# The Effects of Urban Consumer Perceptions on Attitudes for Labeling of Genetically Modified Foods

**R. Wes Harrison and Jae-Hwan Han**

The effects of consumer perceptions on attitudes toward the United States Food and Drug Administration (FDA)'s current labeling policy for GM foods are examined. Results show that as beliefs regarding potential adverse effects of GM crops on wildlife and the environment increase, consumers are less likely to support the FDA's current labeling policy. The perceived safety of GM foods was also found to be important. As consumers perceive GM foods to be safe (unsafe), they are more (less) likely to support the current policy. However, concerns regarding potential environmental damage of GM crops are more important relative to beliefs regarding the potential for negative long-term health effects.

Genetically modified (GM) foods are foods containing ingredients from plant and animal organisms produced using scientific techniques that involves taking genes from one species and inserting them in another species to transfer a desired trait or characteristic.[1] For agricultural producers, GM crops have 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, consumer acceptance of GM foods has been mixed due to perceptions that these foods may have long-term or unforeseen health risks, as well as the risk that GM crops may negatively affect wildlife and the environment. Environmental concerns include the potential for GM crops to interact with non-GM plants, leading to contamination of organic crops and/or to herbicide-resistant weeds. The development of *Bt*-resistant insects and other unanticipated harmful effects on non targeted organisms in the ecosystem are also frequently cited drawbacks of biotechnology (USDA - ERS 1991). There are also concerns that foods with transplanted genes may cause allergic reactions in some consumers, as well as concerns regarding the ethics of tampering with nature via genetic modification.

The FDA and the United States Department of Agriculture (USDA) have adopted voluntary labeling policies for GM foods, unless they are shown to be materially different from their conventional counterparts; mandatory labeling is necessary if a GM product is proven to be materially different from the non-GM counterpart. The U.S. policy also provides for voluntary labeling of foods that contain no GM ingredients.

Consumers' attitudes and use of food labels are related to their desire to make an informed buying decision. Therefore, it follows that a consumer's beliefs regarding the risks and benefits of GM foods will affect his or her attitude and use of GM food labels. The objective of this study is to measure the effects of consumer risk/benefit perceptions regarding foods derived from biotechnology on their attitudes toward the current United States labeling policy for GM foods.

## Literature Review

Numerous surveys regarding the labeling of GM foods have been conducted in the United States. For instance, Hallman and Metcalfe (1995) reported that 84% of 604 New Jersey residents were in favor of mandatory labeling of GM fruits and vegetables. Sixty percent of Hallman and Metcalfe's (1995) sample said they would consider buying fresh vegetables if they were labeled as "produced by genetic engineering." Forty-two percent of the respondents who said they would look for produce labeled as not genetically engineered, also said they would buy produce that was genetically engineered if the label gave this information.

Studies by Douthitt (1990) also found that most

[1] The terms "genetically modified," "genetically engineered," "agricultural biotechnology," and "biotechnology" 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.

Harrison is associate professor and Jae-Hwan Han is a research assistant, Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge.

Americans believed genetically modified foods should be labeled. Surveys in other developed countries report similar results. A national survey of Australian consumers found that 89% of respondents believed genetically engineered tomatoes should be labeled. Only 4% percent of the respondents were against labeling. About 35% percent said labeling GM tomatoes would be a good idea, while 65% percent said unlabeled GM tomatoes would be a bad idea (Kelley 1995).

Other surveys have returned mixed results regarding labeling of GM foods. For instance, the International Food Information Council (IFIC) has sponsored annual consumer surveys on the topic of biotechnology since the mid-1990s. Approximately 1000 separate telephone interviews of U.S. consumers were conducted between 1997 and 2001(IFIC 2001). These surveys reported that 78% of Americans supported the current FDA labeling policy in 1997. However, support for the FDA policy had eroded to only about 37% by the 2001 survey.

Hoban and Kendal (1992) examined perceptions regarding the safety of GM foods among U.S. consumers in 1995 and 1997. Their results showed that an increasing number of consumers were willing to purchase genetically modified foods. They also found that U.S. consumers expressed the most concern about microbial contamination and pesticides, and little concern over the food-safety risks of biotechnology. On the other hand, other studies indicate U.S. consumers are concerned about the safety and environmental risks of GM foods. For instance, a 2002 survey by Teisl et al. (2003) indicated that unknown long-term health and environmental effects of GM foods were among the top five concerns by U.S. consumers.

Moon and Balasubramanian (2001) analyzed U.S. consumers' willingness to pay (WTP) for GM foods. Their results indicated that perceived human health risks had a positive and significant effect on U.S. consumers' WTP for non-GM foods. In another study, Moon and Balasubramanian (2004) investigated the public's attitude toward agrobiotechnology. Survey data from the U.S. and UK were analyzed using a multi-attribute model relating beliefs about the risks and benefits of agrobiotechnology to attitudes toward the new technology. Their results showed that trust in government regulations, a sense of outrage toward the new technology, and selected socio-demographic variables play a significant role in shaping consumer attitudes toward GM crops.

Only a few empirical studies have examined mandatory labeling of GM foods. Lusk and Fox (2002) analyzed consumers' willingness to pay for mandatory labeling of beef administered growth hormones or fed genetically modified corn. Sixty-four percent of the respondents indicated a preference for mandatory labeling of beef fed GM corn. They found 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. In a similar study, Lusk, Roosen, and Fox (2003) estimated the willingness-to-pay (WTP) for beef fed non-GM corn for France, German, UK, and U.S. consumers. Results indicated that feeding GM corn negatively affects U.S. and European consumers' willingness to purchase beef. They also found that consumers were willing to pay approximately US$3.75 to US$11 per pound for beef not fed GM corn. However, the effects of risk and benefit perceptions on WTP, purchase decisions, and labeling preferences were not examined.

Rousu et al. (2002) analyzed the effect of third-party verifiable information, as a mitigating factor to negative information, on consumer's willingness to switch from non-GM to GM foods. Their results indicated that verifiable information has a small but positive effect on consumer's willingness to accept GM foods. In another study, Huffman et al. (2002) used experimental auctions to test whether consumers were willing to pay more for non-GM foods. They also examined the effects of mandatory and voluntary labeling regimes on consumers' WTP for non-GM products. Their results were consistent with those of Lusk, Roosen, and Fox (2003), which found that consumers are willing to pay more for non-GM products. They test the hypothesis that consumers discount GM foods differently under voluntary and mandatory policies. Their analysis indicated consumers use information from the two labeling regimes in the same way, and since a mandatory policy would be more costly for society to implement, they conclude social welfare is greater under the voluntary regime.

Hine and Loureiro (2002) linked consumers' knowledge of genetically modified (GM) foods to preferences for mandatory labeling. Various socio-demographic characteristics were also hypothesized to effect consumer preferences for mandatory labeling. Their results indicated that consumers who considered themselves well-informed about

biotechnology did not appear to be as concerned about mandatory labeling of GM foods as those who are less informed. Harrison and Mclennon (2004) used conjoint analysis to measure the preferences of United States consumers for labeling of GM foods. The study found that consumers generally support mandatory labeling of GM foods. Results also showed the preferred labeling format is a text disclosure that describes the benefits of biotechnology in combination with a biotech logo. The present study differs from previous literature by analyzing linkages between consumer perceptions regarding the risks and benefits of GM foods, and the effects of these beliefs on consumer attitudes toward the current GM labeling policy.

## Methods

### *Conceptual Model*

The conceptual model used in the analysis was developed by Fishbein and Ajzen (1975). The basic premise of their model is that an individual's belief regarding a particular attribute of an object or concept directly affects his or her overall attitude toward the object or concept. Fishbein and Ajzen (1975) define attitudes as a learned predisposition regarding an object or concept. In the present study this is analogous to the consumer's predisposition regarding the current GM food labeling policy (i.e., a preference for or against the current labeling policy). Beliefs are defined as the consumer's perception regarding the association between a particular attribute (e.g., perceived health risk of GM foods) and a given object or concept (Moon and Balasubramanian 2004). The model hypothesizes that the overall attitude toward an object or concept is an additive multi-attribute function of the individual's belief structure. The model is specified as

$$(1)\quad A = \sum_i \beta Xi,$$

where $A$ is the overall attitude toward the object or concept and $\beta$ measures the relative strength of the individual's belief in the "goodness" or "badness" of attribute $i$ (i.e. $Xi$). Moon and Balasubramanian applied this model to examine the effects of consumer beliefs on attitudes toward biotechnology. We apply a similar model to examine the effects of beliefs regarding risks and benefits of biotechnology on consumer attitudes toward the current U.S. labeling policy for GM foods.

### *The Questionnaire and Survey*

A questionnaire was developed following focus groups and pretests regarding consumers' perceptions of potential benefits and risks of GM foods. The survey instrument included statements on the current labeling policy, statements pertaining to consumer beliefs of GM foods, and questions regarding the consumers' use of food labels. We also included questions pertaining to the individual's socio-demographic characteristics, which included age, income, ethnic background, education, gender, and family status.

The questionnaire presented background information on biotechnology, including a definition of biotechnology and GM foods, a description of the present and future uses of biotechnology, and a description of the current labeling policy. This was followed by several questions pertaining to the respondents' general knowledge of biotechnology and questions on how often they read food labels while shopping.

The survey was administered by mail using a modified version of Dillman's (1978) total design method. Three thousand four hundred and fifty surveys were mailed to randomly selected households in the metropolitan areas of Denver, Chicago, Atlanta, Los Angeles, New Orleans, New York, and Houston. A cover letter accompanied the questionnaire, which provided information regarding biotechnology, food labeling, the rationale for the study, 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 non-respondents two weeks after the initial mailings. Five hundred nine usable questionnaires were returned, an overall response rate of 14.75 percent.

Frequency distributions for the socio-demographic information of the sample are presented in Table 1. Fifty-four percent of the respondents were men and forty-six percent were women. All age groups are represented in the sample, with the 45–54 age group representing the largest percentage (27%). Most of the respondents are highly educated: more than 80% finished some college, completed a bachelor degree, or did postgraduate work. The median income of respondents is between $30,000 and $44,999, accounting for 20%

**Table 1. Socioeconomic and Demographic Profiles and Respondent Preferences for Voluntary or Mandatory Labeling Policy for GM Foods.**

| Demographic Profile for Sample | Sample Number | Sample Percentage | U.S. Census Profile for Population[a] | Population Percentage |
|---|---|---|---|---|
| **Gender** | | | **Gender** | |
| Male | 274 | 54.0 | Male | 49.0 |
| Female | 235 | 46.0 | Female | 51.0 |
| **Age** (years) | | | **Age** (years) | |
| 18–24 | 12 | 2.36 | Less than 25 | 37.0 |
| 25–34 | 56 | 11.00 | 25–34 | 16.21 |
| 35–44 | 99 | 19.45 | 35–44 | 16.37 |
| 45–54 | 135 | 26.52 | 45–54 | 12.77 |
| 55–64 | 93 | 18.27 | 55–64 | 7.73 |
| 65 or older | 114 | 22.40 | 65 or older | 9.95 |
| **Education** | | | **Education** | |
| Less than high school | 2 | 0.39 | Less than high school | 23.55 |
| Completed high school | 58 | 11.39 | Completed high school | 22.51 |
| Technical school | 37 | 7.27 | Associate degree | 5.92 |
| Some college | 119 | 23.88 | Some college | 20.59 |
| Completed Bachelor degree | 150 | 29.47 | Completed Bachelor degree | 17.50 |
| Postgraduate work | 143 | 28.09 | Postgraduate work | 9.93 |
| **Income** | | | **Income** | |
| Less than $15,000 | 33 | 6.48 | Less than $14,999 | 15.49 |
| $15,000–$29,999 | 47 | 9.23 | $15,000–$24,999 | 11.17 |
| $30,000–$44,999 | 101 | 19.84 | $25,000–$49,999 | 26.9 |
| $45,000–$59,999 | 99 | 19.45 | $50,000–$74,999 | 19.22 |
| $60,000–$74,999 | 76 | 14.93 | $75,000–$99,999 | 11.27 |
| $75,000–$89,999 | 53 | 10.41 | $100,000–$149,999 | 9.64 |
| $90,000–$104,999 | 32 | 6.29 | More than $150,000 | 6.31 |
| $105,000–$119,999 | 19 | 3.73 | | |
| More than $120,000 | 49 | 9.63 | | |
| Respondents indicating preference for voluntary or mandatory labeling | | | | |
| Voluntary labeling | 103 | 20 | | |
| Mandatory labeling | 406 | 80 | | |
| N=509 | | | | |

[a] Aggregate data for Atlanta, Chicago, Denver, Houston, Los Angeles, New Orleans, and New York (U.S. Census 2000).

of the sample. Frequency distributions concerning respondents' agreement or disagreement with the mandatory labeling versus voluntary labeling question are also presented in Table 1. As shown, of the 509 respondents, 80% (409) support a mandatory labeling policy for biotech products. Only 20% of respondents favor the current labeling policy.

It should be noted that the somewhat low response rate may lead to nonresponse bias. For instance, it is possible that consumers responding to the survey are more interested in GM foods than are nonrespondents, and therefore are more sensitive to the risks and benefits of biotechnology relative to the general population. This may lead to an upward bias in the estimates of consumer attitudes toward GM labeling. Moreover, sampling bias may also be present since the survey targeted only urban consumers. Attitudes may be different for individuals living in rural areas. Another limitation is that most respondents in the survey had either some college or higher levels of education. Less-educated consumers may have different preferences relative to the highest educated consumers.

*Empirical Model*

A stochastic regression model can be used to estimate the βs in the conceptual model (Moon and Balasubramanian 2004). Attitudes for the current U.S. labeling policy is hypothesized to be related to consumer beliefs regarding unknown health and safety risks of GM foods, potential negative effects that GM crops may have on wildlife and the environment, and benefits of GM crops to farmers. Consumers' confidence in the FDA's regulatory policies for GM foods, and the degree in which they use existing food labels are also hypothesized to play an important role in shaping consumer attitudes toward the current labeling policy. Other variables expected to affect labeling preferences include the frequency with which consumers use food labels.

A binary probit model is used in the present study and specified as follows:

$$(2)\quad \Pr(y = 1|x) = \int_{-\infty}^{x'\beta} \phi(t)dt = \Phi(\mathbf{x}'\beta),$$

where $\phi(t)$ is the standard normal density function, $y$ is a binary variable indicating the respondents support or opposition for the current labeling policy, and $\mathbf{x}$ is a matrix of explanatory variables. The regression model for the structural equation is given by $y_i = \mathbf{x}'\mathbf{b} + \varepsilon_i$, where $y_i$ is defined by respondent $i$'s response to the following question:

> "The present policy of the U.S. Food and Drug Administration (FDA) is that labeling of biotech [GM] foods should be voluntary, since it has been determined these foods have the same safety and nutritional contents as other foods. FDA argues that mandatory labeling of biotech [GM] foods could unnecessarily raise the health concerns about biotech [GM] foods. However, critics of this policy say that any food produced through biotechnology should be labeled, even if the safety aspect of the food has not been altered. They argue it is the consumer's right to know. Which labeling policy are you most likely to agree with, the FDA's or its critics?"

A response indicating agreement with the current policy is coded as 1, and a response indicating agreement to a mandatory labeling policy is coded as 0. The coefficient vector b is estimated using maximum-likelihood techniques and interpreted as the change in the conditional mean of $y$ given a change in x. The error term ($\varepsilon_i$) is assumed to be normally distributed with mean of zero and variance equal to one. The $\boldsymbol{x}$ matrix defines the respondent's beliefs regarding risk/benefit attributes of GM foods using responses to a series of statements (statements S1 through S4, Table 2). Statements S1 through S4 are coded using a 5-point Likert scale, where 5 indicates strongly agree and 1 indicates strongly disagree.[2]

Potential risks and benefits of GM crops are discussed by Vogt and Parish (1999). The uncertainty regarding long-term health affects of GM foods includes a belief (by some individuals) that genes introduced to novelty foods or "super crops" could be allergenic or harmful to human health. Other consumers are "worried that a gene introduced into plants to protect against pests could also cause the plant to alter its pollen, thereby affecting the health of humans prone to some sensitivities" (Vogt and

[2] Likert scales are often assumed to be consistent with equal interval scaling, and therefore treated as continuous independent variables in statistical analysis. There is debate within the psychological measurement literature regarding the implications of this assumption, but several studies show that for a 5-point or greater scale, it has little effect on Type I or II errors (Jaccard and Wan 1996).

**Table 2. Probit Estimates of Urban Consumer Preferences for Voluntary Versus Mandatory GMO Labeling, [a]**

| Variable | Coefficient | b/SE | Marginal Probs | b/SE |
|---|---|---|---|---|
| Constant Term | -0.591 | -0.586 | -.127 | -0.589 |
| S1. GM foods are reasonably safe for human consumption. [b] | 0.314** | 2.312 | 0.068** | 2.354 |
| S2. GM crops may have adverse effects on wildlife and the environment. | -0.350*** | -3.645 | -0.075*** | -3.770 |
| S3. Meat products produced using biotechnology are more likely to pose health risks than foods made from GM crops. | 0.0129 | 0.123 | 0.003 | 0.123 |
| S4. Biotechnology benefits society because it allows farmers to produce food more efficiently. | -0.106 | -0.846 | -0.023 | -0.847 |
| S5. There is no need to be concerned about the safety of GM foods because the U.S. Food and Drug Administration (FDA) would not let these products be sold in supermarkets if they are not safe. | 0.310*** | 4.241 | 0.067*** | 4.253 |
| S6. It is unethical to produce a food using GMOs. | -0.081 | -0.804 | -0.018 | -0.808 |
| Q1. How often do you read the ingredients section of food labels before buying a new product? [c] | -0.242** | -2.983 | -0.052*** | -2.975 |
| Q2. How well informed would you say you are about GM foods? | -0 .0004** | -1.972 | -0.0009** | -1.995 |
| Age[d] | | | | |
| Age (18-34) | -0.422* | -1.638 | -0.076** | -1.997 |
| Age (over 55) | -0.298* | -1.630 | -0.062 | -1.680 |
| Income[e] | | | | |
| Income (less than $29,999) | 0.212 | 0.511 | 0.493 | 0.476 |
| Income ($30,000–$59,000) | 0.282 | 0.746 | 0.063 | 0.725 |
| Income ($60,000–$89,000) | 0.099 | 0.256 | 0.022 | 0.249 |
| Income ($105,000–$119,999) | 1.119** | 2.344 | 0.362** | 1.948 |
| Income (more than $120,000) | 0.203 | 0.483 | 0.048 | 0.446 |
| Ethnic Group[f] | | | | |
| African American | 0.647 | 1.174 | 0.180 | 0.977 |
| Hispanic | 0.633 | 1.072 | 0.179 | 0.884 |
| Caucasian (white) | 0.386 | 0.773 | 0.073 | 0.893 |
| Asian | 0.075 | 0.122 | 0.017 | 0.117 |
| Education[g] | | | | |
| High school Graduate | -0.013 | -0.053 | -0.003 | -0.054 |
| College Graduate | 0.092 | 0.516 | 0.020 | 0.520 |
| Gender (Male=1) | -0.131 | -0.822 | -0.028 | -0.815 |
| Child | -0.381** | -2.109 | 0.076** | -2.277 |
| N = 509 | | | | |
| Chi-square ($\chi^2$)= 159.0203 | | | | |

[a] The dependent variable is coded 1 if the respondent agreed with FDA's current voluntary labeling policy, or 0 if the respondent agreed with a mandatory policy.

[b] Statements S1 through S6 are coded using a 5-point scale, where 5 indicates strongly agree and 1 indicates strongly disagree.

[c] Question Q1 is coded using a 5-point scale, where 5 indicates a response of always and 1 indicates a response of never. Question Q2 is also coded on a 5-point scale, where 5 indicates very informed and 1 indicates not at all informed.

[d] excludes the 35–54 age group category.

[e] excludes $90,000–$104,999 income group category.

[f] excludes American Indian and others.

[g] excludes technical and some college category.

[h] *,**, and *** indicate the coefficient is significant at the 0.10, 0.05, and 0.01 level, respectively.

Parish 1999). As consumers' belief in these health risks increase we expect acceptance of GM foods to decrease, and consumers' preference for the current labeling policy to also decrease. Therefore, we expect the sign on S1 to be positive.

Proponents of GM crops believe that biotechnology can be less harsh on the environment than traditional technologies. They believe that fewer agricultural chemicals might be needed to grow pesticide-tolerant or insect-resistant crops, and that land would need less repeated tilling, which could lead to less erosion and soil infertility. Critics express concerns about the long-term risks and consequences of cross-pollination and disruption of "cellular ecology" of plants (Vogt and Parish 1999). Therefore, as a respondent's response to S2 increases we expect acceptance of GM crops to decrease and preference for the current labeling policy to also decrease. We expect the sign of S2 to be negative.

Some surveys have suggested beliefs regarding health and environmental risks may be different for meat products derived from biotechnology relative to GM crops (Hoban and Kendal 1992). Statement S3 is included in the model to test this hypothesis. A significant positive sign would provide evidence to support the hypothesis. As previously discussed, GM crops can potentially reduce production costs and enhance yields, leading to more-efficient food production. Statement S4 was included to capture consumer beliefs in this benefit of biotechnology. As belief in the efficiency attribute of biotechnology increases, consumer acceptance of GM foods is expected to increase. However, the sign on statement S4 is ambiguous, as some consumers who believe in the benefits of biotechnology may also support labeling to disclose these benefits. On the other hand, consumers believing in the benefits of biotechnology may not see the need for mandatory labeling, which would lead to a negative sign for statement S4.

Trust in government regulatory agencies and ethical beliefs associated with production of GM foods are tested using statements S5 and S6 in Table 2. These statements are also measured using a 5-point Likert scale, where 5 indicates strongly agree and 1 indicates strongly disagree. Moon and Balasubramanian (2004) found that consumer trust in regulatory agencies plays an important role in shaping their acceptance of GM foods. It also seems plausible that trust in regulatory agencies would play an important role in consumer attitudes toward the current U.S. labeling policy for GM foods. We expect that as consumer trust in the FDA's ability to regulate the safety of GM foods increases, the consumer's support for the current labeling policy increases. Therefore, we expect the sign of S5 to be positive. Religious beliefs and ethical issues associated with cloning may also play an important role in acceptance of biotechnology (Vogt and Parish 1999). It is plausible that ethical beliefs would also affect consumer attitudes toward GM labeling. We expect the sign on S6 to be negative, indicating that as consumers' believe genetic modification to be unethical, their support for the current labeling policy would decrease.

The $\boldsymbol{x}$ matrix also contains responses to two questions regarding the subject's use of food labels and their perception of how informed they are about GM foods and biotechnology (Q1 and Q2, Table 2). Questions Q1 and Q2 are also coded using 5-point scales, but here 5 indicates a response of always and 1 indicates a response of never for Q1; and, for Q2, 5 indicates very informed and 1 indicates not at all informed. We expect consumers who regularly use food labels to place a premium on information provided by labeling of GM food, thus we expect the sign of Q1 to be negative indicating greater use of food labels leads to less support for the current policy.

Genetically modified foods are produced using relatively new technologies, so the familiarity with this technology will likely affect acceptance. Other research found the degree consumers believe themselves informed about biotechnology had a positive effect on consumer acceptance (Moon and Balasubramanian 2004). It is also plausible that the degree to which consumers believe themselves to be informed about GM foods also affects their support for the current labeling policy. However, we expect the sign for Q2 to be negative, as relatively more informed consumers may place greater value on information provided by a mandatory labeling policy.

In addition to beliefs, knowledge, and label-use questions, the conceptual model is augmented to include socio-demographic variables to control for factors such as income, age, ethnic group, education, gender, and whether the respondent has children. The coding is as follows: $Age_{ij}$=1 if the ith respondent's age corresponds to the jth group, 0 otherwise; $Inc_{ij}$=1 if ith respondent's 2001 income falls into jth category, 0 otherwise; $Eth_{ij}$ =1if the

ith respondent's race corresponds to jth category, 0 otherwise; $Edu_{ij}$=1if the ith respondents' education level corresponds indicates the jth category, 0 otherwise $Male_i$=1 if the ith individual is male, 0 otherwise; $Child_i$=1 if ith respondent has children, 0 otherwise.

## Results

Results of the probit model are presented in Table 2. The chi-square statistic indicates the overall model is significant at the $\alpha = 0.01$ level of significance. Coefficients and marginal probabilities associated with statements S1, S2, and S5 are significant at the $\alpha = 0.05$ percent level, and have the expected signs. The marginal probability for S1 is positive, indicating that as the respondent's belief in the safety of GM foods increases, the probability of supporting the current labeling policy increases. Of course this also implies that consumers who perceive GM foods as risky to health are more likely to support a mandatory labeling policy.

The sign on S2 is negative, indicating that respondents who believe GM crops to be potentially harmful to wildlife and the environment are less likely to support the current policy and more likely to support a mandatory labeling policy. The sign associated with S5 is positive, suggesting that respondents with higher levels of confidence in the U.S. Food and Drug Administration's regulatory policies toward GM foods are more likely to support the current labeling policy.

Statements S3, S4, and S6 were intended to control for the effects of the consumer's sensitivity to GM meats versus crops, beneficial aspects of biotechnology to farmers, and the ethical aspects of GM ingredients in food production, respectively. The coefficients and marginal probabilities associated with these statements are not significantly different from zero, indicating these aspects of the biotechnology debate have little effect on consumer preferences for GM labeling.

The coefficients and marginal probabilities for both Q1 and Q2 are significant at the $\alpha = 0.05$ percent level or higher, and have the expected signs. The negative sign associated with Q1 indicates that frequency of food-label use lowers the probability of consumers supporting the current labeling policy. Alternatively, respondents who make little use of food labels are more likely to support the current labeling policy. Seventy-eight percent of the respondents in our survey indicated they read food labels often or always when buying a new food product.

The negative signs on Q2 indicate that respondents who believe themselves to be relatively well-informed about GM foods are less likely to support the current labeling policy. This provides some evidence to support the hypothesis that consumers considering themselves informed about GM foods would support additional information about GM ingredients on food labels. On the other hand, consumers considering themselves to be minimally informed about biotechnology are more likely to support the current policy. This suggests that consumers who know little about biotechnology are not interested in disclosure of GM ingredients.

Socioeconomic/demographic variables are used in the model to control for differences in respondent characteristics on labeling preferences. Coefficients and marginal probabilities associate with age are significant at the $\alpha = 0.10$ level. The negative sign associated with the over-55 and 18–24 age groups indicate that respondents over fifty-five and under 25 are more likely to support a mandatory labeling policy, as compared to the omitted 35–54 age group. Of the income categories, only the $105,000–$119,999 income group is significant at the $\alpha = 0.05$ level. Results show that respondents in this income category are more likely favor the current labeling policy, as compared to the omitted $90,000–$104,999 income group.

The ethnic group, education, and gender variables are not significantly different from zero, indicating these demographics have no effect on labeling preferences. In general, one might expect more-educated consumers to be more informed about GM foods and therefore more sensitive to the labeling policy. However, our results indicate education is not significant. This may be associated with the fact that our sample is skewed toward a highly educated group of consumers. Therefore, inferences from our results to a less-educated set of consumers should be approached with caution. Other studies have also found a general lack of significance with respect socio-demographic variables (Naoya and Chern 2003; Lusk and Fox 2002; Baker and Burnham 2001).

The coefficient associated with the respondents having children is negative and significant at the $\alpha = 0.05$ level. The negative sign suggests that respondents with children are more likely to support a mandatory labeling policy. This may occur

because respondents with children possess a greater sensitivity to the potential risks of GM foods than do respondents without children.

## Conclusions

This study examined the effects of beliefs regarding the risks and benefits of GM foods on urban consumers' attitudes toward the current U.S. policy for labeling GM foods. Labeling preferences were hypothesized to be related to beliefs regarding unknown health and safety risks of GM foods, the potential negative effects biotechnology may have on wildlife and the environment, and consumer confidence in the regulatory agency charged with controlling GM foods. Other variables expected to affect labeling preferences included the frequency with which consumers use food labels as well as various socioeconomic and demographic variables.

Results showed that as belief in the potential adverse effects of biotechnology on wildlife and the environment increase, consumer support for the current U.S. labeling policy decreases. This variable yielded the largest negative marginal probability relative to other risk perception variables, suggesting that concerns about potential environmental damage of GM crops is perhaps the most important issue to the labeling debate. The safety of GM foods with respect to human consumption was also important, as consumers who perceive them to be safe (unsafe) are more (less) likely to support the current policy. Other results showed that as consumer confidence in the FDA's ability to regulate GM foods increases, the more likely they are to support the current policy.

On the other hand, consumers who read labels more frequently, consider themselves more informed about GM foods, and have children in their households were less likely to support the current policy. A belief in lower cost of food production (a beneficial attribute of biotechnology) did not have a significant effect on consumer attitudes toward the current labeling policy.

We conclude that beliefs regarding health and environmental risks of biotechnology play an important role in shaping consumer opinion toward the U.S. GM labeling policy. This finding is consistent with the findings of studies investigating consumer attitudes toward agrobiotechnology in general (Moon and Balasubramanian 2004). Our results suggest these beliefs are also significant determinates of consumer attitude toward the current labeling policy. Moreover, the consumer's confidence in the U.S. Food and Drug Administration also plays an important role in shaping consumer opinion toward the current labeling policy. Therefore, it is paramount that government agencies continue to provide credible and objective information regarding the risks and benefits of GM foods. This is particularly true since misinformation, which may be provided by special interest groups and other private organizations, will also influence consumer attitudes. Finally, since eighty percent of respondents in our survey indicated they would support a mandatory labeling policy, our results suggest that GM labeling may be an important source of information for urban consumers.

As previously mentioned, a limitation of the present study is that only the seven largest metropolitan regions of the United States were surveyed. Future research should focus on sampling a more diverse group of consumers. Labeling preferences of individuals living in rural areas of the United States may differ from those found among urban consumers. Since mandatory labeling is expected to add to the cost of marketing biotech foods, additional research is also needed regarding consumers' willingness to pay for the information that would be provided on GMO labels. This study did not address the effectiveness of labels in communicating risks and benefits of GM foods. This information may also be provided through educational publications, websites, toll-free hotlines, or some combination of these media sources. Future research that evaluates alternate methods of informing consumers regarding the risks and benefits of GM foods is also needed.

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