Selected Paper for Presentation at Annual Meeting of
American Agricultural Economics Association, Chicago, Aug 5 - 8, 2001

A Multi-attribute Model of Public Acceptance of Genetically Modified Organisms

Abstract

Using Fishbein's multiattribute model as a theoretical background, this paper develops an empirical model to assess and identify attributes of agrobiotechnology and individual characteristics determining public acceptance of biotech foods. This paper uses a database collected in the United States and United Kingdom in November, 2000.

Wanki Moon
Dept. of Agribusiness Economics
Southern Illinois University
Carbondale IL 62901
Tel) 618) 453-6741
Fax) 618) 453-1708
Email) wmoon@siu.edu

Siva Balasubramanian
Dept. of Marketing
Southern Illinois University
Carbondale IL 62901

A Multiattribute Model of Public Acceptance of Genetically Modified Organisms

Introduction

When biotechnology forms of major crops appeared in market in the mid-1990s, agricultural biotechnology has been hailed as a major technological breakthrough that would potentially revolutionize the way crops are produced while enhancing the nutritional value of food products. Since then, because of their ability to increase yields and reduce pest-management cost, the adoption of bio-engineered seeds for corn, soybean and cotton has dramatically expanded. In line with the expansion in production, Hoban (1998) reported that more than 70 percent of consumers surveyed in 1992, 1995, and 1997 supported the application of biotechnology in food production. Beginning from 1999, however, U.S. consumers started to question the credibility of the FDA's approval of transgenic crops and began to diverge with scientists' view that GMOs essentially pose no additional health risks as compared to nonGMOs (Miranowski, 1999; Jostling et al., 1999; ERS, 2000b).

Growing consumer concerns raised such intriguing issues as adoption of identity preservation, market segregation, and labeling as ways of distinguishing GMOs from nonGMOs throughout the food supply chain. These issues of identity preservation, segregation, and labeling constitute the most integral components of the current debate about transgenic crops and the stakes are huge for all involved in the food supply chain including consumers, farmers, food manufacturers, retailers, and government as well as agri-biotechnology firms. Fundamental to the concepts of identity preservation, market segregation, and labeling is public acceptability of biotech foods. How consumers perceive and assess potential risks and benefits associated with agri-biotechnology will determine the emergence and magnitude of the demand for nonbiotech

foods, thus the scope of market segregation and the type of labeling system. Hence, understanding the nature of consumer preferences about biotech foods is of profound significance to the stakeholders including farmers, agribiotechnology industry, and policy makers.

The main objective of this research is to develop empirical models to identify factors shaping public acceptance of biotech foods. In particular, this paper evaluates how consumer perceptions about various attributes of agrobiotechnology are related to public acceptance of biotech foods. Eight attributes including four negative and three positive aspects of agrobiotechnolgy are considered in this paper. Measuring the relative effect of risk and benefit perceptions on public acceptance would present an important insight into understanding public sentiment about biotech foods. The influence of consumer knowledge about and awareness of biotech issues, the level of trust on regulatory agency and global attitude toward food safety on public acceptance of biotech foods are also estimated along with risk and benefit perceptions.

Subsequently, given the dominant role of health risk in the debate about biotech foods, this paper develops health risk perception models and identify individual characteristics impacting health risk perception from eating foods containing biotech ingredients. To develop those models exploring public acceptance of biotech foods and health risk perception, this paper uses a large-scale survey database collected in November, 2000 in two countries including the United States and United Kingdom. The database includes 3,060 respondents from the United States and 2,568 respondents from the United Kingdom. Hence, the database presents an opportunity to compare the preferences of the U.S. and U.K. consumers in regard to foods containing biotech ingredients.

Survey Design

Survey instrument was designed primarily to evaluate factors underlying public attitude toward genetically modified organisms. The instrument was tested and question wording was refined in light of the results of three focus group studies.[1] The survey was implemented by mail in November, 2000 and the data were collected using a consumer panel of about 400,000 consumers across the United States maintained by the National Panel Diary (NPD) group. The NPD group is a marketing consulting firm specializing in the areas of researching consumer behavior and food marketing.

Survey method using such an established panel is called 'permission-based survey' and increasingly used in exploring various respects of consumer behavior for academic or commercial purposes. Advantages associated with the permission-based survey include: (1) response rate is higher than other regular surveys, and (2) demographic information is disclosed for non-returners as well as returners, which would permit researchers to assess potential non-response bias. Questionnaires were distributed to 5,200 households selected across the United States by random sampling: about 3,000 households returned completed questionnaires, yielding a response rate of nearly 58 percent.

The sample is drawn stratified by geographic regions, market size, household head age, education and income to balance with the U.S. census for adults. Table 1 compares the sample with the U.S. census based on socioeconomic and demographic profiles. The comparison suggests that the survey sample is remarkably well representative of the U.S. census in most of

[1] Each focus group consisted of eight people recruited locally. The studies were conducted in Carbondale, Illinois in the fall, 2000.

the demographic categories. In addition, Table 1 shows that the sample is drawn from four geographic regions (Northeast, Midwest/North Central, South, and West) quite in proportion with the U.S. census. The only noticeable discrepancy is the moderate under-representation of 'Not Employed' category in the sample as compared with the U.S. census.

The same instrument was implemented to consumers in the United Kingdom. The survey in the U.K. used on-line method instead of mail. The on-line method uses the Internet as a data collection tool and provides the following advantages over the more traditional methods (e.g., mail, mall, phone): (1) faster response time, (2) lower costs versus mall or mail/phone; (3) ability to follow up with panelists quickly and inexpensively, and (4) more current samples. However, a question arise regarding the validity of on-line method: if online samples are matched demographically to actual census demographic characteristics, are the results obtained via the online methodology the same as those obtained using the traditional data collection methods?

In addition to the potential discrepancy of demographic characteristics, the on-line method could result in a further bias due to the fact that the sampling was restricted to those who have an access to computer and Internet. A possible conjecture about the direction of the bias is that consumers with an access to Internet would be more technologically-oriented and more likely to accept new technologies than those without the access, leading to an upwardly biased acceptance rate. Accordingly, the results from the U.K. survey should be interpreted in light of the potential biases that may be associated with this particular sampling method.

About 9,000 consumers voluntarily registered to participate in the NPD on-line survey panel in the U.K. For this survey, the NPD group sent all of 9,000 consumers e-mails providing a brief description of the survey and leading them to the website exhibiting the questionnaire.

Nearly 2,600 consumers returned completed surveys within the first seven days after they were contacted by the NPD via e-mails.[2]

Multi-attribute Model

Fishbein's multiattribute model (attitude toward an object) offers a conceptual framework for analyzing the linkage between overall attitude toward agrobiotechnology and perceptions about various attributes associated with the application of biotechnology to crop and food production (Fishbein, 1963; Fishbein & Ajzen, 1975). Attitudes are an expression of inner feelings that reflect whether a person is favorably predisposed to some object. While measuring attitudes helps understand consumer's overall evaluation for an object, it fails to present specific insights as to what influences or explains a consumer's evaluative rating. The multiattribute model views an attitude object as possessing multiple characteristics (attributes) that establish the basis of consumer's attitude. Fishbein's model is written as,

(1) $ATTITUDE_t = \sum_{i=1} \beta_{it} Z_{it} \qquad i = 1, 2, ...n$

where $\boldsymbol{\beta_{it}}$ is the importance weight or the goodness or badness of attribute($\boldsymbol{i}$) evaluated by consumer ($\boldsymbol{t}$) and $\boldsymbol{Z}_{it}$ is the strength of the belief of consumer ($\boldsymbol{t}$) that the object has an attribute ($\boldsymbol{i}$); and $\boldsymbol{n}$ is the number of salient attributes. The model thus proposes that attitude toward an object is based on the summed set of beliefs about the object's attributes weighted by the evaluation of these attributes. In marketing studies, both the evaluation ($\boldsymbol{\beta_{it}}$) and belief (Z_{it}) are obtained through consumer surveys, and used for calculation of the overall attitude toward an object.

---

[2] A little fewer than 1,000 consumers responded at the first day of opening the survey field on the Internet.

The data used in this study provide cross-sectional information on overall attitude toward agrobiotechnology and strength of the belief that agrobiotechnology has certain attributes. Consequently, by modifying equation (1) into a stochastic regression model, we can statistically measure the importance weight or evaluation of the goodness or badness of attribute (***i***),

(2) $ATTITUDE_t = \sum \beta_{it} Z_{it} + \varepsilon_t \quad i = 1, 2, ...n$

where subscript (***t***) denotes consumers; $\boldsymbol{Z_t}$ is a vector of perceived attributes of agrobiotechnology and $\boldsymbol{\beta}$ now represents a vector of unknown regression coefficients to be estimated. Magnitudes and signs of the estimated coefficients would measure the importance and goodness or badness of each attribute, respectively, in overall attitude toward agrobiotechnology (Steenkamp, 1997).

Model Specification

The dependent variable in this study, public acceptance of agrobiotechnology, was measured with six-point scale ranging from Strongly Oppose to Strongly Support. About 32 percent of U.S. consumers expressed support for the use of biotechnology in crop production, while 31 percent opposed it (Table 2). Approximately 37 percent responded that they couldn't form their opinions. The percentage of U.K. consumers in support of agrobiotechnology (38 %) was a bit higher as compared to the U.S. consumers, while considerably higher percentage (46 %) opposed the use of biotechnology in crop production. Yet the most noticeable difference lies in the considerably lower percentage of respondents (16 %) who chose 'Don't Know' category in comparison with the U.S. consumers.

In equation (1), consumers' attitude toward agrobiotechnology is hypothesized to be determined by a vector of perceived attributes of agrobiotechnology (Z). Eight perceived attributes in relation to agrobiotechnology are considered in this study: (1) health risks; (2)

environmental risks; (3) moral and ethical considerations; (4) the image of multinational corporations as the primary beneficiaries of biotechnology; (5) the growing control of multinational corporations over farming; (6) potential increase in yields; (7) reduced use of chemical in crop production; and (8) potential improvement in nutritional composition. The first four attributes describe potential risks agrobiotechnolgoy poses while the latter three captures potentially beneficial aspects of agrobiotechnology..

There were considerable correlations (ranging from 0.54 to 0.76) among consumer perceptions about the eight attributes of agrobiotechnology. To cope with potential multicollenearity problem in specifying the empirical model, the eight perceived attributes were reduced to four variables: (i) an index of risk perception (RISK_1) using consumer perceptions about health and environmental risks[3]; (ii) consumer perception about moral and ethical aspects of agrobiotechnology (MORAL_2); (iii) an index of consumer perceptions about multinational corporations (MULTI_3) based on consumer perceptions about (4) and (5); and (iv) an index of benefit perception (BENEFIT_4) based on consumer perceptions about (5), (6) and (7).

In addition to the four indexes representing eight perceived attributes specific to agrobiotechnology (Z_1), the vector Z is augmented in this study to include global attitude toward food safety (Z_2), self-rated knowledge about agrobiotechnology (Z_3), awareness of the agrobiotechnology issues (Z_4), and the level of trust on regulatory authority (Z_5). Accordingly, the vector Z is partitioned into five subgroups $Z = [Z_1, Z_2, Z_3, Z_4, Z_5]$. Table 3 presents a general description of the variables included in the empirical model along with summary statistics.

[3] The index is created by adding up the two variables. Hence, the index would range theoretically from 2 to 12 with 12 representing absolute concerns about health and environments. Other indexes are similarly constructed.

Estimation Results

Public acceptance of agrobiotechnology in this study was measured with six-point scale ranging from 'Strongly Oppose' to 'Strongly Support'. The ordinal property of the measurement scale requires the application of a multi-ordered response model (Madala, 1983). Ordered probit model was adapted to estimate three models based on (1) pooled data, (2) U.S. data, and (3) U.K data. Table 3 presents estimated parameters and asymptotic t-values for the three models along with other summary statistics. The hypotheses that all coefficients in the ordered probit models are simultaneously equal to zero was tested using Loglikelihood Ratio (LR) which is χ^2 distributed. The calculated LR ratio are 243, 198, and 211 for the pooled, U.S. and U.K. data, respectively. Critical value is 25.19 at a 0.01 probability level with 12 degrees of freedom, thus failing to reject the hypotheses. The test results suggest that the specified models have the capabilities to explain the variation in the consumer attitudes across individuals.

Estimated results from the pooled data clearly indicate that not only risk but benefit perceptions in relation to agrobiotechnology play an important role in shaping consumer attitudes toward the use of biotechnology in crop production. If consumers perceived risks on human health from eating biotech foods or believed that agrobiotechnology posed hazards on ecosystem, then they were more likely to oppose agrobiotechnology. In contrast, consumers who associate agrobiotechnology with various benefits as represented by the index, BENEFIT_4, were likely to develop more favorable attitude toward the use of biotechnology in crop and food production than those who do not.

In addition to risk and benefit perceptions, moral and ethical considerations (MORAL_2) and perceptions about multinational corporations had a measurable impact on shaping consumer

acceptance of agrobiotechnology. If consumers perceive that it is ethically morally wrong to use biotechnology, they tended to develop negative attitude toward agrobiotechnology. Similarly, consumers were likely to oppose agrobiotechnology if they believed that corporations were the main beneficiaries from agrobiotechnology, while consumers assumed most of the risk or if they perceived that the influence of multinational seed companies on farming was growing. These results suggest that consumer attitudes toward agrobiotechnology are shaped not only by risk and benefit perceptions but also by other considerations such as moral values or beliefs about multinational corporations.

Global attitude toward food safety (SAFE_1) was also found to exert a significant impact on public acceptance of agrobiotechnology. If consumers consider food safety an important consideration in food purchasing decisions, they had more negative attitude toward agrobiotechnology than those who do not. Knowledge and awareness were important determinants of public acceptance of agrobiotechnology. Self-rated knowledge about and awareness of biotech issues were positively associated with public acceptance of agrobiotechnology, indicating that consumers who think they are knowledgeable about or well aware of biotech issues are more likely to support the application of biotechnology in crop production than those who do not. The degree of trust consumers place on regulatory agency in regard to biotech foods also significantly influenced public acceptance of agrobiotechnology. If consumers believe that FDA has adequate rules and regulations in regard to biotech foods, they were more likely to support the use of biotechnology in crop production. An intriguing result is that U.S. consumers were less likely to support agrobiotechnology in relative to U.K. consumers with other variables being held constant. This may be due to the bias associated with the

different sampling methods used in the U.S. and U.K.

This paper split the data into the U.S. and U.K. and estimated the same model for each country. Comparison of the estimated results from the two countries display important differences in terms of factors influencing consumer attitudes toward agrobiotechnology. For example, food safety consideration was an important component impacting consumer acceptance of biotech foods in the U.K. whereas it was not in the U.S. In addition, self-rated knowledge about biotech issues was statistically significant and positively associated with public acceptance in the U.S. but it did not play a significant role in the U.K.

Perceived Health Risk

The multiattribute model has identified perception about health risk as an important determinant of overall attitude toward agrobiotechnology. In this section, we develop two empirical models to assess demographic and other factors underlying consumer perception about health risk from eating foods containing biotech ingredients. The first model recognizes two major components of perceived risk (i.e., probability and severity of adverse outcome) in addition to demographic profiles, whereas the second model attempts to link consumer awareness, trust on regulatory agency, labeling and availability of information about biotech issues to health risk perception.

Probability and Severity of Adverse Outcome

We define perceived health risk as a consumer's subjective feeling about the probability that a choice may bring an adverse outcome to his/her health (Olgethorpe and Monroe, 1994). This definition involves two aspects of health risk: (1) probability and (2) severity of adverse outcome. Given the definition, we model perceived health risk as a function of measures of the

probability that adverse outcome would occur and severity of the adverse outcome. The probability measure was constructed using consumer responses to the question, *What do you think of the likelihood of health hazards from eating genetically modified foods*? (Table 5). Six-point scale was used ranging from 1 = Extremely Low to 6 = Extremely High. The severity measure was constructed using another six-point scale (1= Not at all severe to 6 = Extremely severe) to the question *If any health problems should occur, how severe do you think they would be?* This model is extended to incorporate demographic characteristics including age, education and gender.

Estimation results for both US and UK show that the measures of both probability and severity strongly influence consumer perception about health risks from eating biotech foods. The results suggest that communication or promotional efforts to deal with consumer perception about the safety of biotech foods should address both the probability of an adverse health outcome to occur and the severity of such an adverse outcome.

For the U.S. consumers, perception of health risks differed significantly by gender and the level of education but not by age. Males were less likely to perceive health risks from biotech foods than females. The higher the level of education the less likely to perceive health risks from biotech foods. In contrast, U.K. consumers' perception of health risks did not vary by the level of education but was significantly influenced by age and gender. Table 6 reports estimated parameters and asymptotic t-values along with other summary statistics.

Awareness, Trust, Information, and Labeling

The following model links consumer perception of health risks to various measures of consume psychological variables including: (1) awareness of agrobiotechnology issues

(AWARENESS), (2) public confidence on regulatory agency regarding the safety of biotech foods (TRUST), (3) consumer perception of information availability (INFORMATION), and (4) consumer reaction to the lack of labeling system to differentiate nonbiotech from biotech foods (LABEL). The four variables were found to play an important role in shaping consumer perception about health risks from biotech foods. Consumers with higher awareness of agrobiotechnology issues were less likely to perceive health risks. If consumers believe that regulatory agency had adequate rules and regulations in regard to biotech foods, then they were less likely to perceive health risks than those who do not. Consumers who feel that there is enough information about biotech foods were less likely to perceive health risks. Finally, if consumers feel outraged that conventional foods are currently not labeled differently than biotech foods in the grocery stores, they were more likely to perceive health risks. In other words, the fact that consumers do not have the right to choose between nonbiotech and biotech foods heightens health risk perception.

References

Ajzen, I. and M. Fishbein. 1980. *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice Hall.

Babcock, B. and J. Beghin. 1999. "Potential Market for Non-GMO Corn and Soybeans." *Economic Perspectives on GMO Market Segregation* Staff Paper No. 298, Iowa State University.

Caswell, J.A. 1998. "Should Use of Genetically Modified Organisms Be Labeled?" *AgbioForum*, 1:22-24.

Caswell, J.A. 2000. "An Evaluation of Risk Analysis as Applied to Agricultural Biotechnology (With a Case Study of GMO Labeling)." *Agribusiness: An International Journal* 16:115-123.

Eom, Y. S. 1994. "Pesticide Residue Risk and Food Safety Valuation." *American Journal of Agricultural Economics* 76: 760-771.

ERS. 2000b. "Biotech Corn and Soybeans: Changing Markets and the Government's Role." *ERS Issues Center*, USDA, April, 12, 2000.

Fishbein M. 1967. "Attitude and the Prediction of Behavior." *Reading in Attitude Theory and Measurement.* Ed. by M. Fishbein. New York: Wiley.

Grobe, D. R. Douthitt, and L. Zepeda. 1996. "Consumer Risk Perception Profiles for the Food-Related Biotechnology, Recombinant Bovine Growth Hormone(rbGH)." *Strategy and Policy in the Food System: Emerging Issues* (Ed. Caswell J. and R.W. Cotterill). Proceedings of NE-165 Conference, June 20-21, 1996, Washington, D.C.

Hoban, T. 1998. "Trends in Consumer Attitudes About Agricultural Biotechnology." *AgbioForum*, 1: 3-7.

Josling, T., L. Unnevehr, L. Hill, and C. Cunningham.1999. "Possible Policy and Market Outcomes in WTO 2000" *The Economics and Politics of Genetically Modified Organisms in Agriculture: Implications for WTO 2000*, Bulletin 809, University of Illinois. November, 1999.

Miranowski, J.A. 1999. *Economic Perspectives on GMO Market Segregation*. Staff Paper No. 298, Iowa State University. October, 1999.

Oglethorpe, J.E. and K. Monroe. 1994. "Determinants of Perceived Health and Safety Risks of Selected Hazardous Products and Activities." *Journal of Consumer Affairs*. Vol 28.

Zechendorf, B. 1998. "Agricultural Biotechnology: Why Do Europeans Have Difficulty Accepting It?" *AgbioForum* 1:8-13.

Table 1. Comparison of the Survey Sample with the U.S. Census for Adults.

	Survey Sample (%)	U.S. Census for Adults(%)		Survey Sample(%)	U.S. Census for Adults (%)
Census Region			**Household Head Education**		
Northeast	21.2	18.9	Grade	1.9	4.7
Midwest	28.0	23.6	Some High	9.3	8.8
South	34.1	35.8	Graduated High	36.8	35.6
West	16.8	21.8	Some College	23.4	23.8
			Graduated	18.9	18.2
			Post College	9.6	9.2
Market Size			**Household Head Occupation**		
<1,000,000	31.0	28.0	White Collar	41.3	44.7
1,000,000 - 2,499,999	22.6	24.6	Blue Collar	31.9	30.4
2,500,000	22.5	28.4	Student	1.0	0.9
Non-MSA	23.8	19.0	Retired	20.5	23.5
			Other	5.2	0.5
Household Head Age			**Household Income**		
18 - 24 years	3.7	6.4	<$15,000	14.9	14.7
25 - 34 years	17.9	21.4	$15,000 - $24,999	11.6	12.2
35 - 44 years	27.5	27.3	$25,000 - $34,999	13.6	13.1
45 - 54 years	24.2	22.9	$35,000 - $49,999	18.2	16.9
55 - 64 years	19.0	15.5	$50,000 - $74,999	21.3	20.5
65 - 69 years	7.7	6.6	$75,000 +	20.4	22.7

Source: NPD Genetically Modified Organism (GMOs) Consumer Survey, 2000

Table 2. Public acceptance of agrobiotechnology: U.S. and U.K.

	Support (%)	Oppose (%)	Don't Know (%)
United States	32	31	37
United Kingdom	38	46	16

Note: Public acceptance of agrobiotechnology was measured with six-point scale ranging from 'Strongly Oppose' to 'Strongly Support. 'Support' is the summation of the higher three categories and 'Oppose' is for the lower three categories.

Source: NPD Genetically Modified Organisms Consumer Survey, 2000.

Table 3. Definitions and descriptive statistics of variables used in the Multi-attribute model

Variable	Description	Mean	St. Dev.
Dependent Variable			
Public Acceptance	Attitude about the use of biotech in crop production		
X_1 Subgroup			
RISK_1		6.89 (8.05)	2.64(2.50)
Health Risks	Biotech foods pose health hazards		
Environmental Risks	Agrobiotechnology poses hazards on eco-system		
MORAL_2	It is morally and ethically wrong to use biotechnology	3.11 (3.28)	1.65(1.75)
MULTI_3		7.98 (9.12)	2.96(2.59)
Beneficiary	Multinational corporations are primary beneficiaries of agrobiotechnology, while consumers assume most of the risks		
Control on farming	Multinational corporations are increasingly controlling farming		
BENEFIT_4		11.8(10.6)	3.33(3.50)
Increase in yields	Agrobiotechnology reduces world food shortages by increasing yields		
Chemical use	Agrobiotechnology reduces the use of chemical in crop production		
Nutritional contents	Agrobiotechnology enhances nutritional composition		
X_2 Subgroup			
SAFE_1	Importance of food safety in food purchasing decisions	4.89 (4.37)	1.13(1.43)
X_3 Subgroup			
Knowledge	How would you rate your knowledge about GMOs?	2.38 (3.15)	1.32 (1.32)
X_4 Subgroup			
AWARE	Have you ever read or heard about (terms)?[2]	3.06 (3.97)	1.39(1.24)
X_5 Subgroup			
TRUST	I believe that FDA has adequate rules and regulations in regard to GMOs	4.88 (5.24)	1.34(1.28)

[1]1 = Never; 6 = All the time. All other questions are measured with six-point scale ranging from 1 = Disagree Completely to 6 = Agree Completely. [2] Awareness index is constructed by adding up 'Yes' responses to questions including:(1)Genetical engineering, (2)Gene splicing, (3) Transgenic crops, (4) Roundup Ready soybean, (5) Bt corn, (6) BST milk, (7) Starlink corn, (8) Monarch butterflies, (9) Liberty Link corn, (10) Frankenfood, (11) Gene escape.
Note: Numbers within parentheses represent means and standard deviations for UK responses.
Source: NPD Genetically Modified Organism (GMOs) Consumer Survey, 2000.

Table 4. Maximum likelihood estimates from ordered probit model: Public acceptance of Genetically Modified Organisms.

	Pooled Data		United States		United Kingdom	
Variable Name	Parameter Estimates	Asymptotic *t*-values	Parameter Estimates	Asymptotic *t*-values	Parameter Estimates	Asymptotic *t*-values
Constant	2.6661***	12.25	1.9483***	6.249	3.127***	10.156
RISK_1	-0.1818***	10.73	-0.1791***	7.004	-0.1898***	8.296
MORAL_2	-0.2733***	11.97	-0.2486***	6.738	-0.2909***	9.921
MULTI_3	-0.1426***	3.077	-0.0879**	2.499	-0.0624**	1.943
BENEFIT_4	0.1444***	14.79	0.1582***	10.54	0.1359***	10.42
SAFE_1	-0.0687***	3.427	0.0052	0.159	-0.1148***	4.493
KNOW_1	0.0612***	2.625	0.0809***	2.375	0.0458	1.420
AWARE_1	0.0312***	2.653	0.0321**	2.005	0.0288*	1.646
TRUST_1	0.0889***	4.309	0.0631**	2.032	0.1019***	3.627
COUNTRY[1]	-0.1190***	2.159	-	-	-	-
μ_1	0.9943	20.39	1.012	12.93	0.992	15.77
μ_2	1.9006	32.09	1.874	20.32	1.939	24.83
μ_3	3.17	43.48	3.07	28.00	3.289	33.08
μ_4	4.46	47.66	4.26	31.42	4.680	35.52
Log-L	-2409.73		-1042.38		-1356.89	
Log-L (β=0)	-3410.9		-1498.34		-2049.45	
χ^2- statistic	2106		817.62		1287.39	
Scaled R^2	0.732		0.683		0.738	
No. of Obs.	1995		834		1161	

* $P < 0.1$; ** $P < 0.05$; and *** $P < 0.01$. [1] COUNTRY denotes a binary variable equal to one if the respondent is from the U.S. [2] Critical value of chi-square with 10 degrees of freedom is 25.19 at α=0.01.

Table 5. Definitions and descriptive statistics of variables used in the Health Risk Perception model.

Variable	Description	Mean	St. Dev.
Dependent Variable			
Perceived Health Risk	Foods based on genetically modified crops pose health hazards to consumers.[1]	3.39(3.52)	1.38(1.42)
PROBABILITY	What do you think is the likelihood of health hazards from eating genetically modified foods?[2]	3.55(3.56)	1.48(1.46)
SEVERITY	If any health problems should occur, how severe do you think they would be?[3]	3.71(3.96)	1.45(1.39)
INFORMATION	I feel that there is enough information available for people to form an opinion about genetically modified foods.[1]	2.52(2.60)	1.42(1.45)
OUTRAGE	How do you feel about the fact that conventional foods are currently not labeled differently than genetically modified foods in the grocery stores?[4]	4.15(4.57)	1.58(1.62)
Demographics			
GENDER	1=Male; 0= Otherwise	0.45(0.56)	
EDUCATION	1 = Grade 2 = Some high 3 = Graduated high 4 = Some college, 5 = Graduated college, and 6 = Post college graduate	3.87(4.31)	
AGE	Actual age (18 -65 years)	45.4(34.4)	

[1] 1= Disagree Completely, 6= Agree Completely. [2] 1 = Extremely low, 2 = Extremely high. [3] 1 = Not at all severe, 6 = Extremely Severe. [4] 1 = Not bothered, 6 = Extremely bothered

Source: NPD Genetically Modified Organisms Consumer Survey, 2000.

Table 6. Maximum likelihood estimates from ordered probit models of health risk perception: Probability, Severity and Demographics

	United States		United Kingdom	
Variable Name	Parameter Estimates	Asymptotic *t*-values	Parameter Estimates	Asymptotic *t*-values
Constant	-0.6285	3.466	-1.6919	10.64
Probability	0.5707	17.49	0.7736	25.99
Severity	0.3632	10.96	0.2917	10.53
Age	-0.0012	0.518	0.0108	4.379
Education	-0.0443	1.969	0.0079	0.358
Gender	-0.1299	2.162	-0.2234	3.850
Scaled R^2	0.678		0.732	
No. of Obs.	1339		1566	

Table 7. Maximum likelihood estimates from ordered probit models of health risk perception: Awareness, Trust, Information and Labeling.

	United States		United Kingdom	
Variable Name	Parameter Estimates	Asymptotic *t*-values	Parameter Estimates	Asymptotic *t*-values
Constant	0.7267	4.463	1.055	6.728
AWARENESS	-0.0406	3.488	-0.0256	2.089
TRUST	-0.1097	4.598	-0.2315	10.39
INFORMATION	-0.0463	2.001	-0.0508	2.568
LABEL	0.4462	18.88	0.3695	17.48
Scaled R^2	0.4194		0.4394	
No. of Obs.	1281		1617	