U.S. Consumers' Willingness to Pay for Labeling Information on Genetically Modified Foods: An Application of Choice Modeling

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Abstract

This study analyzes U.S. consumers' valuation of five types of genetically modified food labels on a cornflakes cereal product. Using a nationwide survey and choice-modeling framework, results indicate that consumers value the label "contains no genetically modified corn" the most with a mean willingness to pay of 20 more cents, followed by "USDA approved genetically modified corn" with a mean willingness to pay of 9 more cents, and "corn genetically modified to reduce pesticide residues in your food" with a mean willingness to pay of 7 more cents. Results also suggest that consumers negatively value the labels "contains genetically modified corn" with a mean willingness to pay of 13 less cents and "may contain genetically modified corn" with a mean willingness to pay of 2 less cents.

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Introduction

Labeling of genetically modified (GM) foods remains a contentious issue. To date, there is no conclusive research done on how GM food products should be labeled or on whether consumers would value such labeling information in the U.S. Globally, countries are grappling to come to a consensus on a harmonized and internationally acceptable system. In the European Union (EU), regulations related to mandatory labeling of GM foods are already in place. In contrast, the U.S. has no mandatory labeling requirements pertaining to GM foods. In its various forms, Einsiedel (2000) has concluded that labeling of genetically modified products is bound to impact food marketing significantly.

While disagreements on a harmonized GM labeling policy persist, adoption of genetically modified crops worldwide is on the increase. To date, 20% of global soybeans, corn, cotton and canola acres are genetically modified, with the United States, Argentina, Canada and China being leading growers of GM crops (James, 2003; Pew Initiative on Food and Biotechnology, 2004). Interestingly, on the consumption side, estimates suggest that between 60% and 70% of processed foods on American supermarkets include at least a fragment of a GM crop and yet most consumers are not aware of this. Hallman et al. (2004) also found that 69% of the American public did not know that GM foods are tested for human safety and three-quarters did not know that GM foods are tested for environmental safety.

A number of countries have passed some form of regulatory framework on GM, ranging from total bans on GM technology to requiring either mandatory or voluntary

labeling (Phillips and McNeill, 2000). Such differences in approach may reflect influence of differences in political and economic structures on policy (Teisl, Garner, Roe and Vayda, 2003). For example, the mandatory labeling regime in the EU may have to do more with ethical/moral considerations. In contrast to the EU's approach, the U.S voluntary labeling regime only requires labeling of GM foods if: it has a significantly different nutritional property; it includes an allergen that consumers would not expect to be present; and it contains a toxicant beyond acceptable limits. There are challenging implications of a mandatory labeling regime for GM foods. For example, mandatory labeling may require segregation imposed on the entire agricultural system, thus increasing the cost of providing the information (Huygen, Veeman, and Lerohl, 2003; Muth, Mancini and Viator, 2003). Hence, GM labeling might cost the consumers, industry and government in varying degrees (Caswell, 2000; Runge and Jackson, 2000).

A few studies have investigated consumer willingness to pay for GM labeling. Most of the research on the subject has examined advantages/disadvantages of types of implementation and the likely costs (Huygen, Veeman, and Lerohl, 2003). In particular, support and opposition to mandatory or voluntary labeling regimes has been a popular subject of study (Huffman et al., 2004; Caswell 1998, 2000; Carter and Gruère, 2003). An important conclusion is that a successful label must contain features that appeal to consumers, truthful and not misleading, and driven by free market demands. Also investigated are topics related to information asymmetry on producers, government and industry as well as label information prioritizing (Huffman, 2003; Fulton and Giannakas, 2004; McCluskey and Loureiro, 2003; Senhui, Fletcher, and Rimal, 2003). Other studies have focused on language and label positioning (e.g., Hallman, Aquino and Phillips,

2003). A recent study by Carlson, Frykblom, and Lagerkvist (2004) measured willingness to pay for a mandatory, voluntary or total bans for beef, pork and eggs in Sweden. The findings of the study show that GM food can be a credence good that can cause market failure. Additionally, the study found that consumers are also willing to pay a significantly higher product price to ensure a total ban on the use of GM in animal fodder. None of these studies, however, have investigated consumer valuation of different GM label statements.

To fill this void, this study assesses consumers' valuation of GM labels. In particular, this study contributes to the ongoing debate by assessing consumers' willingness to pay (WTP) for the information provided by GM labels. Findings from recent focus group studies in the U.S. suggest that the wording on labels could have a significant effect on consumer understanding and acceptance of biotechnology (Hallman, Aquino and Phillips, 2003). There are also concerns as to whether consumers would use such labels (Quan, McCluskey, and Wahl, 2004; Teisl et al., 2003). This study measures consumer's willingness to pay for the information provided by GM labels, by estimating marginal effects of and relationships between specific labeling statements. Consumer choice of GM food labels is analyzed within the choice-modeling framework (Louviere, Hensher, and Swait, 2000). Specifically, the study analyzes (i) how consumers value labeling information and (ii) the differential valuation of labeling information by content (i.e., from no information to detailed information). Various parameters such as price elasticities with respect to various labeling statements are obtained. The following sections will discuss the empirical model, survey methods, results, and conclusions.

Empirical Model

Consumer preferences over GM labeling type are analyzed within the random utility discrete choice model framework (McFadden, 1978; Revelt and Train, 1998). Since market data for GM food labels are not available, a choice-modeling framework is used. In this framework, the consumer is assumed to have a well-behaved utility function (i.e., with preferences that are complete, reflexive and transitive). The consumer is then able to compare and rank alternative commodity bundles. In relation to particular choice set, the various options available are contained in a universal choice set C. A consumer i may consider all, or only a subset of these options and either chooses one of these options or chooses none of them. The Lancaster (1966a,b) model provides the framework within which the type of label wording chosen by consumers is analyzed. In this model, consumer i derives utility (U_{ij}) from chosen option j, where Z_{ij} is the vector of attributes of option j available to this individual. $\boldsymbol{S_i}$ is the vector of his/her socioeconomic characteristics:

$$U_{ij} = U(z_{ij}, S_i) \tag{1}$$

However the above utility function cannot be observed. Thus, it is further assumed that the utility function is decomposed into the deterministic part, which is observed by the researcher and a random component, which is unobservable given by:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_{mj} Z_{mj} + \varepsilon_j \tag{2}$$

where U_{ij} is the latent utility associated with choice j , V_{ij} is the explainable part of latent utility and ε_{ij} is the random component of utility associated with choice j. The consumer's decision process involves defining the choice problem, generating the alternatives, evaluating the attributes of the alternative, making a choice, and

implementing (action), i.e. chose alternative j if $U_j > Un$ ($j \neq n$). Therefore, the probability that the consumer chooses the option j is given by:

$$\Pr(j / C = j) = \Pr(V_{ij} + \varepsilon_{ij}) > (V_{in} + \varepsilon_{in}), \forall (n \neq j) \in C \tag{3}$$

The model is implemented by making assumption about the distribution ε_j. Assuming that ε_j are iid with type-I extreme value (Gumbel) distribution, the probability that the consumer chooses option j is given by (McFadden, 1973):

$$P(y_i = j) = \exp\left(\sum_m \beta_m z_{mj}\right) \Big/ \sum_j \exp\left(\sum_m \beta_m z_{mj}\right) \tag{4}$$

which leads to the standard conditional logit model. However, the above model suffers from the restrictive *Independence from Irrelevant Alternatives (IIA)* property, and therefore, is unable to incorporate preference heterogeneity across consumers. To address this problem, we will model consumer preference using the random coefficient logistic (random parameter) model. In this framework, it is assumed that β_{ij} (β_j associated with consumer i) is random across individual consumers whose distribution can be specified as follows:

$$\beta_{ij} = \bar{\beta}_j + \sum_k \theta_{kj} x_{ik} + \sigma_k u_{ik} \tag{5}$$

where u_{ik} is normally distributed with correlation matrix **R**, σ_k is the standard deviation of the distribution, $\bar{\beta}_j + \sum \theta_{kj} x_{ik}$ is the mean of the distribution that depend on x_{ik} representing person-specific (observable) characteristics, and u_{ik} are random errors that capture unobservable and excluded consumer attributes. In this formulation, $\bar{\beta}_j$ reflects the *average taste* (preference) of all consumers for choice j and $\sum \theta_{kj} x_{ik}$ denotes the variation (or deviation) of individual preference that depends on observable consumer characteristics. The constant term b can be portioned into alternative specific constants (ASC) that are unique to each alternative that are considered in the choice sets. ASC

capture the influence on choice of unobserved attributes relative to the specific alternative.

Substituting equation (5) in equation (2), the random utility function can be written as:

$$U_{ij} = \sum_m \bar{\beta}_m z_{im} + \sum_m \sum_k \theta_{km} x_{ik} z_{im} + \sum_m z_{im} \sigma_k u_{ik} \quad (6)$$

In this model, the mean utility is $\sum \bar{\beta}_m z_{im}$ which depends only on product attributes (z_{ij}) and thus, it is a product specific component that does not depend on consumer characteristics. On the other hand, heterogeneity in preferences depends on the interaction between product attributes and consumer characteristics. The parameters of the model are estimated using the Maximum Likelihood (ML) estimator.

Survey Methods

A survey instrument developed by the Food Policy Institute, Rutgers University was used to collect data for this study. The survey collected information on core questions related to American awareness and knowledge of GM food, willingness to purchase GM products, attitudes toward risks and benefits, opinions on mandatory product labeling and overall approval of the transgenic technique as it relates to animal and plant biotechnology. The Food Policy Institute contracted the opinion polling firm, Shulman, Ronca, and Bucuvalas, Inc. to conduct 1,201 telephone interviews using computer-assisted telephone interview (CATI) technology.

Interviewers were consistently monitored throughout the field period. The interviews were conducted between May 4, 2004 and June 14th, 2004. To reduce interview time, there were two versions of the survey in which core questions remained the same but with different supplemental questions divided between the two versions. Version A had

601 respondents and an average interview time of 19.5 minutes and Version B had 600 respondents and an average interview time of 21.9 minutes. All interviews were conducted in English. Potential respondents were selected using national random digit dialing across all 50 states. U.S. Census Bureau population estimates determined the distribution necessary for proportionate geographic coverage. The CATI program guided a random but balanced selection process to ensure that representative numbers of males and females were interviewed.

Many of the telephone numbers originally selected as part of the sampling frame were excluded as non-residential or non-working numbers. Only 25% of the numbers selected at random yielded completed interviews. However, calls to 66% of the working residential numbers resulted in completed interviews[1]. When weighted, the 1,201 completed interviews have a sampling error rate of ±3%. For those questions asked of only half the sample (the adjusted N will be indicated in text and tables where appropriate), the sampling error rate increases to ±4%. After completing the telephone survey, the 1,201 respondents were asked to receive a mail questionnaire. 47 % of the respondents (559) agreed to receive a mail questionnaire and gave a valid mailing address. Respondents were mailed the questionnaire and $5.00 within 3 to 4 days of agreeing to receive a mail questionnaire. All questionnaires were sent first class mail

[1] *To achieve the maximum response rate, many working numbers were attempted 16 or more times. Numbers were dialed on different days of the week and at varying times of day in an effort to reach elusive respondents. For households that used call-blocking systems, the research company allowed identifying information to be displayed. If an answering machine picked up three times in a row on any given number, interviewers left messages identifying the research company and the purpose of the call.*

with a cover letter thanking them for their participation. A follow up non-returnees was based on no response within 14 days after first mailing, with a second questionnaire (without the $5.00 gratuity) being mailed once again. A total of 363(65%) surveys were returned, of which 7 were incomplete (1%).

Based on previous labeling focus-group research (Hallman, Aquino and Phillips, 2003), a decision was made on the product to be analyzed. The product had to be readily available in stores, was familiar to majority of consumers, and is partly made of GM ingredients. Cornflakes were selected on account of the three factors. Care also had to be taken in explaining the CM part of the questionnaire; this included any traces of biases introduced by giving the subject prominence over other issues related to GM subject in totality.

One section was devoted to providing background information on genetic modification and labeling. In terms of background, the following information was provided: Definition of GM**: "**Genetic modification used in food production involves methods that make it possible for scientists to create new varieties of plants and animals by taking parts of the genes of one plant or animal and inserting them into the cells of another plant or animal. This is sometimes called genetic engineering or biotechnology. Currently, 40% of the corn grown in the United States is a genetically modified variety. This corn is approved by the United States Department of Agriculture (USDA) to be as safe for human consumption as the corn grown using traditional farming methods. Because genetically modified corn is sometimes mixed with traditional corn during storage and transport, food products that have corn ingredients (like cornflakes) may or may not contain genetically modified corn. The only way for you to know for sure if

cornflakes are made from genetically modified corn or not is if the manufacturers put this information on their product's label."

In addition, respondents were provided this information about the GM labels: "There are 6 types of special labeling information concerning the possible presence or absence of genetically modified corn in the cereal. The information should be viewed as entirely truthful. This information will vary for products A and B, but choice C will always have no special label. "***No special label***" means there is no indication as to whether or not the cornflakes contain genetically modified corn. Please note that the initials USDA used on some of the food labels means the United States Department of Agriculture." (see Table 1).

Another section of the choice-modeling questionnaire provided instructions on choice selection on their stated GM labeling preferences. The instructions were: "Carefully read and think about each question since you will be asked to select the box of cornflakes you most prefer out of three possible boxes of cornflakes. There are no right or wrong answers; we are only interested in your opinion." The choice modeling questions were pretested at Rutgers with suggestions to put "Price", and "labeling statements" as row headings and "Survey Instructions" at the top of the page.

The execution and planning of the mail survey was a stepwise procedure with the experimental design for the choice modeling first being subjected to several lengthy discussions by researchers and reference was made on existing GM labeling literature. Possible statements on label were discussed and it was agreed that the statements should reflect the amount of information on an incremental basis. The labeling information provided by the statements ranged from ***NO*** information, some information to detailed

information about the label. The information was cast in terms of label usefulness to the consumer decision-making process (Caswell, 2000).

Careful planning before execution of the CM experiment took into account the following: objectively elicit consumer stated willingness to pay for GM labeling information. A fraction factorial experiment design was used to create a balanced and efficient design matrix for a number of choice sets. The product to be analyzed was characterized by two (factors): label and price each with five different levels. The Choice modeling experiment yielded 32 choice sets. After removal of the dominated choices, 28 choice sets remained. Two of the alternatives in each choice set were all variants of a labeling and price variation scheme. Status quo was the third alterative (No special label), which was constant and common to all choice sets across the three products. The 28 choice sets were split into 4 subsets, with each respondent randomly allocated one set of 7 questions to complete. In this study, the six different labeling statements and price levels are as shown in table 1.

The actual choice questions were posed in the following manner: **"***Imagine you are at the grocery store and want to buy a box of cornflakes. You have to choose among three boxes of cornflakes: A, B or C. Which will you choose? You'll be asked to do this 7 times. While the combination of products may seem the same, they are all slightly different. Choose carefully and read all of the information given. By combining your choices with those of others, we'll be able to better understand what's important to consumers.*"(For an example, see Table 2). The cornflakes contain the exact same ingredients except that some contain genetically modified corn and some do not contain genetically modified corn. They will differ from each other on the basis of ***price, the***

presence of genetically modified corn, and special labeling information about the product. The boxes are all the same weight and the cornflakes all look and taste exactly the same. You can choose from cornflakes A, B, or C."

General Results

The random parameter logit model results as well as the random attributes correlations, elasticities, marginal willingness to pay for the labeling statements, and the corresponding 95% confidence intervals are presented in Tables 3 and 4. The estimated mean for price and both the estimated mean and standard deviations of the random attributes are also reported. The model was estimated with simulated maximum likelihood using the Halton draws with 250 replications.

The mail survey was administered to those who agreed to participate (559). 363 surveys were returned of which 7 were incomplete. Hence, in this analysis, we use the 356 completed surveys. Although these surveys yielded 7476 choice sets, after removal of lexicographic responses, 7182 choice sets were actually analyzed (96% of clean choice sets).

The results show both negative and positive labeling valuations. Results on consumer's mean willingness to pay are presented in Table 3 and Figure 1. The results show monetary values for the labeling statements given per unit change in price. The values were estimated by evaluating the ratio of the labeling statement coefficient to the coefficient of price. Positive mean willingness to pay was associated with the following labeling statements: "Contains NO genetically modified corn" (20.29 cents); "USDA approved genetically modified corn" (9.13 cents); and "Corn genetically modified to reduce pesticide residues in food" (7.32 cents). The results also show how much it will

take consumers to accept certain labeling statements. Consumers will require a discount of 1% for the statement "may contain GM corn" (-2.0 cents) and a discount of 6.5% for the statement "contains genetically modified corn" (-13.11 cents). The own and cross price elasticities have the expected signs and are of almost similar magnitude for choice A and B, with the status quo choice having relatively smaller magnitude compared to those of choice A or B.

Concluding Comments

Evidence from public polls in the U.S and elsewhere show overwhelming support to label GM foods. Findings from a recent national survey show that 94% of U.S consumers agree that GM ingredients should be labeled. Similar results were obtained from a consumer survey in France, Germany and UK showing 90% support for mandatory labeling of beef produced from cattle fed on genetically modified crops (Hallman et al., 2003, 2004; Roosen, Lusk and Fox, 2001). Despite the overwhelming support for GM labeling in the U.S. among consumers, no known study has evaluated how consumers would value different types of GM labeling statements. This paper examined consumer attitudes towards GM foods in the context of labeling and the tradeoffs made between labeling statements. The results of this study show that the choice modeling experiments provided a way of valuing labeling statements on cornflakes, thus giving some direction as to what the consumers' preferences will be if GM products had to be labeled. Consumer preference for a GM label is influenced by the nature of information conveyed by different labeling statements. Results generally suggest that statements that inform the consumer about product certification and benefit are valued positively. On the other hand, statements that indicate only the possible

presence of GM are valued negatively. Consumer' willingness to pay a premium for certain label statements such as "contains no GM corn", "USDA approved GM corn", and "corn genetically modified to reduce pesticide residues in your food" shows that there is potential market for GM labels. The differences in the valuation of the statements also imply that some statements are preferred than others.

The information generated by this study can be used as a guide by the food industry and the government in the design of possible labeling schemes that are acceptable and valued by consumers. Future studies, however, should replicate the present study to assess the robustness of these findings. In addition, other labeling statements not included in this study should be considered in the future.

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Table 1: Cornflakes attributes and levels

Attribute	Levels
Price Levels	***Current price*** ($2.00) 15 % discount ($1.70) 10 % discount ($1.80) 5 % discount ($1.90) 5 % premium ($2.10)
Labeling	**No special label *(no label)*** Contains no genetically modified corn May contain genetically modified corn Contains genetically modified corn Corn genetically modified to reduce pesticide residues in your food USDA approved genetically modified corn

Table 2: Choice Example: Based on the following information which would you choose box A, B, or C? ***Please place an X in one box only below.***

	☐ **Cornflakes A**	☐ **Cornflakes B**	☐ **Cornflakes C**
Price	$2.10	$2.00	$2.00
Special Labeling Information	"Corn genetically modified to reduce pesticides residues in your food"	"Contains genetically modified corn"	"No special label"

Table 3: Parameter Estimates of The Mixed Logit Model (Normally distributed random parameters) and Mean Willingness to Pay Values

Variable		Coefficient	t-ratio	p-value
PRICE		-0.1146	-3.89	0.00
Contains NO genetically modified corn	Mean Coefficient	2.3246	9.94	0.00
	Standard Deviation of the Coefficient	2.6977	10.43	0.00
May contain genetically modified corn	Mean Coefficient	-0.2293	-1.12	0.26
	Standard Deviation of the Coefficient	2.4128	10.50	0.00
Contains genetically modified corn	Mean Coefficient	-1.5020	-5.16	0.00
	Standard Deviation of the Coefficient	3.2473	9.66	0.00
Corn genetically modified to reduce pesticide residues in your food	Mean Coefficient	0.8386	2.73	0.01
	Standard Deviation of the Coefficient	5.3254	10.87	0.00
USDA approved genetically modified corn	Mean Coefficient	1.0459	3.26	0.00
	Standard Deviation of the Coefficient	4.9918	8.10	0.00
Model statistics				
Log Likelihood	-963.21			
Restricted Log Likelihood	-1386.29			
Chi Square	846.17			
DF	39			

Mean Willingness to Pay	Mean	Std Dev.	Lower Bound	Upper Bound
Contains NO genetically modified corn	20.29	23.54	-26.79	67.38
May contain genetically modified corn	-2.00	21.06	-49.08	40.11
Contains genetically modified corn	-13.11	28.34	-60.19	43.57
Corn genetically modified to reduce pesticide residues in your food	7.32	46.48	-39.76	100.27
USDA approved genetically modified corn	9.13	43.57	-37.95	96.26

Table 4: Correlation Matrix for random parameters & Elasticity Estimates

	Contains NO genetically modified corn	May contain genetically modified corn	Contains genetically modified corn	Corn genetically modified to reduce pesticide residues in your food	USDA approved genetically modified corn
Contains NO genetically modified corn	1	0.363	0.086	0.087	0.152
May contain genetically modified corn		1	-0.897	-0.665	-0.656
Contains genetically modified corn			1	0.756	0.755
Corn genetically modified to reduce pesticide residues in your food				1	0.3691
USDA approved genetically modified corn					1

Price elasticity Estimates (estimated marginal utility increase of 1 % in Price)

	K=1	K=2	K=3
j=1	-0.145	0.09	0.092
j=2	0.077	-0.156	0.079
j=3	0.017	0.018	-0.05

K= is attribute reflecting changes in price
j=1,2, and 3 (i.e., of A, B, and C alternatives/ choices in a set)

Figure 1: Labeling Statements: Mean Willingness to Pay