Factor and Cluster Analysis of Willingness to Pay for Organic and Non-GM Food

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A large segment of consumers appear to value niche products including organic, "non-GM," "pesticide-free," and "no antibiotics used" more in fresh products than in processed. About ten percent of the respondents were especially interested in non-GM products. These consumers feel that GM labeling is important, but felt that other types of food labels were relatively unimportant. The non-GM audience defied easy demographic profiling. Data were collected by both surveys and experimental auctions, with factor analysis and cluster analysis used to interpret the data. The survey and experimental auction data yielded different willingness-to-pay values but showed similar patterns of consumer preferences.

The rapid growth in sales of organic food and the proliferation of genetically modified ingredients are two well-documented trends in the United States. In 2005, sales of organic food reached $13.8 billion in the United States, or 2.5 percent of total food sales, up from 0.8 percent in 1997 (Organic Trade Association 2006). Certified organic foods must not include GM ingredients or antibiotics use, and pesticide use is strictly limited. Virtually all types of organic foods have experienced double-digit growth rates while remaining a profitable niche market. Sales of non-GM food are harder to quantify, since labeling is voluntary, rare, and usually associated with another claim such as organic (Gifford and Bernard 2004).

Consumers who are well-educated about food choices can assume that nearly all processed foods contain some genetically modified (GM) ingredients and that the only way to be certain of buying non-GM is to buy organic food or, more rarely, foods that are not organic but are labeled "non-GM" or "no-GMOs." (Hallman et al. 2003; Gifford 2004). Another method often advertised with organic, and more rarely seen separately, is "no antibiotics used" with meat or dairy products. Pesticide use, an older but still often negatively viewed practice, has also attracted attention resulting in another niche market of variants on claims of "pesticide-free" or "pesticide residue free." While much research has been done on the topic of these niche markets, the information is often presented in such a way that direct comparisons between studies or products are difficult, and advice for marketing or decision-making is therefore limited. Studies also typically focus on just one of the technologies—such as GM, organic, or pesticide-free—separately, making direct comparisons difficult. Producers or food companies wishing to enter these profitable markets may assume that organic is the most attractive option, but the organic standards include the non-GM, no-antibiotics, and limited-pesticide requirements. Farmers or food companies could benefit from an understanding of the consumer's value for those individual traits of organic food and potentially serve the market without adhering to the stringent organic standards in their entirety. Only a direct comparison of the value of those traits within the same research study is likely to provide enough information to make such a decision.

This research provides a useful marketing profile of consumers who would pay a premium for niche products including non-GM and organic. Most studies examining willingness to pay (WTP) for a food product look at one or two types of food, making direct comparison between fresh and processed foods with similar ingredients (such as potatoes and potato chips) difficult. Our goal is to provide a within-subject comparison of willingness to pay for fresh and processed foods by comparing the same person's valuation of each. Another gap in the literature is a within-subject comparison of willingness to pay premiums elicited by different methods. Surveys and experimental auctions are two ways of determining willingness to pay, and for a product such as non-GM food they have been found to elicit different values. However, few

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studies directly compare within-subject values of willingness to pay for two different methods, making an objective criticism of either method more difficult. Our goal is to determine whether surveys and experimental methods yield similar values for willingness to pay. In order to achieve this objective, both survey and experimental auction methods of willingness-to-pay data collection were employed, as well as factor and cluster analysis and linear regression to aid in data interpretation and market segmentation.

Review of Past Studies

Lusk and Hudson (2004) discuss the common tendency of academic literature to focus on mean values of willingness to pay premiums and prices in spite of the fact that this is not necessarily what provides the most information about the market. Purveyors of organic or non-GM food are no doubt aware that not everyone will be interested in what they have to sell, much less be willing to pay a premium for it. However, if even a small number of consumers have high willingness to pay for the product, a market may exist; organic food currently represents only about two percent of food sold, but is a profitable niche market. In order for research to have practical interest to business concerns, it should report information such as the distribution of willingness-to-pay values and not just mean values. Umberger and Feuz (2004) evaluated several methods of collecting willingness-to-pay values and found that none translated perfectly to real markets. However, when investigating willingness to pay for more than one product at a time, they found that experimental auctions are a valid way to determine relative willingness-to-pay values for one product versus another. The premium for a particular product versus another is therefore a more useful result to present than the actual willingness to pay value or bid.

Lusk et al. (2004) conducted a meta-analysis by examining 25 studies of GM food, with a data set including 57 consumer values for GM food. Whether or not the willingness to pay elicitation method was real (with money at stake, such as in an auction) or hypothetical (such as a survey) was examined for its effect on price premiums for non-GM foods. The premiums were all analyzed in percentage terms. They found an average *worldwide* willingness-to-pay value of 29 percent for non-GM foods. However, the average value in the United States was much lower, eight percent. Conducting valuations in-person resulted in higher premiums than did collecting results by mail or over the phone. They also concluded that real, auction-elicited premiums were significantly lower than hypothetical ones *worldwide*, by as much as 40 percent. However, in the United States, hypothetical premiums were lower than those that were experimentally measured, at five percent versus nine percent. In a study not included in the meta-analysis, Rousu et al. (2004) found that a panel of Iowa consumers put a seven to 13 percent premium on potatoes and tortilla chips that were guaranteed free of GM content. This seven–13 percent range overlaps with the five–nine percent range seen in the meta-analysis results, suggesting that willingness-to-pay premiums for non-GM are fairly consistent in research studies.

One gap in the literature revealed by the Lusk et al. (2004) meta-analysis is that few studies have focused directly on whether a difference exists in willingness to pay for fresh or processed non-GM or organic foods. Most studies examine willingness to pay for one or a few food products, and rarely compare a fresh and processed food in the same study. The strongest volume growth in organic sales is in processed and packaged foods, but fresh, single-ingredient foods such as produce still represent the largest share of sales (Organic Trade Association 2006). In a *Wall Street Journal* article summarizing research on the potential benefits of organic food, processed foods were singled out as perhaps not worth buying (McKay 2007). Batte et al. (2007), however, found that consumers were willing to pay a price premium for processed organic foods, even those with only 70 percent organic content. The Organic Trade Association (2006) report also showed that although fruits and vegetables made up the largest volume of sales, 39 percent, their growth rate over the previous year was slower (10.8 percent) than that of some processed foods like snacks and packaged/prepared foods (19 percent), fresh meat (55 percent), and dairy (23 percent). A comprehensive USDA report (Dimitri and Greene 2002) showed premiums for organic foods ranging from ten percent to 217 percent depending on the type of food, while examples of organic products costing as much as 50 percent less than the conventional counterpart have also been noted (Brown and

Sperow 2004). In-store price premiums of non-GM food are harder to quantify, since labeling is voluntary, scarce, and usually associated with another claim such as organic.

Organic and non-GM are not the only niche products competing for consumer attention. Consumer concern about pesticides has also resulted in a product niche. In Canada, a set of rules for pesticide-free production (PFP™) was created in the late 1990s, but labeled products are still not commercially available. Magnusson and Cranfield (2005) found that consumers who were younger with higher income, and having higher education but not to the graduate level, were more interested in pesticide-free products. Health and environmental concerns were also predictors of interest in pesticide-free production products. In the United States, producers can make the claim “Grown without Synthetic Pesticides and Fertilizers” or “Pesticide Residue Free,” a market that continues to expand in certain regions such as California and the Pacific Northwest (Scientific Certification Systems 2004, 2006).

With the many niche products available in food—including organic, non-GM, pesticide-free, and others—it is possible to collect information about consumer willingness to pay or interest in many traits. Condensing the findings into a meaningful prediction or understanding of consumer interests is of practical interest, and one technique that can assist is factor analysis. Factor analysis allows a variable set to be reduced into a smaller set of variables (called factors) that attempt to explain as much about the data as the original, larger variable set. Hwang, Rowe, and Teisl (2005) analyzed consumer concern about eight food production and processing technologies using factor analysis and OLS regression. They conducted a mail survey with over 1,600 respondents, collecting ratings on a scale from one to five for levels of concern about antibiotics, pesticides, artificial growth hormones, GM ingredients, irradiation, artificial colors or flavors, pasteurization, and preservatives. The eight variables were subjected to factor analysis and reduced to three factors: growth hormones, genetic modification, and irradiation (the “HGI” factor); the older technologies of pasteurization, artificial colors and flavors, and preservatives; and antibiotics and pesticides. Not surprisingly, people who purchase organic foods had higher concern about the HGI factor. Other predictors of higher concern included lower income, female, non-white, middle-aged, having no children, and having some college but not post-graduate education.

In the United States, very few researchers have used cluster analysis to examine the market for GM foods. Baker and Burnham (2001) conducted a conjoint analysis of preference for corn-flake cereal using a mail survey with 448 respondents. A non-GMO trait was one of the possible attributes of the cereal. They identified three market segments called “Brand Buyers,” “Safety Seekers,” and “Price Pickers.” The “Safety Seeker” cluster represented about 30 percent of the sample, and was the market segment where the GM trait of the cereal was of significant concern.

Onyango et al. (2006) performed factor and cluster analysis on consumer acceptance of GM foods in South Korea. A sample of 1,054 respondents to a telephone survey provided the data. The analysis reduced 18 variables related to public perception of GM and other foods into six core factors accounting for 61 percent of the variance in the data. The six factors revealed that naturalness, purchase incentives (taste/health benefits), convenience, fear/risk, information seeking, and food adventurism all affect GM food choice. The factors were subsequently used in a cluster analysis showing that only 19 percent of the sample was specifically averse to GM foods, a segment dubbed “Biotechnology Apprehensives,” and an additional 28 percent, called “Food Naturalness Seekers,” strongly prefer natural or organic foods. The remaining two segments, “Food Adventurers” and “Biotechnology Information Seekers,” were more open to trying GM foods.

Methods

Data Collection

From September 2004 to May 2005, research sessions were held in Delaware, Pennsylvania, and Maryland, with groups ranging in size from 12 to 50 participants for a total of 154 subjects. The participants were recruited using classified ads and community connections for a food-marketing experiment with the promise of approximately $30 in payment. Table 1 presents the demographic and lifestyle variables collected from the respondents

Table 1. Socio-Demographic Variables.

Gender	%	Primary shopper	%
Male	44.2	No	36.4
Female	54.5	Yes	63.6
Income ($)	%	Community type	%
<10,000	2.6	Urban	11.6
10,000–14,999	4.5	Suburban	45.5
15,000–24,999	5.2	Rural	41.6
25,000–34,999	7.8		
35,000–49,999	14.9	Race	%
50,000–74,999	20.8	White	86
75,000–99,999	17.5	Black	3
100,000–149,999	17.5	Hispanic	2
150,000–199,999	2.6	Ind/Alask	1
200,000+	2.6	Asian	4
		Other	1
Education level	%		
Less than HS	4.5	Vegetarian	%
High School	17.5	No	87.7
Some College	20.1	Yes	11
College	41.6		
Post-graduate	14.3	Children under 18 at home	
		No	%
Age	Years	Yes	48.1
Range	18–81		51
Mean	38.8		
Standard Deviation	14	Ever lived or worked on a farm?	
		No	%
Marital status	%	Yes	63
Married	60.4		
Not married	37		

(due to missing values for some respondents, certain questions may not sum to 100 percent). The sample was diverse in terms of age, education, income, and gender—factors that have been found to affect preference for alternative agricultural production methods.

Each subject completed a questionnaire about willingness to pay for fresh and processed food produced in the following nine ways: pesticide-free, irradiated, using sewage-sludge fertilizer, non-genetically modified, country of origin USA, environmentally friendly, no antibiotics used, family-farm produced, and organic. The survey was considered an incoming willingness to pay because no information was given about any of the topics before the survey was administered. Since the terms were not defined for the subjects, a "don't know" option was provided for people who truly felt they had no knowledge of what the attributes meant. After completing the willingness-to-pay worksheet, a questionnaire covering attitudes and preferences toward labeling and other issues was administered. A short presentation was given in which each attribute was briefly described; subjects were told approximately how long each practice has been in use, how widespread it is, and whether labeling information about the practice is required, regulated, or allowed. Following the presentation, an auction was conducted in order to collect bids for versions of six food products (three fresh and three processed) that included non-GM, organic, conventional, and pesticide-free fresh plant products or "no antibiotics used" fresh animal products.

The willingness-to-pay questionnaire elicited values by having the subjects choose from a range of percentages they would be willing to pay for each attribute. The ranges were 1–5, 6–10, 11–20, 21–30, 31–40, 41–50, and 50+. Each range was offered twice on the survey sheet so that respondents could clearly indicate whether it was a percentage "more" or "less." It was explained that selecting, for instance, "6–10% less" for a pesticide-free product meant that the person would buy a product produced without pesticides as long as it was six–10 percent less expensive, and that selecting "6–10% more" meant that the person would pay a six–10 percent premium for a product grown without pesticides. A "0%" option was offered as well, meaning that the respondent would pay the same for a product with or without pesticides used. A "No Knowledge" option was also offered for people who were not familiar with the attribute. For ease of calculation, the midpoints of the percent ranges were used to calculate mean values, with "55" or "–55" used for the "50+" more or less selections, respectively. Two versions of the questionnaire were given, identical except for the headings "Fresh Foods (for example: meat, vegetables, fruit)" and "Processed Foods (for example: snacks, cereal, oils)." The goal was to determine whether certain attributes bring more value to fresh foods or processed foods in the mind of the consumer.

After the willingness-to-pay worksheet and the questionnaire about labeling, the participants were shown a short PowerPoint presentation defining each of the terms. The experimental auction procedure was also explained to the group. An n^{th} price auction extension of Vickrey's (1961) sealed-bid second-price auction was used. This was chosen because of the demand-revealing nature of its anonymous, simultaneous bid collection. Practice auctions were conducted so that subjects could be familiarized with the best strategy of bidding their true value for each item. A further discussion of the use of the Vickrey auction can be found in Bernard, Zhang, and Gifford (2006). The auction collected written bids for the three fresh foods (milk, corn, and potatoes) and the three processed foods (milk chocolate, tortilla chips, and potato chips). One food auction was randomly selected to be binding, and the person with the highest bid purchased that food product at the n^{th} highest price and received it at the end of the research session.

Analysis

Factor analysis allows for the examination of relationships between variables that may be correlated or associated with each other, providing a distilled set of variables that can explain variance in the data as well as why certain variables are related to each other (The University of Texas at Austin Statistical Services 1995; Bryant 2000). Factor analysis can be exploratory, as a form of data-mining and refinement, or confirmatory, when hypotheses are made about the data *a priori* based on existing theory. This study uses factor analysis as a confirmatory technique.

Common Factor Analysis (CFA) is used when one is not performing an exploratory analysis and wants information to be used in a testable model. The goal of Common Factor Analysis is to extract a small number of factors that explain why the variables are correlated with one another, and to use variables that are indicators of the latent constructs to be measured—variables such as scores on an attitude scale, or, in our case, bids, that may have some error in measurement. Each observed variable—in this case a premium for a particular food type—can be expressed as a weighted composite of a set of unobserved latent variables called factors (represented by "f"), such that

$$(1)\quad y_i = a_{i1}f_1 + a_{i2}f_2 + a_{i3}f_3 + a_{i4}f_4 + e_i\ ,$$

where y_i is the i^{th} observed variable on the factors and e_i is the residual of y_i on the factors.

It is common to choose a rotation type in order to maximize the variance of the squared loadings of a factor (column) on all the variables (rows) in a factor matrix. Each factor will tend to have either large or small loadings of any particular variable. Varimax rotation is an orthogonal rotation that yields a solution which makes it as easy as possible to identify each variable with the least number of factors possible, aiding interpretations. This is the most common rotation option. Furthermore, a z-score ranging from –3 to 3 can be calculated for each observation (in this case, each survey respondent) based on how well their responses fit with each factor. This information can be used for regression analysis.

The hypothesis is that at least three factors will be necessary in order to explain a sufficient amount of the common variance in the data. Bids for pesticide-free, no antibiotics used, and organic products are expected to be in one factor, following Hwang, Rowe, and Teisl's (2005) finding that concerns about pesticide and antibiotics use are related, and that both are well-known characteristics of organic food (Gifford 2004). It is hypothesized that premiums for non-GM will be in a separate factor, following Bernard, Zhang, and Gifford's (2005) finding that, once informed about the prevalence of non-GM, it emerges as a quality of high value. Finally, the premiums for fresh products are expected to be in another factor, since those are the largest component of organic sales (Organic Trade Association 2006) and, by extension, perhaps for other niche products as well.

Empirical Results

Data Description

Variables resulting from the first questionnaire are shown in Table 2. The variable "label importance" is the subject's mean rating of the nine traits referenced on the incoming willingness-to-pay survey, and represents the level of importance of labeling overall for the subject. Only six percent of the respondents had an average value lower than three; the remainder had an average value equal to or greater than three, with the overall mean for the sample equal to 3.44. The perceived health risk from pesticide use and genetically modified foods was more evenly distributed, with the mean for the sample falling above the midpoint of the scale for pesticides and slightly below for GM food, suggesting that consumers are not as concerned about GM food as they are about pesticide use.

The next four variables deal with consumer interest in organic foods. Consumers have a positive opinion of organic food, and value its labeling. Knowledge of organic still tends to be limited to the three traits pesticide-free, no antibiotics used, and not irradiated. Consumers are less knowledgeable about the rule that organic must be non-GM and that sewage-sludge fertilizers must not be used, the remaining two points. The survey respondents place a relatively high average importance on those five points of the organic standards, significantly above the midpoint of the scale. The last three variables in Table 2 deal with genetically modified food. Importance of non-GM labeling rates slightly above the midpoint of the scale, and the opinion of GM food falls slightly below the midpoint of the scale. Nearly half of respondents, 45 percent, gave it exactly a "3" rating, indicating that a large portion of respondents have a neutral opinion of GM food.

The mean willingness-to-pay values for fresh and processed versions are shown in Table 3. Organic products can be found bearing price premiums similar to those seen in the survey and auction, ranging from ten to 20 percent, although many products sell for higher premiums as well (Dimitri and Greene 2002; Brown and Sperow 2004). All premiums were tested to determine whether they were significantly greater than zero, and all were significant at least at the five-percent level.

Table 4 shows the breakdown of how many re-

Table 2. Description of Attitude Variables.

Variable	Description	Mean	Std. dev.	Range
label importance	Importance of food labeling of 9 separate traits from survey; 1 = Not at all, 5 = Very	3.44	0.80	1.44–5
hrpest	Perceived health risk from pesticides; 1 = Very low, 5 = Very high	3.66	1.05	1–5
hrgm	Perceived health risk from GM food; 1 = None, 5 = Very high	2.84	1.09	1–5
orglab	Importance of organic food labeling 1 = Not at all important, 5 = Very important	3.40	1.31	1–5
orgopin	Opinion of organic food; 1 = Very negative, 5 = Very positive	3.85	1.01	1–5
orgknow	Self-reported knowledge of 5 points of organic standards (sum of points known)	3.08	1.38	0–5
orgstand	Importance of the organic standards 1 = Not at all, 5 = Very important	3.93	0.91	1–5
ngmlab	Importance of non-GM food labeling 1 = Not at all, 5 = Very important	3.31	1.28	1–5
gmopin	Opinion of GM food; 1 = Very negative, 5 = Very positive	2.80	1.06	1–5
recall	Knowledge of whether there has ever been a GM food recall, 0 = no 1 = yes	0.22	0.41	0–1

Table 3. Mean Premiums from Surveys and Experimental Auctions (%).

Type of premium (all)	Auction	Survey
fresh organic*	18.8	8.7
processed organic	12.9	6.6
fresh non-gm	7.0	4.4
processed non-gm	6.3	3.4
fresh no antibiotics used	9.9	8.2
processed no antibiotics	.	6.1
fresh pesticide-free	13.5	9.6
processed pesticide-free	.	6.5
fresh organic *over non-gm*	9.8	.
processed organic *over non-gm*	8.1	.

*Unless otherwise stated, all percentages are the premium over a conventional product.

Table 4. Distribution of Fresh and Processed WTP (%).

	Organic		Non-GM	
	Survey	Auction	Survey	Auction
Higher WTP for fresh	18	51	25	55
Same WTP for fresh and processed	56	17	63	6
Higher WTP for processed	9	30	9	37

spondents had a premium for fresh over processed food in the survey or auctions. In the survey, only 18 percent of respondents had a higher premium for the fresh organic product versus a processed one. However, in actual bidding, about half the respondents had a premium for fresh over processed for organic food, while 17 percent had equal value for fresh or processed. For non-GM food, the shift was even more dramatic. While over half of the respondents had equivalent premiums for a fresh or processed non-GM product on the incoming survey, the number dropped sharply to 6 percent in actual bidding.

The distribution of premiums for fresh organic products from both the survey and auction are shown in Figure 1 for organic and Figure 2 for non-GM. About 25 percent of the subjects bid a premium of at least 45 percent for organic over conventional. Very few respondents had a willingness to pay close to zero for organic. By contrast, for non-GM, over 40 percent of respondents had a willingness to pay close to zero (selecting –3%, 0%, or 3%), and only six percent of the sample had a willingness to pay of 45 percent more for non-GM over conventional in bidding.

Factor Analysis

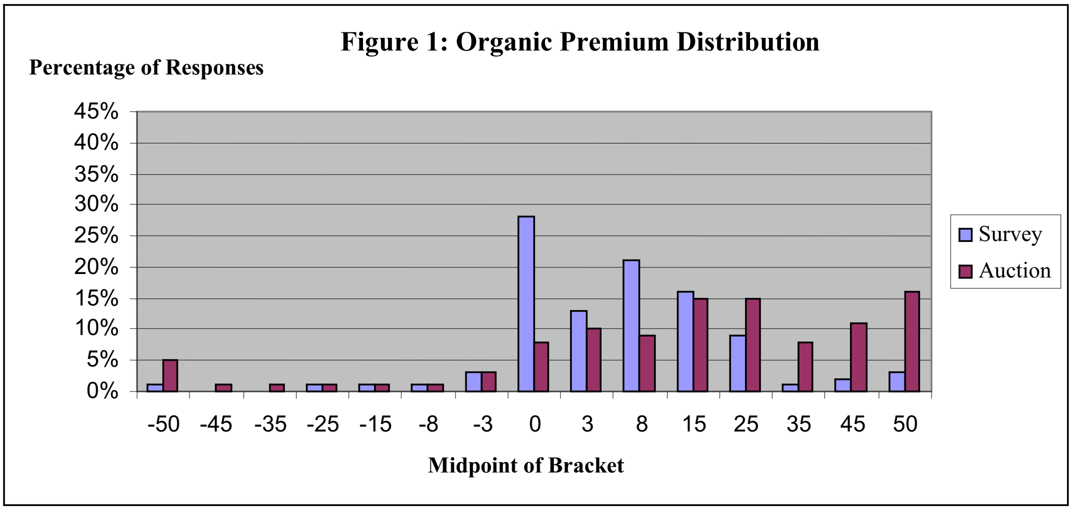
A total of sixteen premiums were collected from each participant, including the eight hypothetical values on the incoming survey and eight through bidding in the experimental auctions. These values are shown in Table 3. All premiums were in the same units (percent) and possibly correlated with each other, providing a suitable situation for factor analysis. SAS Proc Factor was used for factor analysis. The four factors together (shown in Table 5) explain 72.4 percent of the variance in the data, above the commonly chosen cutoff point of 70 percent.

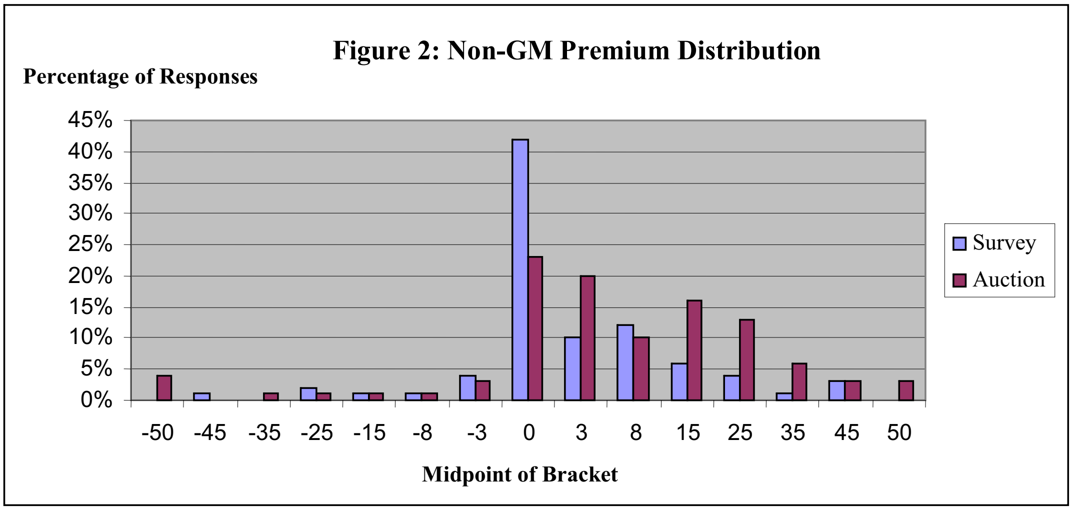
Factor 1, dubbed "Thinker," shows that willingness-to-pay values on the incoming questionnaire were highly correlated with each other. Factor 2, "Bidder," shows that most bids in the experimental auction were likewise correlated with each other. The willingness-to-pay premiums on the incoming survey are distinctly in a separate factor from the bidding behavior. This indicates that while almost as much information can be gained by asking one or two survey questions as from asking eight, or collecting one or two bids as by collecting eight, the survey willingness-to-pay values do not correlate well with the bidding values.

Factor 3, "Freshness," shows that bid premiums for fresh products were grouped together in a factor that excludes the premiums for the processed products. Factor 4 is the only factor to combine bidding and incoming survey behavior, and shows a segment that finds non-GM especially appealing. This is called this the "Non-GM" factor. As part of the factor analysis examination in SAS, a score representing how well each survey respondent fits into each factor is calculated. This score for each factor can then be modeled using standard regression analysis (with the factor score as the dependent variable) to determine what demographic and attitude variables predict each survey respondent's score for the "Thinker," "Bidder," "Freshness," and "Non-GM" factors.

Regression Analysis

The results of an OLS regression of each respondent's score, representing how well their responses matched each factor, are shown in Table 6. Two separate models were run, one for demographic variables and one for attitude variables, in order





to directly compare the model fit and determine which type of variable is better suited for analyzing preferences.

As education level increased, so did the "Thinker" factor's score. Being vegetarian was a weak predictor, at the 10 percent level. This suggests that consumers who are more highly educated or vegetarian may have more value for alternative agricultural methods such as organic or non-GM. Having lived or worked on a farm decreased the score, suggesting that closer relationship to food production may lower the value of alternative agricultural methods. The "Bidder" factor was negatively predicted by having children and by being married, suggesting that these subjects place a lower value on the organic and non-GM products. Perhaps these consumers are more budget or cost conscious. The "Freshness" factor was positively predicted by the presence of children in the household or by increasing age of the respondent. As income increased, the "Freshness"

Table 5. Results of a Varimax-Rotated Common Factor Analysis.

Type of premium (all)	Factor loadings			
	Thinker: Factor 1	Bidder: Factor 2	Freshness: Factor 3	Non-GM: Factor 4
Bids				
y_1 fresh organic	.	0.774	0.529	.
y_2 processed organic	.	0.937	.	.
y_3 fresh non-gm	.	0.481	0.419	0.439
y_4 processed non-gm	.	.	.	0.510
y_5 no antibiotics used (fresh only)	.	0.330	0.717	.
y_6 pesticide-free (fresh only)	.	.	0.827	.
y_7 fresh organic over non-gm	.	0.730	0.440	.
y_8 processed organic over non-gm	.	0.884	.	.
Incoming				
y_9 fresh organic	0.865	.	.	.
y_{10} processed organic	0.867	.	.	.
y_{11} fresh non-gm	0.489	.	.	0.713
y_{12} processed non-gm	0.366	.	.	0.729
y_{13} fresh no antibiotics	0.796	.	.	.
y_{14} processed no antibiotics	0.841	.	.	.
y_{15} fresh pesticide-free	0.768	.	.	0.302
y_{16} processed pesticide-free	0.649	.	.	.
Variance Explained	31.5%	25.0%	9.0%	6.9%

factor decreased. For the "Non-GM" factor, married people and vegetarians have a lower predicted score. None of the variables—gender, being the primary shopper, or community type—were significant in any of the models.

Opinion and knowledge variables (Table 2) were expected to be better at predicting the factors. The model using attitude variables did have higher F and R^2 values, denoting a better fit for the data. A desire to see organic labeling, higher perceived health risk from pesticides, and GM ingredients significantly increased the "Thinker" score. Opinion of organic and importance of organic labeling significantly increased the "Bidder" score. For "Freshness," overall labeling importance, knowledge of organic, and importance of the organic standards were important. Knowledge decreased the factor but the subject's opinion of the importance of the organic standards increased it, suggesting that consumer behavior is based more on opinion or emotions than on rationality. For the "Non-GM" factor, only a desire to see non-GM labeling and a relatively low rating of the importance of other types of labeling were weakly significant.

Cluster Analysis

Cluster analysis is a technique that allows for the segmentation of observations by how well they align with a chosen set of explanatory variables (Hair and

Table 6. Regression Analysis of Factors by Demographic and Attitude Variables.

	Factors			
	Thinker	Bidder	Freshness	Non-GM
Demographic				
male	-1.2755	0.02444	-0.14014	-0.14152
children	-0.02396	-0.26071*	0.32794**	0.09416
age	-0.2026	0.01088	0.02859***	-0.00052
married	-0.0094	-0.71544*	0.25337	-0.74135**
education	0.3097**	-0.03642	0.12956	-0.01474
income	0.00225	0.04234	-0.23576***	0.04205
primary	0.08603	0.36396	0.23922	-0.20139
community	0.24488	-0.18012	-0.17609	0.11922
veget	0.8399*	-0.19880	0.56614	-1.03695*
farmer	-0.685***	0.10782	0.09314	-0.31397
F	2.44	1.70	2.82	1.14
R^2	0.2428	0.1826	0.2708	0.1303
Attitude				
label importance	0.04928	-0.19242	0.57151**	-0.54407*
perceived health risk from pesticides	0.2776**	0.21491	-0.05855	-0.08294
perceived health risk from biotechnology	0.15449	-0.05210	0.08303	0.16641
organic labeling importance	0.3169**	0.31955**	-0.15512	0.18942
opinion of organic food	0.0624	-0.27358*	0.00725	-0.01251
self-reported knowledge of organic methods	0.1332	-0.03465	-0.23510**	0.04714
importance of the organic standards	-0.03026	-0.25765	0.38423**	0.08494
importance of labeling non-GM	-0.24644*	0.09895	-0.13451	0.27574*
opinion of GM foods	-0.14998	0.18501	0.00302	-0.17707
knowledge that there has been a GM recall	0.30722	-0.23985	0.41329*	0.26036
F	4.32	1.54	3.45	2.34
R^2	0.3653	0.1704	0.3151	0.2378

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Black 1998). In this case, we are using the factors identified in factor analysis to segment consumers, because one subject may have high scores on more than one factor. Common criticisms of cluster analysis are that it is not a robust statistical method and is highly dependent on the choice of explanatory variables and the clustering method, and that it is more difficult to extend the results of cluster analysis to a larger population than it is for other statistical techniques such as regression analysis. However, cluster analysis is appealing because it allows for the sorting of observations into distinct groups. In this case, six clusters were needed to sort the sample. Only three were large enough to have interesting implications (Table 7).

The largest cluster, Cluster 2, contained the majority of the sample, with 70 percent of subjects fitting into the cluster. The key factor in this component is "Freshness," as the only factor with a positive value. This result shows that a majority of people care about fresh products more than they do about processed, no matter which niche attribute the products possess. However, the magnitude of the effect was small, indicating that fresh products may obtain a small but statistically significant price premium with most consumers. The only other two clusters with a high enough percentage of observations to be worth reporting were Clusters 1 and 3. In Cluster 1, we see that about 14 percent of the survey participants care specifically about the non-GM trait and tended to have higher auction premiums than hypothetical premiums. Cluster 3 represents the opposite type of consumer, about 10 percent of the sample, who has higher willingness to pay in the survey than they do when actual money is at stake.

Conclusions and Implications

From a marketing standpoint, several easy-to-observe variables—such as gender and community type—were not good indicators of a target audience for the generally more expensive organic and non-GM products. However, the fact that single, childless people are likely to bid more for all the specialty products (the "Bidder" factor) suggests that targeting advertising to this group may be effective. Having children and being older did increase the score for the "Freshness" factor, so promotion of fresh, single-ingredient foods that are organic or non-GM could be targeted to this audience. From the attitude model, organic labeling and pro-organic messages about the importance of the organic standards could increase this factor further.

For the "Non-GM" factor, no simple target audience can be found, since non-married and vegetarian were the only weak predictors. However, the model showed that non-GM labeling would specifically appeal to this group, a designation that is currently scarce and usually paired with organic on label information. This study suggests that a separate non-GM market may exist, a niche that has not been heavily promoted in the United States. Currently, pesticide-free products can be found at least regionally in the United States, and certification is available for such products. But in this research, factor analysis showed that non-GM emerged as a factor, whereas pesticide-free did not; the growth in sales of pesticide-free products may therefore be more limited. If certification for non-GM can be developed and made available, it appears that a market does exist. It is likely to be a much smaller market than organic, because the portion of respon-

Table 7. Three Largest Clusters Resulting from FASTCLUS Procedure.

	1: Bids & non-GM	2: Freshness	3: Thinker
% of sample	14.3	70.3	9.9
Factor1: Thinker	–0.47	–0.26	2.20
Factor2: Bidder	1.36	–0.24	0.28
Factor3: Freshness	0.20	0.04	0.35
Factor4: Non-GM	1.02	–0.22	0.64

dents with high willingness to pay for non-GM was much smaller than for organic, at six percent versus 40 percent.

The study found a definite contrast in the data collected through surveys and through experimental auction data. The number of respondents willing to pay a premium for fresh versus processed products increased dramatically for bidding data versus survey data. However, in this experiment, that result could be the result of new information given in a presentation to participants after the survey and before the auction. By their own reporting, about one-third of respondents said that participating in the session increased their willingness to pay for each of organic and non-GM. It was not explicitly asked whether this increase was for fresh or processed products, but it appears from the data that significantly more benefit accrued to the premium for fresh products than for processed.

The factor analysis also showed that all the incoming willingness-to-pay values from the survey were in one factor. This finding means that asking about one or a few of the traits could provide as much information as asking about all eight. Much more information was obtained from the experimental auctions, and separate traits became more important than others, chiefly whether a product was fresh and whether it was non-GM. This research lends support to experimental auctions as an effective technique for determining willingness to pay for individual traits relative to each other. This research further supports the evidence of Lusk et al. (2004) that, at least in the United States, hypothetical premiums are lower than real premiums and that experimental auctions will actually provide higher willingness-to-pay values than will surveys.

The combination of factor- and regression-analysis techniques seems to be an effective method to test for relationships between willingness to pay for various food attributes. Cluster analysis reinforced the finding that fresh niche foods may be more popular than processed ones and that price premiums obtained by surveys and auctions may capture willingness to pay differently.

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