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Analysis of Consumer Preferences for Biotech Labeling Formats

R. Wes Harrison and Everald Mclennon

Conjoint analysis is used to measure the preferences of United States consumers for labeling of biotech foods. The study found that consumers in the sample support mandatory labeling of biotech foods. This suggests that U.S. consumers would support revisions to the present voluntary labeling policy of the U.S. Food and Drug Administration and the U.S. Department of Agriculture. Results also showed that the preferred labeling format is a text disclosure that describes the benefits of biotechnology in combination with a biotech logo.

Key Words: Agricultural Biotechnology, Labeling, Conjoint Analysis

JEL Classifications: Q18,Q13

Agricultural biotechnology (AB) is broadly defined as a collection of scientific techniques that involves taking the genes from one plant or animal species and inserting them into another species to transfer a desired trait or characteristic.[1] For farmers, AB has led to reduced production costs, enhanced yields, and the potential for increased profits. Other potential benefits include reductions in pesticide and herbicide use, as well as the potential for enhanced nutritional value, flavor, and shelf life of some foods.

Despite the benefits of biotechnology, consumer acceptance has been mixed—some interest groups have expressed concerns over safety and harmful environmental effects of biotech foods (U.S. Department of Agriculture, Environmental Resource Service 1991). These concerns are due to the public's perception that biotech foods may have some long-term or unforeseen health risks, as well as unforeseen negative effects on wildlife and the environment. Environmental concerns include the potential for biotech crops to interact with nonbiotech plants, leading to the contamination of organic crops and/or herbicide-resistant weeds. The development of Bt-resistant insects and other unanticipated harmful effects on nontargeted organisms in the ecosystem are also frequently cited drawbacks of biotechnology (U.S. Department of Agriculture, Environmental Resource Service 2000). There are also concerns that biotech foods with transplanted genes may cause allergic reactions in some consumers. Health and environmental concerns are particularly strong among European, Japanese, Australian, and New Zealand consumers and have led to mandatory labeling of all biotech foods in these trading regions.

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[1] The terms "agricultural biotechnology," "genetically modified," "genetically engineered," and "biotech" are used interchangeably in this paper. These terms refer to all modern techniques in cellular and molecular biology used to alter the genetic composition of foods or food ingredients, including in vitro nucleic acid, recombinant DNA, genetic modification, and genetic engineering.

Food labeling has been an important issue in the United States since the Nutrition Labeling and Education Act (NLEA) of 1990 replaced the voluntary labeling system established by the U.S. Food and Drug Administration (FDA) in 1973. The act requires mandatory nutrition labeling for all packaged foods and strict regulations regarding nutritional content and health claims. However, the FDA and the U.S. Department of Agriculture have adopted voluntary labeling policies for biotech foods, unless they are materially different from their conventional counterparts. Mandatory labeling is necessary if a biotech product is proved to be materially different from the non-biotech counterpart. Material differences include circumstances in which the common or usual name no longer adequately describes the biotech food, where a biotech food or ingredient changes how the food is used or consequences of its use, if a biotech food has significantly different nutritional properties from the conventional food, or if a biotech food includes an allergen that consumers would not expect to be present based on the name of the food. The U.S. policy also provides for a "GMO-Free" label if foods contain no biotech ingredients (Caswell 1998).

Critics of the FDA's voluntary labeling policy argue that all food produced through biotechnology should be labeled, even if the material aspects of the food have not been altered. They argue that consumers have a right to know when biotech ingredients are present in their food. Proponents of the current policy argue that mandatory labeling of all biotech foods would unnecessarily raise health concerns of consumers, increase the costs of marketing food products, and ultimately lead to higher food prices. The present study examines the labeling preferences of U.S. consumers for biotech foods. The principal objective was to measure consumer preferences for alternate biotech labeling formats.

The Current Debate

The theory of food labeling was articulated in the mid-1990s by Caswell and Padberg and Caswell and Mojduszka. Theory suggests that the government regulation of food labels is justified when market failure occurs because of information asymmetry between consumers and food suppliers. Caswell and Mojduszka argued that a food product may be viewed as bundles of product characteristics that consumers evaluate when making buying decisions. These characteristics can be classified as search attributes, experience attributes, or credence attributes. Search attributes are characteristics that consumers can easily inspect or research prior to purchase—for example, price, diversity of goods supplied, color, and some quality characteristics. Experience attributes can be evaluated only after purchase, such as flavor and cooking characteristics. Food safety characteristics may also be experience attributes, but food-borne illnesses are often difficult to trace back to a specific food or food-borne pathogen. Credence attributes are characteristics that consumers cannot easily identify or inspect prior to or after purchase. These include many food safety attributes, as well as process-oriented attributes, such as how a crop is grown, how food is processed, and whether biotechnology was used in the production of food ingredients. Although some attributes resulting from biotechnology may be search or experience attributes (e.g., color and flavor), the debate over labeling biotech foods is typically couched in terms of the consumer's right to full disclosure of the credence aspects of biotech ingredients, balanced by the government's role in regulating the amount and type of information supplied to consumers, and the cost of supplying this information.

The right to full disclosure is the basis for the European Union's mandatory labeling policy. As was discussed by Isaac and Phillips, consumers are concerned about the long-term effects on human health, environmental biodiversity, and the moral, ethical, and religious implications of biotechnology. Voluntary labeling means that consumers are given limited choices if they wish to avoid biotech foods. For instance, even if consumers purchased "GMO-free" or "organic" food products to avoid biotechnology, the variety and availability of these foods is more limited, and they tend to be offered at higher prices than conventional foods.

Caswell (1999) argued that there are several practical and economic reasons for not requiring all information to be disclosed on food labels. For example, Isaac and Phillips argued that the present status of the global supply chain for food makes it virtually impossible to ensure that GMO ingredients are not commingled with non-GMO ingredients. The cost of assuring the segregation of GMO and non-GMO ingredients would be large, and this cost would be passed on to consumers in the form of higher food prices. Moreover, there is a limit to the amount of information that can be realistically displayed on a label, as well as limits on the desire and ability of consumers to make use of this information. The current U.S. policy is based on the rationale that the consumer's right to know should be mitigated by the fact that scientific testing can determine whether biotech foods are materially different from their traditional counterparts.

Literature Review

Numerous surveys regarding the labeling of genetically modified (GM) foods have been conducted in the United States. For instance, Hallman reported that 84% of 604 New Jersey residents were in favor of mandatory labeling of GM fruits and vegetables. Sixty percent of Hallman's sample said they would still consider buying fresh vegetables if they were labeled as having been produced by genetic engineering. Also, 58% would not look specifically for biotech labels while shopping. Forty-two percent of the people, who said they would look for produce labeled as not genetically engineered, also said that they would buy produce that was genetically engineered if the label gave this information.

Other studies by Douthitt, Maki, and Novartis also found that the majority of Americans responding to their surveys believed that genetically modified foods should be clearly labeled. Surveys in other developed countries have reported similar results. For instance, a national survey of Australian consumers found that 89% of respondents believed that genetically engineered tomatoes should be labeled. Only 4% percent of the respondents were against labeling. Approximately 65% percent said that labeling engineered tomatoes would be a good idea, whereas 65% percent said that unlabeled engineered tomatoes would be a bad idea (Kelley).

Other surveys have returned mixed results regarding the labeling of biotech foods. For instance, the International Food Information Council (IFIC) has sponsored annual consumer surveys on the topic of biotechnology since the mid-1990s. Approximately 1,000 separate telephone interviews of U.S. consumers were conducted in 1997, 1999, 2000, and 2001 (IFIC). These surveys reported that 78% of Americans supported the FDA voluntary labeling policy in 1997. However, support for the FDA policy had eroded to 37% by the 2001 survey.

Some studies have examined the linkages between consumer perceptions of biotechnology and their willingness to purchase these foods. Hoban and Kendal analyzed consumers' perception regarding the safety of biotechnology in developed countries such as the United States, Australia, United Kingdom, and Japan. Telephone surveys were conducted from 1995 to 1998. Their results showed that an increasing number of consumers were willing to purchase GM food products.

Several empirical studies have addressed the value of mandatory nutritional information on food labels. For instance, Mojduszka and Caswell examined whether voluntary information disclosure is linked to the nutritional quality of food products. They found evidence supporting the hypothesis that private quality signaling (i.e., voluntary labeling) was not reliably at work in food markets and concluded that the 1990 NLEA nutritional labeling requirements would significantly increase the amount of information available to consumers (Mojduszka and Caswell). Kim, Nayga, and Capps found that use of mandatory nutritional labeling decreases individuals' average daily intakes of calories from total fat and saturated fat, cholesterol, and sodium by 6.9% and 2.1% 67.6 and 29.6 milligrams, respectively. Teisl, Bockstael, and Levy used a cost/benefit approach to analyze the effects of nutritional labeling in combination with an information campaign on consumer welfare and purchasing behavior. They found that nutrition labeling in combination with an information campaign significantly affects consumer behavior, but does not necessarily lead to consumers switching their consumption away from "unhealthy" foods.

The studies on nutrition labeling have suggested that consumers are influenced by mandatory labeling policies. However, aside from the previously cited descriptive surveys, only a couple of empirical studies have addressed the mandatory labeling of biotech foods. These studies have produced mixed results. For instance, Lusk and Fox analyzed consumers' willingness to pay for the mandatory labeling of beef administered growth hormones or fed GM corn. Eighty-five percent of the respondents in their study indicated a preference for the mandatory labeling of beef produced using growth hormones, and 64% of respondents preferred the mandatory labeling of beef fed GM corn. They found that consumers would be willing to pay 17% and 10.6% more for information obtained through mandatory labeling of cattle produced using growth hormones or fed GM corn, respectively. Hine and Loureiro linked consumers' risk perceptions of GM foods to preferences for mandatory labeling. Various sociodemographic characteristics hypothesized to affect consumer preference for mandatory labeling were examined. Their results indicated that consumers who are well informed about biotechnology do not appear to be as concerned about mandatory labeling of GM foods as those who are less informed. The present study differs from previous literature in examining the preferences of U.S. consumers for the mandatory labeling of foods containing biotech ingredients. More specifically, conjoint analysis was used to examine consumer preferences for alternate labeling formats, which vary according to the amount and type of information conveyed on the label.

Methods

Conjoint analysis (CA) is widely used in market research because it allows for a consumer's total utility for a multidimensional product to be decomposed into combinations of part-worth utilities for each attribute of the product. Numerous studies have used conjoint analysis to examine buyer or user preferences for new food products (e.g., Halbrendt, Wirth, and Vaughn; Harrison, Özayan, and Meyers; Harrison, Stringer, and Prinyawiwatkul; Holland and Wessells; Huang and Fu; Stevens, Barrett, and Willis; Yoo and Ohta). Although no studies were found that applied CA to the biotech labeling issue, it is a useful technique because it provides a means to measure and analyze the relative importance of selected labeling characteristics.

Selection of Labeling Attributes

A focused group discussion is frequently used for identifying and refining attribute levels in CA studies. A focus group for the present study was conducted on October 17, 2001. The purpose of the focus group was to (1) obtain information regarding the consumers' general knowledge about biotechnology and (2) identify labeling attributes that are likely to contribute to the consumer's preferences and understanding of biotech foods. Participants were presented with 12 different examples of biotech food labeling. The labels differed in terms of (1) the use of a biotech logo, (2) text disclosure of biotech ingredients, and (3) information about government agencies that inspect and approve food products for human consumption. Participants were asked to rate labeling formats that ranged from a simple text disclosure to a "GMO-Free" logo.

Results of the focus group suggested that participants rated short and simple text disclosures the highest—for example, "this product contains ingredients produced using biotechnology." Text disclosures that indicated a personal health benefit were also rated highly by focus group participants—for example,"this product contains soybean oil developed through biotechnology to decrease the amount

Table 1. Attributes, Attribute Levels, and Fractional Design Used in the Conjoint Survey

Attribute	Levels
Text Disclosure on Biotech Label	1. Insert in the ingredients section of information panel reads: "This product contains ingredients derived through biotechnology."
	2. Insert in the ingredients section of information panel reads: "This product contains soybean oil developed through biotechnology to decrease the amount of saturated fat."
	3. No text Disclosure
Biotech logo	1. Present
	2. Absent
Location of a Biotech Logo	1. Principal Display Panel (PDP)
	2. Information Display Panel (IDP)

Note: The seven-treatment fractional design used in the conjoint survey. Treatment 1 is no text disclosure and no biotech logo; Treatment 2 is text disclosure 2 without the biotech logo; Treatment 3 is text disclosure 2 with the biotech logo displayed on the PDP; Treatment 4 is no text disclosure, but biotech logo displayed on the PDP; Treatment 5 is text disclosure 1 without biotech logo; Treatment 6 is text disclosure 1 with biotech logo on IDP; and Treatment 7 is text disclosure 1 with biotech logo on PDP.

of saturated fat." A biotech logo was also included in the pretests. Labels with only a logo were rated lower than text disclosure, but some respondents indicated that a logo on the primary display panel with text disclosure on the information panel was desirable. The "GMO-Free" label did not rate high among the focus group participants.

On the basis of the focus group results, the attributes and attribute-levels selected for the present study are presented in Table 1. As illustrated in the table, the study called for a 3 $\times$ 2 $\times$ 2 factorial design. A full factorial design would involve 12 hypothetical labeling formats. Many subjects have difficulty rating more than 10 product profiles, so researchers generally use fractional factorial designs to overcome the information overload problem. The primary advantage of a fractional design is the number of hypothetical products a subject must evaluate is reduced, although enough information is retained to estimate all part-worth main effects. A disadvantage of the fractional design is that interaction part-worth effects are not usually recoverable. However, this may not be a significant restriction—previous research has found attribute interactions to have negligible effects on total utility (Harrison, Özayan, and Meyers). The Bretton-Clark Designer program was used to select the fractional design for our study. This program produces a subset of hypothetical products based on the attribute levels provided by the researcher. More specifically, the program minimizes the confounding of attribute main effects by selecting a subsample of orthogonal product combinations. The program yielded seven hypothetical labeling treatments, which are also presented in Table 1.

The Questionnaire and Survey

A questionnaire was developed that included questions on mandatory versus voluntary labeling preferences, a conjoint experimental design on labeling formats, questions on the knowledge of and purchasing patterns of biotech foods, questions regarding the consumer's use of food labels, and questions on consumer demographics.

The first part of the questionnaire provided background information on biotechnology. The background text included a definition of biotechnology and a description of its potential benefits and drawbacks. This was followed by several questions regarding the respondent's general knowledge of and their attitudes toward biotechnology. After this introductory section, respondents were asked to choose between a mandatory labeling policy for biotech

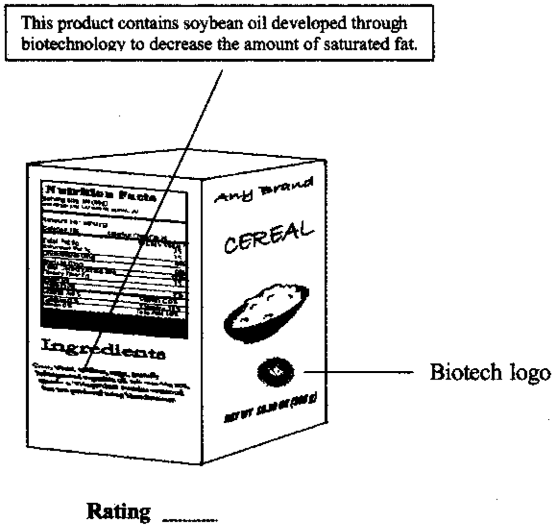

Figure 1. Example of Hypothetical Labeling Format for Conjoint Analysis of Food Product Containing Biotech Ingredients

foods and the current FDA voluntary labeling policy. A follow-up question asked respondents to choose the minimum percentage of GM ingredients necessary for a product to be labeled. The final set of questions collected information regarding the demographic and socioeconomic characteristics of the respondent (e.g., age, income, marital status, and education).

The conjoint section of the questionnaire consisted of a two-page layout that displayed a hypothetical cereal product with the seven label treatments, as prescribed by Bretton-Clark software. The following instructions were included on the questionnaire: "The following diagrams show different labeling formats for a hypothetical biotech food. The labels differ in terms of (1) the use of a biotech logo, (2) location of the biotech logo on the package, and (3) the text disclosure of biotech ingredients. Please rate each example, where 10 is the most preferred and 0 the least preferred. Ties are okay."

An example of one label treatment, as it appeared in the conjoint section of the questionnaire, is presented in Figure 1. Because the objective of the study was to determine the preferred labeling format, only the label attributes were varied across the seven treatments. All other aspects of the product were held constant (i.e., product type, product name, package appearance, etc.).

The survey was administered by mail during the month of July 2002. A modified version of Dillman's total design method was used to administer the survey. A total of 3,450 surveys were mailed to randomly selected households in Denver, Chicago, Atlanta, Los Angeles, New Orleans, New York, and Houston. A cover letter accompanied the questionnaire, which provided information regarding the benefits and drawbacks of biotechnology, food labeling, the reason the study was being conducted, and the importance of the subject's response to the success and usefulness of the study. A reminder letter and a follow-up questionnaire were sent to nonrespondents 2 weeks after the initial mailings. Five hundred and nine usable questionnaires were returned, yielding a 14.75% response rate. The results associated with mandatory versus voluntary labeling and the conjoint analyses of labeling formats are reported in the present article.

The Empirical Model

Two commonly used methods for coding respondent preferences are rank order (RO) and interval rating (IR) scales. The RO method requires subjects to unambiguously rank all hypothetical product choices. In these cases, the dependent variable is ordinal, and ordered regression models such as ordered probit or logit (OLP) are most suitable for conjoint estimation. The IR method allows subjects to express order, indifference, and intensity across product choices, a feature that allows both metric and nonmetric properties of utility to be elicited. Model selection becomes less clear if IR scaling is used. Some studies have used linear regression (LR) to estimate part-worth parameters (Halbrendt, Wirth, and Vaughn; Harrison, Özayan, and Meyers; Prentice and Benell; Roe, Boyle, and Teisl; Stevens, Barrett, and Willis). These studies assumed that IR scales are metric and continuous. However, even if one argues that subjects express metric information in their responses, IR scales are limited by upper and lower bounds. Under these circumstances, LR models yield truncated residuals and asymptotically biased parameters. The censored nature of the scale can be accounted for with a two-limit Tobit model, which corrects for censoring and retains metric information between the bounds. However, some researchers have argued that OLP models are more suitable for part-worth estimation, because IR scales are typically measured as discrete variables and ordinal preferences are more appealing theoretically (Holland and Wessells; Mackenzie; Sy et al.).

As described in the previous section, respondents were presented with seven hypothetical labeling formats and were asked to rate each using an interval rating scale from 0 to 10. An ordered probit model was used to estimate consumer preferences for the labeling attributes. Conjoint measurement assumes that a consumer's total utility for a particular combination of attributes is a linear function of part-worth effects. The structural equation for the model is specified as follows:

$$(1) \qquad U_i^* = \boldsymbol{\beta}\mathbf{X} + \varepsilon_i,$$

where U_i^* is a latent variable representing the ith individual's total utility for a particular combination of label attributes, β is a row vector of part-worth utility effects and the effects associated with selected demographic variables, $\mathbf{X}$ is a matrix containing dummy variables that identify the selected attribute levels for alternate labeling formats and dummy variables that indicate socioeconomic/demographic information, and ε_i is the error term. The OP model assumes that U_i^* is censored, with the following relationship to the observed rating scale:

$$r_i = \begin{cases} 0, & \text{if } U_i^* \leq 0; \\ 1, & \text{if } 0 < U_i^* \leq \mu_1; \\ 2, & \text{if } \mu_1 < U_i^* \leq \mu_2; \quad \text{and} \\ \vdots & \\ 10, & \text{if } \mu_9 \leq U_i^*, \end{cases}$$

where r_i is the ith respondent's rating for a particular combination of label attributes and the μs are unknown threshold parameters. The OP model assumes that ε_i is normally distributed, with zero mean and variance equal to one.

The log-likelihood function for the ordered probit model is written as follows:

$$(2) \qquad \ln L(\boldsymbol{\beta}, \boldsymbol{\mu} | \mathbf{r}, \mathbf{X}) = \sum_{j=0}^{10} \sum_{r_i=j} \ln[\Phi(\mu_j - \boldsymbol{\beta}\mathbf{X}) - \Phi(\mu_{j-1} - \boldsymbol{\beta}\mathbf{X})],$$

where all variables are as previously defined and the vectors $\boldsymbol{\beta}$ and $\boldsymbol{\mu}$ are estimated using maximum-likelihood techniques (Long, p. 124). The term $\boldsymbol{\beta}\mathbf{X}$ (referred to as the index function) in Equation 2 is the conditional mean of the underlying utility scale U^* given $\mathbf{X}$. Because the estimation of the utility scale is the primary objective in conjoint analysis, the index function parameters (i.e., $\boldsymbol{\beta}$) are of primary interest in most CA studies. They represent the "part-worth" effects and are interpreted as the change in the underlying utility index given a unit change in x. Although the ordered probit model also provides the probabilities that a label format will fall within any of the j categories, the predicted values and marginal probabilities are not typically reported in CA studies.

The dummy variable coding for the $\mathbf{X}$ matrix is defined as follows: $X_1 = 1$ and $X_2 = 0$ if the text disclosure reads "this product contains soybean oil developed through biotechnology to decrease the amount of saturated fat," $X_1 = 0$ and $X_2 = 1$ if the text disclosure reads "this product contains ingredients derived using biotechnology," and $X_1 = -1$ and $X_2 = -1$ if no text disclosure is present. The logo attributes are coded as follows: $X_3 = 1$ if the logo appears on the primary display panel (PDP) and $X_3 = -1$ if the biotech logo appears on the information panel (IP). Similarly, $X_4 = 1$ if the biotech logo is present and $X_4 = -1$ if no logo is present.

The coding for the socioeconomic/demographic variables are defined as follows: $EDU_{ij} = 1$ if the ith respondent's education level falls in the jth of six education categories and zero otherwise; $INC_{ij} = 1$ if the ith respondent's income falls in the jth of nine income categories and zero otherwise; $ETH_{ij} = 1$ if the ith respondent indicated their ethnic

Table 2. Frequency Distribution of Socio-demographic Characteristics of Respondents for Biotech Labeling Survey

Demographic Characteristics Sample (n = 509)	Number	Percentage
Gender		
Male	274	54.0
Female	235	46.0
Age (years)		
18–24	12	2.36
25–34	56	11.00
35–44	99	19.45
45–54	135	26.52
55–65	93	18.27
65 or older	114	22.40
Education		
Less than high school	2	0.39
Completed high school	58	11.39
Technical school	37	7.27
Some college	119	23.88
Completed bachelor degree	150	29.47
Post graduate work	143	28.09
Income		
Less than $15,000	33	6.48
$15,000–$29,000	47	9.23
$30,000–$44,999	101	19.84
$45,000–$59,999	99	19.45
$60,000–$74,999	76	14.93
$75,000–$89,999	53	10.41
$90,000–$104,999	32	6.29
$105,000–$119,999	19	3.73
More than $120,000	49	9.63

origins corresponds to the jth of six ethnic categories amd zero otherwise; AGE_{ij} = 1 if the ith respondent's age corresponds to the jth of six age groups and zero otherwise; and GEN_{ij} = 1 if the ith respondent is male and zero otherwise.

Results

Frequency distributions of the socioeconomic/demographic composition of the sample are presented in Table 2. Of the 509 respondents, 274 (54%) were men and 235 (46%) were women. All age groups were represented in the sample, with the 45–54 age group accounting for most responses, approximately 27% of sample. Most of the respondents were also well educated—more than three quarters of the sample (80%) completed some college courses, graduated with a bachelor degree, or had done postgraduate work. The modal annual income of respondents was $30,000–$44,999, which accounted for approximately 20% of the sample. Six percent had annual income of less than $15,000, and 10% of respondents made more than $120,000 in yearly earnings.

Table 3. Respondents' Responses to Mandatory or Voluntary Labeling Policy

	Number of Respondents	Percentage of Respondents
Prefer Voluntary Labeling	103	20
Prefer Mandatory Labeling	406	80

Frequency distributions regarding respondents' agreement or disagreement with a voluntary versus mandatory labeling policy are presented in Table 3. Of the 509 respondents, 80% of the sample was in favor of a mandatory labeling policy for biotech foods. Only 20% of the respondents indicated that they agreed with FDA's voluntary labeling policy, despite being informed of FDA's conclusion that biotech foods carry no greater health risks than nonbiotech foods and the concern that mandatory labeling may unnecessarily raise health concerns among consumers.

Results of the ordered probit model are presented in Table 4. The results of the log-likelihood ratio test indicated that the overall model is significant at the α = 0.01 level. Unlike the R^2 in linear regression, there is not a generally recognized measure for goodness-of-fit in a limited dependent variable model (Long, p. 102). However, many "pseudo" R^2s have been proposed. McKelvey and Zavoina (p. 112) developed a pseudo R^2 (denoted $R^2_{M\&Z}$) for the ordered probit model. The $R^2_{M\&Z}$ for the present study is 0.317 (Table 4). It measures the proportion of variance in the latent variable (i.e., U^*) explained by the model if we could have measured the dependent variable on its true underlying interval scale. However, because $R^2_{M\&Z}$ is only an estimate of the true R^2 for the underlying regression and the distributional properties of the true R^2 are unknown, its usefulness is somewhat limited. Pseudo R^2s are typically used to evaluate competing models within a particular study rather than as a generalized measure of goodness-of-fit.

All part-worth estimates were significant at the $\alpha = 0.01$ level. The relatively large positive coefficient (0.575, Table 4) for the disclosure attribute that reads "this product contains soybean oil developed through biotechnology to decrease the amount of saturated fat" suggests that consumers prefer disclosures describing the health benefits of biotechnology. This alone is not surprising, because consumers naturally are more attracted to food products with perceived health benefits. However, the negative sign on the "simple disclosure" statement implies that preference for the label format decreases when health benefits of biotechnology are not disclosed. That is, because all characteristics of the hypothetical biotech product are held constant except the label, the results imply that respondents prefer labels that indicate what the health benefit of the biotechnology is, if such is indeed present. This is an interesting result and implies a desire for information regarding the beneficial aspects of biotechnology. Moreover, the relatively large negative coefficient associated with "no text disclosure" implies that either of the two text disclosures tested in the study are preferred to no disclosure.

The coefficient indicating the presence of a biotech logo had the second largest positive coefficient (0.56, Table 4). This implies that the biotech logo increases the average consumer's preference for the labeling format when it is included. Conversely, labeling formats without the biotech logo were less preferred by the average respondent in the sample, as indicated by the −0.56 estimate associated with absence of the logo. The location of the logo had the lowest effect on respondents' labeling preferences. However, when the logo appeared on the PDP, as opposed to the IP, the average consumer's preference for the label increased, as indicated by a positive 0.12 (Table 4).

Socioeconomic and demographic variables were also included in the model, to control for differences in respondent characteristics on labeling preferences. Most coefficients associated with education are not significant. However, the coefficient associated with having a bachelor degree was positive and significantly different from the postgraduate category (the omitted category) at the $\alpha = 0.10$ level. This provides some evidence that less educated individuals have a greater preference for biotech labels, compared with respondents with higher education levels. The coefficient for the 55–65 and 65 or greater age categories are positive and significant at the $\alpha = 0.10$ level or higher. This suggests that respondents older than 55 years of age have a greater preference for biotech labeling relative to the omitted age group (45–54). Most of the income variables are not significant. However, the \$15,000–\$29,000 income group, and the more than \$120,000 income group coefficients are negative and significant at the $\alpha = 0.05$ level. This implies that preferences for biotech labels are lower in these categories, relative to the omitted category of \$30,000–\$44,999. In regard to ethnic background, all estimated coefficients were not significant except for whites, which was negative and significant at the $\alpha = 0.10$ level. This suggests that Asians (the omitted category) are more likely to prefer the labeling of food products produced from biotechnology relative to whites. The gender coefficient was not significantly different from zero, which indicates that gender had little effect on the preferences for biotech labeling.

The relative importance of labeling attributes was also calculated using the part-worth estimates from the ordered probit model. To determine the relative importance of an attribute, each attribute's highest and lowest part-worth utilities were used. The difference between the highest and lowest part-worth values established the utility range for a given attribute. Once the utility range for each attribute is determined, the relative importance for the kth attribute is calculated as follows:

$$RI_k = \frac{R_k}{\sum R_k \ \forall Attributes} \times 100,$$

Table 4. Ordered Probit Part-worth Estimates for Biotech Labeling Formats

Variable	Coefficient[b]	Standard Error	(β/SE)
Constant	1.207***	0.151	7.961
Text Disclosure (40.7%)[a]			
Text Disclosure with Benefits of Biotech Ingredients	0.575***	0.037	15.255
Simple Biotech Text Disclosure	−0.218***	0.039	−5.522
No Text Disclosure	−0.357***	0.049	−7.262
Location of Biotech Logo (10.7%)			
Primary Display Panel	0.122***	0.030	4.029
Information Panel	−0.122***	0.030	−4.029
Biotech Logo (48.6%)			
Present on Label	0.557***	0.033	17.074
Absent from Label	−0.557***	0.033	−17.074
Gender			
Female[c]	0.012	0.051	0.241
Education[d]			
Completed high school	0.083	0.097	0.856
Technical college	0.042	0.099	0.422
Some college	0.064	0.073	0.886
Bachelor degree	0.119*	0.071	1.684
Income[e]			
Less than $15,000	−0.191	0.127	−1.510
$15,000–$29,999	−0.258***	0.094	−2.746
$45,000–$59,999	−0.244***	0.081	−3.019
$60,000–$74,999	−0.121	0.088	−1.383
$75,000–$89,999	−0.041	0.094	−0.441
$90,000–$104,999	−0.074	0.113	−0.657
$105,000–$119,999	−0.014	0.133	−0.104
More than $120,000	−0.282**	0.119	−2.364
Age[f]			
18–24	0.135	0.161	0.834
25–34	0.026	0.096	0.271
35–44	0.101	0.075	1.396
55–65	0.124*	0.069	1.813
65 or older	0.172**	0.078	2.197
Ethnic Origin[g]			
White	−0.229*	0.132	−1.743
African American	−0.255	0.176	−1.447
American Indian	−0.139	0.394	−0.353
Hispanic	−0.237	0.167	−1.415
Other	−0.203	0.180	−1.125

Ordered Probit Thresholds	Coefficient	SE	(β/SE)
μ_1	0.160***	0.0170	9.412
μ_2	0.368***	0.0236	15.593
μ_3	0.530***	0.0273	19.414
μ_4	0.688***	0.0300	22.933
μ_5	1.084***	0.0352	30.795

Table 4. (Continued)

Ordered Probit Thresholds	Coefficient	SE	(β/SE)
μ_6	1.241***	0.0370	33.540
μ_7	1.450***	0.0394	36.802
μ_8	1.820***	0.0426	42.723
μ_9	2.069***	0.0462	44.784
Log-L Ratio = 777.28			
Pseudo R^2 = .317			
N = 3,563			

[a] Relative importance coefficients are indicated parenthetically.
[b] The notation ***, **, and *, denotes that coefficient is significant at the α = .01, .05, and .10 levels, respectively.
[c] The omitted dummy variable for sex is male.
[d] The omitted dummy variable for education is the post graduate work category.
[e] The omitted dummy variable for income is the $30,000–$44,999 category.
[f] The omitted dummy variable for age is the 45–54 year category.
[g] The omitted dummy variable for ethnicity is the Asian category.

where R_k is the range of part-worth values for the kth attribute and RI_k is defined as the relative importance for the kth attribute (Harrison, Stringer, and Prinyawiwatkul, p. 166).

The relative importance values are shown parenthetically in Table 4. The results indicated that the most important attribute was the presence of a logo, contributing 48.6% to the preference rating. This implies that approximately 49% of the variation in the preference rating is attributed to the presence or absence of a biotech logo. The type of text disclosure was determined to be the second most important attribute, accounting for 40.7% of the variation in preference ratings. The third most important attribute, contributing only 10.7%, was the location of the logo on the product package.

Conclusions

Our study examined U.S. consumer preferences for the mandatory labeling of foods containing ingredients derived through AB. A national survey was administered to measure consumer perceptions and attitudes regarding alternate labeling formats. Conjoint analysis is used to measure consumer preferences for selected attribute levels.

An important finding of the study is that U.S. consumers support the mandatory labeling of biotech foods. Negative part-worth estimates for label formats without text disclosure of biotech ingredients and no biotech logo on the product's package suggest that respondents in our sample preferred the labeling of biotech foods. This is supported by the fact that 80% of the respondents indicated that they favored a mandatory labeling policy for biotech foods. Moreover, these results are consistent with the findings of the 2001 IFIC survey, which indicated a growing desire by U.S. consumers for the mandatory labeling of these products. Our findings are also consistent with those of Lusk and Fox, who found that consumers would be willing to pay more for information obtained through the mandatory labeling of cattle produced using growth hormones or fed GMO corn.

Our results contribute to growing empirical evidence that suggests that U.S. consumers would support revisions to the present U.S. labeling policy for biotech foods. This may result in mandatory labeling policies similar to those of the European Union, Japan, Australia, and New Zealand. If mandatory labeling were adopted by U.S. regulatory agencies, then results from the present study show that U.S. consumers prefer a labeling format that describes the benefits of biotechnology in combination with a biotech logo. Therefore, consumers prefer information on the biotech label that exceeds a simple text disclosure of biotech ingredients.

A limitation of the present study is that only the seven largest metropolitan regions of the United States were surveyed. The labeling preferences of individuals living in rural areas of the United States may differ from those of urban consumers. Another limitation of the study was that most respondents had either some college or higher levels of education. Less-educated consumers may have different preferences regarding labeling formats relative to the highest educated consumers. For instance, the present study showed some evidence suggesting that less-educated consumers had a stronger preference for biotech labels relative to the highest educated consumers. Future research should focus on sampling a more diverse group of consumers. Moreover, because mandatory labeling is expected to add to the cost of marketing biotech foods, future research should focus on measuring consumers' willingness to pay for biotech labels.

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