this will undoubtedly increase the number of policy options which must be considered, it should also result in alternatives which more closely meet consumer needs and which may be priced accordingly.

Our results indicate that while there were substantial differences between consumer segments regarding their willingness to pay for certified produce, individuals in all three consumer segments were willing to pay a substantial price premium to ensure that produce meets established safety standards. Consumers in segment 3, the segment willing to pay the least for testing and certification, were willing to pay an additional 22.5¢ per pound for the government to certify that apples met established safety standards. Furthermore, consumers in two of the three segments, representing over 70% of respondents, preferred government testing over private laboratory testing.

There was much less agreement on the subject of pesticide reduction. Only one segment, representing 16% of the sample, favored limiting pesticide usage and was insensitive to changes in price or quality. A second segment, representing 55% of respondents, favored reducing pesticide usage, but only if it resulted in virtually no increase in damage levels. Consumers in both of these groups showed a strong preference for banning probable carcinogens versus simply reducing the quantity of pesticides used as a method of pesticide reduction. The last segment, representing 29% of the sample, was willing to pay a relatively small amount for reducing pesticide usage, and then only if quality did not suffer.

These results suggest that a policy of restricting pesticide usage, such as the 35% reduction in pesticides or ban on carcinogens proposed in California, will be unpopular with most consumers unless it can be achieved at a very low cost and with very little increase in produce damage. On the other hand, this may indicate an opportunity for private firms to meet the needs of the pesticide-sensitive segment by marketing "reduced-pesticide" or "pesticide-free" produce.

Our research has several limitations. The small geographical area studied, the relatively small sample size, and the possibility of selection bias due to the use of an incentive payment limit our ability to make generalizations from the study's results. While it is likely that consumers in other markets also fall into distinct segments regarding their preference for food safety product attributes, these segments may be different than those determined in this study in terms of what characteristics are valued or how strongly attributes are valued. Furthermore, the sample was comprised of supermarket shoppers and therefore was not random. This is appropriate for designing products or policies which must meet the approval of consumers who make the buying decision, but the results should be interpreted cautiously in developing policy which affects the broader population.

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