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Who Should Certify the Safety of Genetically Modified Foods?

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Abstract

Two methods of addressing consumer concerns regarding the use of genetically modified foods are evaluated using conjoint analysis – the use of a familiar brand and government certification. In one survey, consumers were asked to rate hypothetical products based on brand, price, and production technology attributes. In a second survey, consumers rated hypothetical products that included government certification, price, and production technology attributes. Both the individual and aggregate results indicate that government certification would be more effective at assuaging consumers concerns than would the use of a familiar brand, although a familiar brand was sufficient to address consumer concerns for a significant number of respondents. The analysis also indicated that different factors are associated with strong consumer preferences for a familiar brand and government certification.

Keywords: branding, certification, consumer demand, genetically modified food, GMO

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Introduction

The introduction of genetically modified organisms (GMOs), that is organisms with DNA from foreign organisms, has been received with mixed reaction by consumers. Nonetheless, in the U.S., farmers have increasingly adopted genetically modified (GM) varieties. In 2003, plantings of GM corn, soybeans, and upland cotton are estimated to represent 38%, 80%, and 70% of acres planted (U.S. Department of Agriculture, National Agricultural Statistics Service, 2003), respectively, up from 25%, 52%, and 56% in 2000 (U.S. Department of Agriculture, National Agricultural Statistics Service, 2000). GM food products have, for the most part, received little attention from the media and consumer groups in the U.S. The introduction of bST and the inadvertent use of the GM StarLink corn in Taco Shells are two notable exceptions. On the other hand, some U.S. companies have fueled the debate by advertising that they will not use GM food ingredients. Gerber puts "NO GMO's" labels on its baby food, whereas Ben and Jerry's products include the statement "The family farmers who supply our milk and cream pledge not to treat their cows with rBGH."

The reaction in Europe has been much more severe. In the U.K., two of the three major supermarkets have bowed to consumer pressure and promised that their house-brand meat and dairy products will be produced from animals that will not receive GM feed (Moore). Furthermore, the European Union had imposed a moratorium on the introduction of new GM crops since 1999. In April, 2004, a law passed by the European Parliament required that food products with GM content of greater than 0.9% include the label "This product contains genetically modified organisms."

Food Quality Attributes

In considering how to convey product attribute information to consumers, it is important to distinguish between the different types of attributes. Nelson classified attributes as either search or experience. Search attributes are those characteristics whose qualities can be discovered during the search process, prior to the purchase of a good. On the other hand, experience attributes may only be determined after purchasing the product. Using fresh apples as an example, color and external blemishes would be search attributes, whereas flavor and sweetness would be experience attributes. Darby and Karni identified a third category of attributes, which they call credence attributes. They define credence attributes as "those which, although worthwhile, cannot be evaluated in normal use." Credence attributes are not easily discovered by consumers or are discovered only at great cost. Caswell argues that food safety and food process qualities are credence attributes because consumers cannot reliably determine the process used, nor evaluate its quality. Likewise, nutrition is a credence attribute (Caswell and Mojduszka).

The production of foods using biotechnology, or GMOs, is considered a credence attribute because in most cases consumers cannot easily ascertain the process by which the food is produced. While there may be some noteworthy exceptions, as would be the case if a GMO yielded a product with a distinct color or shape, in most cases the production process is not detectable by consumers or is detectable only with considerable effort or expense.

Private markets for quality attributes often perform inefficiently because of "imperfect information, transaction costs in acquiring and using information, and externalities" causing policy makers to search out remedies (Caswell and Mojduszka). Such remedies include mandatory disclosure of information, controls regulating voluntary information claims, providing public information, subsidies for providing information (Caswell and Mojduszka), published guidelines indicating the types of acceptable claims, and a prohibition against deceptive claims (Caswell).

The roles of government and private firms in providing information to consumers on food quality credence attributes are not well defined. Government often assumes a role in the provision of information, perhaps because it is perceived as a reputable certification agent (Caswell and Mojduszka).

Previous Research

A number of U.S. studies have examined consumer response to GM foods and generally concluded that there is limited resistance to such foods. Baker and Burnham concluded that, given detailed information on the production technology, up to one-third of U.S. consumers may base their purchase decision on the GM content of food. The International Food Information Council Foundation, which has tracked U.S. consumer opinion on biotechnology since 1997, has found that public opinion has remained fairly stable with a small majority of consumers indicating that they would be likely to purchase produce that has been modified using biotechnology to make the food taste better or fresher (IFIC).

Several studies have assessed the response of consumers outside of the US to GM foods and have generally found that these consumers have a much greater aversion to GMOs than do U.S. consumers. McCluskey, et al. reported that Japanese consumers required discounts of at least 50% in order to purchase GM noodles and tofu. Noussair, Robin, and Ruffieux found in a study of French consumers that providing information that a food was genetically modified decreased willingness to pay by approximately 20%.

Prior research yields some insight into consumer valuation of various labeling schemes as they relate to the use of biotechnology. Huffman et al. evaluated the use of mandatory and voluntary labeling of GM foods and show that in the U.S.

voluntary labeling would be more efficient because it is less expensive but still gives consumers the information they need to choose between GM and non-GM foods. In a study of French, German, and British consumers, Roosen, Lusk, and Fox evaluate the use of private brands, labels of origin, and mandatory labeling of beef from cattle fed GM crops. They found that consumers in all three countries placed greater importance on labels of origin than brands and that the importance of both brands and labels of origin increased with consumer concern for production technologies. The vast majority of consumers in France, Germany, and the U.K. desired mandatory labeling of cattle fed GM crops (95%, 93%, and 83%, respectively). In surveys of Utah and U.K consumers, Christensen found that in the U.S., federal and state governments were the most trusted groups for certifying food safety. Conversely, consumers in the U.K. generally had lower confidence in the government to ensure food safety and placed greater trust in private organizations and special interest groups.

Research Objectives

The results of previous research indicate that there is some level of resistance to GM foods in the U.S. and that most U.S. consumers would benefit from being provided information regarding whether the foods they consume are the products of genetic engineering. However, it is not clear that U.S. consumers are willing to pay much for information relating to how their foods are produced. Furthermore, it is not clear which type of organization is best positioned to provide such information. Previous research has examined consumer preferences for labeling of GM content and the level of trust in various types of agencies. The motivation for this study is to explore the effectiveness of private brands and government certification in assuaging consumers' concerns regarding the safety of GM foods. Specifically, the objectives of this research are to examine the extent to which a familiar brand and government certification may lessen consumer concern over the safety of a GM food. Factors that influence consumers' preferences for branding and government certification are also explored. This information will be useful to food companies in determining whether consumer trust in their brands is sufficient to offset concerns related to GM technology. Likewise, policymakers may use the results of this study to determine whether the certification of the safety of GM foods is a role best fulfilled by the government.

In the following section, the application of conjoint analysis to the research problem is discussed. This is followed by the development of the specific model used in the research in the section entitled Theoretical and Empirical Models. The Procedures section contains detailed information on the implementation of the survey that was used to collect the data. Finally, the results of the analysis are presented in the Results section and discussed in the Conclusions and Implications section.

Methods

Stated preference methods have been widely applied to problems of consumer choice when revealed preference data are not easily obtained. Stated preference methods have been used for evaluating hypothetical products, hypothetical product characteristics, products for which no market exists, or proposed policies that may result in new products or product characteristics. In this paper, conjoint analysis, one of many stated preference methods, is used to elicit consumer preferences for the two means of addressing consumer concerns regarding GM food products identified in the previous section.

Conjoint analysis (CA) has been used to evaluate a wide range of hypothetical products and product characteristics (Hair et al.) including food products such as apples (Baker), corn flakes (Baker and Burnham), and salmon (Anderson and Bettencourt). CA is frequently used to model consumer choice because it allows researchers to realistically assess consumer response to new products and new product characteristics without the expense and time involved in product development and test marketing. Several disadvantages of the CA method should also be noted. They include the possibility of hypothetical bias, respondent ratings that vary with the measure of respondent preference (rating, ranking, or discrete choice), and inconsistent respondent ratings across product profiles.

CA surveys are typically designed so that subjects are presented with realistic product choices, similar to what they would experience in a retail shopping environment. Subjects are asked to express their preferences for these hypothetical products, represented by bundles of attributes, by rating or ranking them. Multiple observations for each subject permit the estimation of a utility function for each individual and an estimate of how each attribute is valued.

In this research, we chose a simple and straightforward design involving two surveys designed to independently assess the effectiveness of marketing GM food products under a familiar brand and with government certification. Our purpose was to minimize the possibility of respondent confusion by constructing separate surveys for the brand and certification questions and limiting the number of attributes and attribute levels.

In the first survey, consumers were presented with hypothetical banana products that included a GM alternative sold either as an unbranded product or marketed under a familiar brand name. In the second survey, unbranded hypothetical banana products were presented that included either government safety certification or no safety certification. Bananas were chosen as the product because they met two criteria, consumer familiarity with the product and the presence of a familiar brand. Furthermore, to the best of the authors' knowledge there were no GM bananas

marketed in the U.S. at the time of the survey and there had been very little discussion in the media of GM bananas.

Hypothetical products are developed by choosing product attributes and attribute levels so that the hypothetical products are realistically and fully described. However, the desire for realism must be tempered by the need to keep the number of products (combinations of attributes and attribute levels), which subjects must evaluate, to a manageable number. This is typically accomplished by omitting attributes that are unimportant to consumers and holding constant other attributes. Because we conducted separate surveys for the brand and certification attributes and limited the number of attributes and attribute levels, we were able to use a full factorial design could in both surveys. The most important product attributes were determined by surveying a small sample of 20 consumers in September 2001. The most frequently mentioned observable attributes for bananas included, color, brand, size, and price.

In the first survey (brand survey) three attributes were chosen to describe the hypothetical banana products: brand, a variable representing the production technology, and price. The attributes were chosen to address the underlying research question, that is, to permit the analysis of the tradeoffs consumers make among the choice of brand, production technology, and price. The color and size attributes were held constant; all banana products were described as yellow, firm, and of medium size.

The objective of the second survey (certification survey) was to evaluate the extent to which government certification might assuage consumers' GMO fears. Again, three attributes were chosen to describe the hypothetical banana products. Like the first experiment, production technology and price attributes were specified, but a certification attribute was substituted for the brand attribute. Because brand was not included in the second version of the survey, it was necessary to hold brand constant. All banana products were described as unbranded, yellow, firm, and of medium size.

Two attribute levels were selected for each attribute. For the brand attribute, the bananas were described as either "unbranded," indicating that they were grown by an unidentified grower or "Chiquita brand," indicating that they were grown by Chiquita. To determine the price levels, an informal survey of banana prices at several supermarket chains around the U.S. was conducted in October, 2001. Based on the results of the survey, price levels of $0.39 and $0.59 per pound were established, representing the low and high ends of the price range at the time of the survey. The great majority of non-sale prices for bananas fell within this price range. Because most previous research has indicated that consumers were willing to pay only relatively small price premiums for attributes such as labeling or certification, a spread of approximately $0.20 (a margin of approximately 50 percent

over the lower price) was deemed sufficient, given the other variables in the models. For the production technology attribute, the bananas were described as either "conventionally produced" or "genetically engineered." Conventionally produced bananas were described as developed using traditional breeding techniques. Genetically engineered bananas were described as developed using modern biotechnology techniques (commonly used to alter specific genes in order to increase production, provide disease resistance, or enhance nutritional value). The two levels for the certification attribute were "no certification" and "FDA certified." No certification was described as not including a label and indicating that no special testing had been conducted to ensure that the product was safe for human consumption. FDA certified was described as being labeled "FDA Certified," and indicating that the product had undergone special testing by the Food and Drug Administration to ensure that it was safe for human consumption. The term "special testing" was used to indicate that additional testing was conducted to ensure that the GM food was safe. This could be an important distinction for consumers who are aware that all food products approved by the FDA are considered safe.

The possibility of interaction effects between the attributes was explored by conducting a pilot survey with a small sample of 25 people in October, 2001. For each pair of attributes, respondents were asked to rate their preference for each level of one attribute at each level of a second attribute. Strong interaction is indicated when the rank order of the ratings for one attribute varies with the level of a second attribute. No interaction effects were evident among the attributes in this study.

A full factorial design was used resulting in 8 hypothetical products. The survey was designed and subsequently pretested in October, 2001 using a group of 10 people to ensure that the instructions were clear and the survey was easy to complete. A follow up discussion with the group resulted in several improvements to the survey.

Theoretical and Empirical Models

Random utility theory provides the basis for modeling consumer choices. Consumers are assumed to maximize utility as expressed in the following equation:

(1) $U_{ij} = V_{ij} + \varepsilon_{ij}$

where U_{ij} represents the utility of the ith individual for the jth alternative. Utility is partitioned into two components, a systematic component V_{ij} that is a function of product attributes and sociodemographic characteristics, and a random component ε_{ij}. (Louviere, Hensher, and Swait).

V_{ij} may be expanded as follows:

$$(2)\quad V_{ij} = \sum_{k=1}^{K} ß_{ijk} a_{ijk}$$

where a_{ijk} represents the kth attribute for the ith individual for the jth alternative and the ßs are corresponding utility parameters that may vary with individual sociodemographic characteristics.

The empirical consumer choice models for the two experiments described in the previous section follow from equation (2). The brand model is specified as:

$$(3)\quad P_i = ß_{i1} + ß_{i2}BRAND + ß_{i3}PRICE + ß_{i4}TECHNOLOGY + \varepsilon_i, \text{ for } i = 1, \ldots, I,$$

where P_i is the preference rating for the ith individual (scale of 1 to 10, with 10 being most preferred), *BRAND*, is a binary variable indicating whether the product was branded or not (1 if Chiquita brand, 0 if unbranded), *PRICE* is the price per pound (either \$0.39 or \$0.59), and *TECHNOLOGY* is a binary variable representing the production technology (1 if genetically engineered, 0 if conventionally produced).

The empirical model for the certification model is specified as:

$$(4)\quad P_i = ß_{i1} + ß_{i2}CERTIFICATION + ß_{i3}PRICE + ß_{i4}TECHNOLOGY + \varepsilon_i, \text{ for } i = 1, \ldots, I,$$

where *CERTIFICATION* is a binary variable indicating whether the product was certified (1 if FDA certified, 0 if not certified).

Procedures

Two surveys were constructed as described in the Methods section. In both cases, the eight hypothetical products consisted of three attributes each with two attribute levels. Survey recipients, who received only one of the two surveys, were instructed to rate each of the banana products on a scale of 1 to 10, with 10 representing the most preferred and 1 representing the least preferred alternative. The bananas were described as being either yellow, firm and of medium size (brand survey) or as unbranded, yellow, firm and of medium size (certification survey). Each of the eight alternative hypothetical products was described, using the attribute levels as descriptors, with a space provided for the respondent's rating. The survey also included questions regarding sociodemographic characteristics, knowledge of biotechnology, risk averseness, trust in government and private companies, and new product adoption.

The survey was mailed with a letter that encouraged the recipient's participation in the study and provided instructions for completing the survey. A postage-paid

return envelope was also provided. A follow-up post card was mailed after approximately one month to encourage non-respondents to complete and return the survey.

The survey was conducted in two batches using mailing lists purchased from reputable private companies that acquired the names and addresses from multiple sources, including telephone directories, credit card records, courthouse records, and other public sources. The first mailing of 1,000 surveys was sent in November, 2001 with a second mailing of 2,000 surveys following in May, 2002. A total of 586 surveys were returned yielding 567 usable responses, 279 for the brand model and 288 for the certification model. After accounting for the 466 inaccurate addresses, the net response rate was 22.4%.

Sample statistics for the survey respondents and the U.S. population are presented in table 1. Because surveys were only sent to individuals who were at least 18 years of age, we would expect some differences between the survey sample and the U.S. population. As expected, the median age of respondents in our sample was higher than that of the U.S. population. Participants in our survey were also more highly educated as compared to the U.S. population. However, there was roughly the same percentage of women in our sample as in the nation as a whole.

Table 1: Sociodemographic Characteristics of Survey Respondents and U.S. Population

Characteristic	Survey Sample (N=567)	U.S. Population*
Gender (% female)	53.3	51.2
Median Age (years)	49.6	35.7
Completed High School (%)	98.1	82.1
Ethnicity (%)**		
• African-American	4.4	
• Anglo-American	73.2	
• Asian	5.7	
• Hispanic	3.8	
• Other	13.0	

*U.S. Department of Commerce, 2001.
**Ethnicity data are not reported for the U.S. population because of differences in how the data are categorized.

Comparisons of sample statistics for respondents to both surveys were made to determine whether there were any statistically significant differences in sociodemographic characteristics between the two samples. The characteristics of the two samples were compared with respect to age, gender, percentage who completed high school, and percentage of Anglo-Americans. No statistically significant differences were found at the 10% probability level.

Results

The results of the conjoint analysis experiments for the brand and certification models were analyzed using the SAS TRANSREG procedure (SAS Institute, Inc.). Main effects ANOVA models were estimated based on equations (3) and (4), respectively. Eight observations were recorded for each respondent allowing the estimation of a preference function for each of the 567 respondents, 279 for the brand model and 288 for the certification model. The results of the analysis for the brand and certification models are presented in tables 2 and 3, respectively.

To assess the goodness of fit for the brand and certification models, R^2 statistics were calculated. An average R^2 was calculated for each model by averaging the R^2 statistics for each of the 279 estimated equations for the brand model and the 288 equations for the certification model. Similarly, average adjusted R^2 statistics were calculated. Both models exhibited a reasonably good fit with an R^2 of 0.84 for the both models and an adjusted R^2 of 0.72 for the brand model and 0.73 for the certification model.

Aggregate Results

One way to measure and compare the relative impact of each of the variables on an individual's preference function is to calculate relative factor importance scores[2]. The scores represent the variation in the preference rating for one variable relative to the variation in the preference rating over all variables. For each characteristic, the variation in the preference rating is calculated as the absolute value of the difference between the preference ratings of the most preferred and least preferred options. For binary variables this is simply the absolute value of the coefficient for

Table 2: Aggregate Preference Function for Brand Model (Model 1)

Variable	Coefficient	Standard Error	Relative Factor Importance Score
Intercept	9.45	1.99	-
BRAND	1.65	0.40	29.36%
PRICE	-7.78	3.97	27.67%
TECHNOLOGY	-2.42	0.40	42.97%
Average R^2	0.84		
Average $\bar{R}^2$	0.72		

Note: Sample size = 279.

[2] It should be noted that a limitation of using relative factor importance scores is that these measures may be influenced by the choice of attribute levels. This is particularly true for factors such as price, where the levels used are largely subject to the discretion of the research.

Table 3: Aggregate Preference Function for Government Certification Model (Model 2)

Variable	Coefficient	Standard Error	Relative Factor Importance Score
Intercept	8.42	2.17	-
CERTIFICATION	2.70	0.43	44.80%
PRICE	-6.12	4.33	20.45%
TECHNOLOGY	-2.09	0.43	34.75%
Average R^2	0.84		
Average $\bar{R}^2$	0.73		

Note: Sample size = 288.

the variable. For continuous variables, the variation in the preference rating is calculated as the absolute value of the difference between the most preferred and least preferred attribute levels times the estimated coefficient for the variable. For example, for the aggregate preference functions in table 2, the variation in the *PRICE* variable is calculated as the absolute value of -0.2 (the difference between the least preferred option of $0.39 and the most preferred option of $0.59) multiplied times the coefficient on the price variable (-7.78), or 1.56. The variation in the *BRAND* and *TECHNOLOGY* variables is 1.65 and 2.42, respectively, and the sum of the variations for all variables is 5.63. Thus the relative factor importance score for the *PRICE* is 27.7% (1.56 divided by 5.63).

The results of both the brand and certification models indicate that there is a fairly strong penalty associated with the use of GMO technology. The coefficients on the *TECHNOLOGY* variables are -2.42 and -2.09 for the brand and certification models, yielding relative factor importance scores of 42.97% and 34.75%, respectively. The results of the brand model suggest that, in the aggregate, the premium associated with marketing bananas under a brand (1.65) was not sufficient to offset the GMO technology penalty of -2.42. On the other hand, the aggregate certification model results indicate that government certification may be an effective way of ensuring consumers that GMO technology is safe. The certification premium of 2.70 was more than adequate to offset the GMO technology penalty of -2.09.

Another way to represent the value of the various alternatives is by calculating the monetary value of each alternative. This is accomplished by dividing the coefficient on each alternative by the price coefficient, which represents the value of a $1.00 increase in the price per pound of bananas. Thus, the brand model shows that consumers impose a penalty for GMO technology of $0.34 per pound (-2.09 divided by -6.12). Similarly, a penalty of $0.31 (-2.42 divided by -6.78) is calculated for the certification model. Considering the results of both models, our research indicates that consumers are willing to pay slightly more that $0.30 per pound to avoid GMO technology in bananas.

The GMO penalties may be compared with the premiums for brand or government certification. The brand and certification premiums are calculated as $0.21 (1.65 divided by –7.78) and $0.44 (2.70 divided by –6.12), respectively. Again, we see that only the certification premium is sufficient to offset the GMO technology penalty.

Individual Level Results

The aggregate results provide useful information regarding the general consumer preferences for the various attributes. However, aggregate results mask important information regarding the number of respondents with specific preferences and the strength of these preferences. Because multiple observations were recorded for each respondent, it is possible to evaluate each respondent's preference function. This is one of the primary advantages of using the type of CA analysis employed in this study.

An examination of the individual preference functions indicates that the great majority of consumers in both experiments exhibited a preference for avoiding GMO technology. In the brand experiment, 81% (225 of the 279 respondents) indicated that the use of GMO technology reduced their preference for the product. In the certification experiment, a similarly high percentage of respondents, 78% (226 of the 288 respondents), had a negative perception of GMO technology.

By comparing the brand and certification premiums with the GMO penalty for every respondent who had a negative perception of GMO technology for both models, it is possible to determine the effectiveness of the branding and certification methods in addressing consumers' reservations regarding GMOs. In the brand model, the brand premium was at least as great as the GMO penalty for 36.44% of the respondents (82 out of 225). This suggests that the use of a familiar brand is sufficient to assuage the fears associated with GM food products for about a third of the sample. For the certification model, the analysis suggests that for a majority of the respondents (123 out of 226, or 54.45%) government certification was sufficient to offset the negative perceptions associated with the GM product.

Factors Affecting Brand and Certification Preferences

In order to explore the factors associated with strong brand and certification preferences, a qualitative choice model was specified. Respondents were classified based on the relative factor importance scores for either the brand or certification variables, depending on whether they were sent the brand or certification survey. A respondent was considered to have a strong brand preference if the relative factor importance score for the brand attribute was as least as great as the combined relative factor importance scores for the price and technology attributes. Likewise, a respondent was categorized as having a strong certification preference if the

Table 4: Description of Variables for Logit Model of Factors Affecting Consumer Preferences for Brands and Government Certification

Variable Name	*Description*
Dependent Variables:	
STRONGBRAND	1 if strong brand preference 0 if weak brand preference
STRONGCERT	1 if strong government certification preference 0 if weak government certification preference
Independent Variables:	
GENDER	1 if female 0 if male
AGE	Years
WHITE	1 if Anglo-American 0 otherwise
CHILDHOME	1 if child 12 or younger lives in household 0 otherwise
EDUCATION	Highest level of education completed: 1 if elementary school 2 if some high school 3 if high school 4 if some college 5 if college 6 if grad school
POPULATION	Population of town in millions of people
PRIMEGROCERY	1 if household's primary grocery shopper 0 otherwise
GMOKNOWLEDGE	Knowledge of biotechnology 1 if none . . . 5 if a lot
*RISKAVERSE**	Level of risk aversion 1 if very low . . . 5 if very high

TRUSTFIRMS	Trust in large companies 1 if strongly disagree . . . 9 if strongly agree
TRUSTGOVT	Belief that government keeps companies in check 1 if strongly disagree . . . 9 if strongly agree
FIRSTCOMPUTER	One of first of peers to own a computer 1 if strongly disagree . . . 9 if strongly agree

*The *RISKAVERSE* variable is a composite index based on the answer to three questions. Respondents were asked to rate on a scale of 1 to 5, with 1 representing strong disagreement and 5 representing strong agreement with the following statements: 1) I don't like to take chances if I don't have to; 2) I like to experiment with new ways of doing things; and 3) I am cautious in trying new/different products. In calculating the index, the responses to the second question were inverted so that a high number corresponded to a high level of risk aversion to be consistent with the scale used for questions one and three. The answers to all three questions were then averaged for each respondent to create the *RISKAVERSE* variable.

relative factor importance score for certification was at least as great as the combined scores for the price and technology attributes.

Two logistic regression models were estimated, one for strong brand preference and another for strong certification preference. Assuming a logistic distribution, the binomial logit models were defined as:

$$(5) \qquad P(PREFERENCE = 1) = \frac{\exp(\mathbf{x}'\beta)}{1+\exp(\mathbf{x}'\beta)},$$

$$P(PREFERENCE = 0) = \frac{1}{1+\exp(\mathbf{x}'\beta)},$$

such that *PREFERENCE* represents either strong brand preference (*STRONGBRAND*) or strong certification preference (*STRONGCERT*), both as defined above, and $\mathbf{x}$ is the vector of explanatory variables including sociodemographic, knowledge, and opinion variables, as defined in Table 4.

Table 5: Logit Models of Strong Brand and Strong Government Certification Preference

Variable	Brand Model		Government Certification Model	
	Coefficient (Significance)	Marginal Probability	Coefficient (Significance)	Marginal Probability
CONSTANT	0.1829 (0.8855)	—	-0.4449 (0.6619)	—
GENDER	-0.0377 (0.9177)	-0.0036	-0.0954 (0.7339)	-0.0047
AGE	-0.0105 (0.3103)	-0.0016	-0.0133 (0.1334)	-0.0032
WHITE	-0.8689 (0.0088)**	-0.0807	0.3872 (0.1906)	0.0220
CHILDHOME	-0.7053 (0.1069)	-0.0636	-0.2898 (0.3552)	-0.0161
EDUCATION	-0.4804 (0.0012)**	-0.0734	-0.1657 (0.1510)	-0.0397
POPULATION	-0.0861 (0.6570)	-0.0132	-0.0155 (0.9065)	-0.0037
PRIMEGROCERY	-0.5329 (0.1842)	-0.0507	0.0984 (0.7467)	0.0050
GMOKNOWLEDGE	-0.1508 (0.4152)	-0.0230	-0.1386 (0.3706)	-0.0332
RISKAVERSE	0.5517 (0.0075)**	0.0843	0.2643 (0.0881)*	0.0633
TRUSTFIRMS	0.1083 (0.2436)	0.0166	-0.0539 (0.4518)	-0.0129
TRUSTGOVT	-0.0015 (0.9877)	-0.0002	0.2835** (0.0001)	0.0686
FIRSTCOMPUTER	0.0979 (0.1138)	0.0150	-0.0592 (0.2364)	-0.0142
-2 Log Likelihood	258.1		360.2	
χ^2	39.9**		28.9**	
Correct Predictions	75.1%		68.0%	

Note: A single and double asterisk indicate significance at the 10% and 1% levels of probability, respectively.

The analysis was performed using the SAS LOGISTIC procedure (SAS Institute, Inc.). Both models represent a reasonably good fit as indicated by the summary statistics in table 5. The brand and certification models correctly predicted 68.0% and 75.1% of the responses, respectively.

The results of the brand model indicate that three variables were statistically significant. Those individuals who were most risk averse, the least educated, and non-white were most likely to have a strong brand preference. For the government certification model, only two variables were statistically significant. Individuals who

were most risk averse and those who placed the most trust in government were most likely to have a strong preference for government certification.

Conclusions and Implications

Addressing consumer concerns for the safety of GM food products is an important issue for consumers, government, and food producers. The results of this research provide insights into consumers' attitudes regarding GMO food products and the way they are regulated and marketed. One interesting result is the apparent paradox between the large number of respondents who had a negative perception of GMOs and the seeming lack of concern by the U.S. consuming public, particularly given the prevalence of food products containing GMOs. We do not believe that these findings are inconsistent. On the one hand, the tacit acceptance of GMOs by most U.S. consumers may reflect the routine purchase of food products that consumers believe are safe. These routine food purchases are made in the absence of specific information concerning the technology used to produce the products. On the other hand, respondents to our survey were given explicit information regarding the GMO content of the food product. It seems likely that such an explicit provision of information regarding the GMO content of a food could trigger a host of questions in consumers' minds, including the issue of product safety. This has implications for whether GMO food products should be labeled. While information on the GMO content of foods may be of interest to consumers, providing this information may cause consumers to question the safety of the food.

The primary objective of this research was to explore the effectiveness of branding and certification in addressing consumers' fears regarding GMOs. The results of the analysis clearly indicate that government certification of a GMO product would be more effective than marketing the product under a well-known brand name. This finding was confirmed by the analysis of both aggregate and individual results.

In the aggregate case, the penalties associated with the use of GMO technology were compared to the premiums associated with the use of a familiar brand and government certification in two separate models. In the government certification model, the government certification premium was more than sufficient to compensate for the penalty associated with a GM food product. However, in the brand model, the strength of a familiar brand was insufficient to offset consumers' fears of GMOs.

While aggregate results are indicative of general consumer preferences, purchasing decisions are not made in the aggregate. It is revealing to examine the preferences of individual consumers to determine the effectiveness of certification and branding in mitigating consumer concerns for GMOs. Once again, government certification was found to be more effective than branding. For a majority of respondents (54%) government certification was an effective means of signaling the safety of the GM

food. Although the use of a familiar brand was less effective than government certification, a familiar brand was still sufficient to compensate for the negative impact of GMOs on consumer preferences for slightly over one-third of the sample (36%).

The finding that government certification is the preferred option for signaling GMO safety in the U.S. is consistent with the findings of Christensen, who, in a study of Utah consumers, directly compared consumer trust in government, private firms, and special interest groups in ensuring the safety of beef products. Consumers overwhelming chose government as the most trusted organization.

We speculate that our findings are due to the high level of confidence that most U.S. consumers have in the government agencies that are charged with protecting consumer health and safety. Agencies such as the FDA, USDA, and EPA do not have a financial stake in any particular product and enjoy a high level of consumer trust as protectors of public health and safety. On the other hand, companies are likely perceived as acting in their own best interest. They are primarily motivated by the pursuit of profit and may therefore be perceived as acting in the consumer interest only insofar as it satisfies their profit objective.

A secondary objective of this research was to explore the factors that influenced consumers' preferences for government certification and branding. The analysis indicated that those people who had the strongest preferences for certification and branding were also most averse to risk. This suggests that consumers may seek out mechanisms such as certification or branding as a way to mitigate the perceived risks associated with GMO food products. The results also hinted at the reason for respondents' preferences for government certification. Those consumers who most preferred government certification also had the highest level of trust in the government. These results provide insight into the effective use of programs designed to assure consumers that the food they consume is safe. The most successful programs are likely to be those that most effectively address consumers' concerns and are offered by entities in which consumers have a high level of trust.

In conclusion, government certification was shown to be a more effective tool than branding for addressing consumers' food safety concerns. However, both methods fell well short of assuring all consumers of the safety of GMOs. This indicates that a strategy that employs a single element, such as either branding or certification, may be inadequate to address the full range of consumers' concerns. Assuring consumers that GMO food products are safe may require a multi-pronged strategy including elements such as additional research, education, certification, and branding. Our results do not preclude the use of private branding as a strategy to signal the safety of GM food products. Slightly more than a third of the consumers in this study exhibited preferences indicating that a familiar brand was an effective way to offset their apprehensions regarding GM foods. The use of a familiar brand

may be an effective strategy for signaling product safety when no good alternative exits, such as government or third party certification. Branding may be particularly effective when coupled with a beneficial GM trait such as enhanced nutrition, longer shelf life, or a distinctive flavor. However, government sponsored certification, whether voluntary or mandatory, would likely be a better alternative than marketing GMOs under a company brand name if the safety of GMO products becomes a major consumer issue. Such a strategy may also help protect a company's brand name by providing independent verification of the safety of foods sold under its brand.

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