Are U.S. Consumers Tolerant of GM Foods?
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Abstract

Genetically modified (GM) foods have caused many controversies. One important controversy relates to tolerance—the impurity rate that is tolerated before a commodity must be labeled as genetically modified. Currently, the United States does not have a specific tolerance or threshold level for GM foods. This paper uses experimental auctions to determine consumers' acceptance of non-GM foods with zero, 1 percent, and 5 percent tolerance for genetically modified material. Our results indicate that consumers would pay less for food that tolerates GM material, but the discount is not significantly different for foods with 1-percent and 5-percent GM content.

Key words: genetically modified (GM) foods, contamination thresholds, laboratory auctions, *n*th-price auction, vegetable oil, tortilla chips, russet potatoes

The use of biotechnology to create genetically-modified products has generated exuberance in those looking forward to a new Green Revolution. GMOs, however, have attracted strong criticism from a set of antagonists, and some consumers are reluctant to accept new food products they perceive as risky, which includes products that involve some form of genetic modification. Genetically modified (GM) foods remain controversial; some groups want GM foods banned (Greenpeace; Friends of the Earth), while others believe GM foods can help feed the world (Council for Biotechnology Education, Gates). But because a complete GM ban has thus far been politically infeasible, environmental and consumer groups have successfully lobbied for labeling of GM foods in the European Union and some other countries, including Australia, Brazil, China, Japan, Korea, and New Zealand.

A key issue in the labeling debate is *tolerance*, the acceptable percentage of GM impurity in a product before it must be labeled as GM or before it cannot use a non-GM label. Countries have accepted *positive tolerance standards* because a zero tolerance standard is prohibitively costly, and a perfect segregation system can never be guaranteed (Shoemaker et al.; Golan, Krissoff, and Kuchler).[1]

The European Union, for instance, revised its mandatory GM-labeling policy in January 2000 to contain a positive tolerance level—all foods have to be labeled as GM if any ingredient in the product is at least 1 percent GM (Rousu and Huffman, 2001). The European Parliament recently voted for a 0.5 percent threshold (Food Traceability Report, 2002), but that will not take effect until 2003 at the earliest. Australia's GM-labeling policy is identical. Many other countries have also have defined tolerance levels. Japan tolerates up to 5 percent impurity before a GM label is needed. Korea allows a 3 percent tolerance of GM material, and Brazil allows a 4 percent tolerance. Thailand has different tolerance levels for different products—5 percent for soybeans and 3 percent for corn (Shipman, 2001).

The United States currently does not require labeling of GM foods and does not have a positive tolerance standard. The question we address here is how U.S. consumers react to a positive tolerance standard for GM ingredients. Using the tools of statistical experimental design, we designed an experimental auction using three GM products to test two hypotheses: (a) mean consumer bids for the GM-free products equal the mean bids for the GM-threshold products, set either at 1 percent or 5 percent and (b) mean bids for the 1-percent GM product equal the mean bids for the 5-percent GM product.[2] Given our results, we reject the first hypothesis (a) but not the second one (b). Our sample of consumers reduced their valuation of one unit of the commodity by an average of about 10 percent relative to the certain baseline, irrespective of whether the GM threshold was set at 1 or 5 percent. This finding points to a policy recommendation that is worthy of future study in nationwide survey work—if a tolerance level is to be used in the United States, a 5-percent GM threshold has the potential to be more efficient than a 1-percent GM threshold because the 5-percent level is less costly to meet and demand reduction is independent of the 1-and 5-percent tolerance levels.

Experimental Design

Previous experimental auctions have examined the willingness to pay for GM foods. Using potatoes, vegetable oil, and tortilla chips, U.S. consumers from the Midwest discounted GM-labeled foods by an average of 14 percent, and the discount could be higher (or lower), depending on the information the consumer received (Rousu et al). Lusk et al., using 50 students from the Midwestern United States, found that most subjects in an experiment were not willing to pay to upgrade a bag of non-GM chips to a bag of GM chips. Noussair, Robin, and Ruffieux (2002a) conducted experimental auctions using 97 consumers in France and found that consumers valued biscuits with a 1 percent and a 0.1 percent tolerance level differently (they also were bidding on non-GM and GM biscuits—four biscuits total). They reported that consumers did not view 0.1 percent GM or 1.0 percent GM content as good as a GM-free product. One problem with their experimental design is that they were selling consumers four different biscuits that were, in their words, close substitutes. Selling four close substitutes leads to demand reduction by consumers perceiving the potential of obtaining multiple units (List and Lucking-Reilly), which could cause a confounding problem where one does not know if bid reduction is due to genetic modification or demand reduction.

Our experimental auction markets used a randomized treatment, statistical experimental design. Consumers bid on three food products that have different tolerance labels. In one trial, all consumers bid on foods with a non-GM label, certified to be completely free of genetically engineered material in one trial, and in the other trial consumers bid on foods with a non-GM-label, indicating that a certain percentage of genetically modified material, either 1 percent or 5 percent, was tolerated. These specific tolerance levels are of particular importance because they match the current European and Japanese standards and would be the United States' likely tolerance choices should a standard be enacted.

The experimental design had two treatments. The treatments were randomly assigned to three experimental units, each consisting of 13 to 16 adult consumers drawn from households in the Des Moines, Iowa, area and who were paid to participate. Our total sample size is 44 consumers.

Consider now the four elements in the experiments—the GM food, the auction mechanism, the experimental units, and the specific steps in the experiment. First, we anticipated consumers might react differently to GM content for foods of different types. Believing that one food item was unlikely to reveal enough information, we selected three items: a 32-ounce bottle of vegetable oil made from canola, a 16-ounce bag of tortilla chips made from yellow corn, and a 5-pound bag of russet potatoes.[3] Second, following earlier work, we used the random *n*th-price auction for our GM-food experiments because it is designed to engage both the on- and off-the-margin bidders (also see Shogren et al).[4]

Third, all auctions were conducted in Des Moines, Iowa. Participants in the auctions were consumers contacted by the Iowa State University (ISU) Statistics Laboratory. The Statistics Laboratory used a sample of randomly selected telephone numbers to solicit participants. An employee of the ISU Statistics Laboratory called each number to make sure that it was in fact a residence and then asked to speak to a person in the household who was 18 years of age or older. They were told that "Iowa State University was looking for people who were willing to participate in a group session in Des Moines that related to how people select food and household products."[5]

Fourth, the experiment had nine specific steps. In Step 1 each consumer signed a consent form and was given $40 for participating and an ID number to preserve the participant's anonymity. The participants then read brief instructions and completed a pre-valuation questionnaire.[6] The questionnaire was purposefully given to consumers before the experiment to elicit demographic information and to capture the consumer's prior perception of GM foods before bidding, which allowed us to compare their prior beliefs to the posterior beliefs after the valuation experiment. In Step 2 participants were given detailed instructions (both oral and written) about how the random *n*th-price auction works. A short quiz was given to ensure everyone understood how the auction worked. In Step 3 the random *n*th-price auction was introduced by conducting an auction in which the consumers bid on one brand-name candy bar. Each consumer examined the candy bar, submitted a bid, and the auction was run for real.[7]

In Step 4 the second practice round of bidding was run, and consumers bid separately on three different items: the same brand-name candy bar, a deck of playing cards, and a box of pens. Participants knew that only one of the two rounds would be chosen at random to be binding, which prevented anyone from taking home more than one unit of any product. Following Melton et al., we used this random binding round to eliminate the threat of a person reducing his bids because he could buy more than one unit. The consumers first examined the three products and then submitted their bids. In

Step 5 the binding round and the binding *n*th-prices were revealed to the consumers. All bid prices were written on the blackboard, and the *n*th-price was circled for each of the three products. Participants could see the items they won and the market-clearing price. The participants were told that the exchange of money for goods was in another room nearby and would take place after the entire experiment was completed.

In Step 5 the GM-food products were introduced for the next two rounds of bidding. The two bidding rounds were differentiated by the food label—either a non-GM label certified to be GM-free or a non-GM label that indicated the tolerance of GM material. Figure 1 shows the three types of labels used for the vegetable oil product; the other product labels were constructed similarly. These labels were on the front of the package and large enough for participants to easily read them.[8] In one round (which could be round 1 or 2 depending on the experimental unit), participants bid on the three food products each with the certified non-GM food label. In the other round, participants bid on the same three food products with the 1 percent or 5 percent GM tolerance level. Consumers knew that only one round would be chosen as the binding round that determined auction winners.

In Step 6 consumers submitted sealed bids for the vegetable oil, tortilla chips, and potatoes, either with the certified non-GM label or the GM-tolerant label. Each consumer bid on each good separately. The monitor collected the bids and then told the participants that they would now look at another group of food items. In Step 7 consumers examined the same three food products, each with a different label from round 1. Again they examined the products and submitted their bids.[9] In addition, each consumer bid on food products with only two types of labels, the GM-free and the GM-tolerant label. To correctly account for potential bias due to the order in which consumers saw the food products, we ensured that no consumer saw both GM-tolerant labels. Seeing both GM-tolerant labels would have required us to conduct additional treatments. In Step 8 the monitor selected the binding round and the binding random *n*th-prices for the three goods and notified the winners. In Step 9 each consumer completed a brief post-auction questionnaire, and the monitors dismissed the participants who did not win. The monitors and the winners then exchanged money for goods, and the auction ended.

Although we followed standard experimental auction valuation procedures (e.g., Shogren et al.), we made several refinements to our experimental design to better reflect consumer purchases. First, our subjects submitted only one bid per product. Hence, we stepped back from the protocol of using multiple repeated trials and posted market-clearing prices to avoid any question of creating affiliated values that can affect the demand-revealing nature of a laboratory auction (see, for example, List and Shogren). Second, we did not endow our subjects with any food item and then ask them to "upgrade" to another food item; rather participants were paid $40, and then they bid on different foods in only two trials. This avoids the risk that an in-kind endowment effect distorts the participant's bidding behavior (e.g., Lusk and Shroeder) and of any credit constraint. Third, each consumer bid on three unrelated food items, such that if he or she did not have positive demand for one or two products, we could still obtain information from them on their taste for genetic modification based on the second and (or) third products. Fourth, we randomly assigned treatments to the experimental units; now estimation of treatment effect is simply the difference in means across treatments (see Wooldridge).

Finally, we used adult consumers over 18 years of age from two different Midwestern metropolitan areas that were chosen using a random digit dialing method. Table 1 summarizes the demographic characteristics. The demographics of our sample do not perfectly match the U.S. census demographic characteristics for these regions, but they are similar and provide a sufficient representation for our initial probe into labeling and information for GM products (see Appendix A for the demographic characteristics of the areas). In addition, because we use common food items available to shoppers in grocery stores and supermarkets, we wanted adults rather than students to better reflect a typical household of consumers. Although several studies have used college undergraduates in laboratory auctions of food items (including Lusk et al. and Hayes et al.), they are not the best choice for participants when the items being auctioned are ones sold in grocery stores or supermarkets. Using a national random sample of grocery store shoppers, Katsara et al. show that the share of college-age (18 to 24 years) shoppers falls far below their share in the population—8.5 percent of shoppers versus 12.8 percent in the U.S. Census of Population. College students obtain a large share of their food from school cafeterias and a small share from grocery stores and supermarkets compared to older shoppers (Carlson, Kinsey, and Nadav). Although our participants are slightly skewed toward women, Katsara et al. show that women make up a disproportional share of grocery shoppers—83 percent of shoppers versus 52 percent in the U.S. Census of Population. A sample primarily of grocery store shoppers also weakens the sometimesstated need for having students participate in several rounds of bidding to stabilize bids for food items. We also minimize Hawthorne effects in bidding (Melton et al).

Data and Results

Two main results emerge from our experiment. First, consumers reduced their demand for the products having GM-tolerance levels relative to the GM-free benchmark. Table 2 shows the mean and median bids by food type. Twenty-eight participants bid in the 5 percent tolerance treatments; 16 participants bid in the 1 percent treatment. Overall, the average consumer bid less on the food product with the GM-tolerance labels relative to the GM-free products. Consumers on average bid 7 cents less on the GM-tolerant oil, 14 cents less on the tortilla chips, and 9 cents less on the potatoes.[10] Consumers on average discounted the foods with the GM tolerance by an average of 7 to 13 percent. This is a significant demand reduction for 1 percent and 5 percent GM products relative to the GM-free benchmark. In comparison, Rousu et al. observe that consumers discounted food that had a GM label without a tolerance level by an average of 14 percent. Pooling all observations,[11] Table 3 shows we can reject the null hypothesis that bidding behavior over GM-tolerance labels is identical to that for the GM-free benchmark for the tortilla chips and the potatoes but not for the vegetable oil.[12] Considering the 1 percent and 5 percent GM treatments separately, we cannot reject the null hypothesis that bids differ for five of six products.[13] This significant discount for the GM-tolerant food is consistent with Viscusi et al.'s findings. In his study, consumers initially purchased a given product when told that it injured 15 out of 10,000 people who used the product, but over two-thirds of the consumers were unwilling to purchase the same product when the chance of injury increased to 16 out of 10,000. This indicates a strong *reference risk effect*, which could help explain why consumers placed such a large discount on the GM-tolerant food.

Second, no statistically significant difference existed for consumers' discount of the 5-percent GM products and 1- percent GM food. Table 4 shows that at the 5 percent significance level we cannot reject the null hypothesis that demand reduction is independent of the two GM-tolerance level. This supports the view that if a GM-tolerance policy is implemented in the United States, consumers might not place a greater value on a 1 percent GM tolerance level relative to a 5 percent GM tolerance level. Because of the higher segregation and handling cost of a 1 percent tolerance level compared to a 5 percent level, society may be better off implementing a higher tolerance level. Consumers value GM-free products, but if GM contamination does exist, we find no evidence that consumers prefer a 1 percent GM-tolerant food relative to a 5 percent GM-tolerant food.

This result is consistent with the notion of surrogate bidding, or scope effects (for a review see Shogren). Such bidding occurs when consumers reveal nearly the same willingness to pay to avoid varying levels of contamination relative to an uncontaminated product. Surrogate bidding has been shown to exist in other experimental food markets. Hayes et al. used experimental auctions to show that when consumer bid to reduce risk by eliminating a cluster of foodborne pathogens they were indistinguishable from bids to reduce specific pathogens. Using a survey, Hammitt and Graham found the same result: consumers were insensitive to different probability levels.

Conclusion and Implications

In our experimental treatments, consumers reduce their demand by an average of 7 percent to 13 percent for each food product having 1-percent and 5-percent tolerance levels for GM material relative to GM-free food. We found no evidence, however, that consumers value a food with a 1 percent GM tolerance greater than a food with a 5 percent GM tolerance. These results support the a policy proposal that, if the United States decides to allow a tolerance of GM material in food products, the 5 percent tolerance would be better socially than the 1 percent tolerance. Consumers do not value a product with 1-percent impurity significantly higher than with 5-percent impurity, and it is less expensive for food producers and distributors to comply with a higher tolerance level.

Our findings suggest consumers are willing to pay a large premium to avoid contamination in an uncontaminated product but are not willing to pay to reduce contamination in a product that already has a small amount of contamination. An interesting extension of this work, however, would be to examine whether consumers view 10-percent (20-percent) impurity significantly differently from 1- or 5-percent levels. Also, it would be interesting to see if our results generalize to other products by examining the marginal willingness to avoid small amounts of contamination. If our result could be generalized to a broad range of products, which would need to be substantiated first, this could affect environmental policy. For instance, it might help explain the fierce opposition to drilling in the Alaska wildlife area. For example, it might suggest if proponents of drilling were initially successful in getting public approval for a small amount of oil drilling, convincing the public to further increase drilling would be easier.

Future research remains to be done. More information is needed on the cost of producing non-GM crops at different tolerance levels. Also, this study could be replicated internationally to provide evidence on the efficiency of GM-tolerance policies in foreign countries (e.g., Europe and Japan). Trading across countries would be easier if all countries maintained the same tolerance levels. If research could show that consumers have similar values for tolerance levels across countries, it could be useful for setting international GM-tolerance standards.

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Figure 1. The three types of labels used for the vegetable oil

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* This product is certified to BE FREE OF ANY
GM-material.

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* Subject to a 1 percent tolerance, that is up to
1 percent of any ingredient could be genetically
engineered.

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* Subject to a 5 percent tolerance, that is up to
5 percent of any ingredient could be genetically
engineered.

Table 1. Characteristics of the auction participants

Variable	Definition	Mean	St. Dev
Gender	1 if female	0.70	0.46
Age	The participant's age	49.7	17.1
Married	1 if the individual is married	0.59	0.50
Education	Years of schooling	14.49	2.41
Household	Number of people in participant's household	2.75	1.42
Income	The households income level (in thousands)	50.6	36.8
White	1 if participant is white	0.95	0.21
Read_L	1 if never reads labels before a new food purchase	0.02	0.15
	1 if rarely reads labels before a new food purchase	0.02	0.15
	1 if sometimes reads labels before a new food purchase	0.34	0.48
	1 if often reads labels before a new food purchase	0.41	0.50
	1 if always reads labels before a new food purchase	0.20	0.41

Table 2. Mean bids

A. Mean bids—all participants

	N	Mean Bid	Std. Dev.	Median	Minimum	Maximum
Food Type						
Oil	44	0.99	0.92	0.75	0	3.50
Oil—Tolerance	44	0.92	0.76	0.75	0	2.50
Chips	44	1.13	0.99	0.82	0	5.00
Chips—Tolerance	44	0.99	0.80	0.75	0	3.49
Potatoes	44	0.95	0.71	0.89	0	3.00
Potatoes—Tolerance	44	0.86	0.67	0.84	0	3.00

B. Mean bids when participants bid on food with a 5 percent tolerance level

Food Type	N	Mean Bid	Std. Dev.	Median	Minimum	Maximum
Oil	28	0.94	0.81	0.75	0	3.00
Oil—Tolerance	28	0.88	0.71	0.68	0	2.50
Chips	28	0.99	0.77	0.75	0	3.00
Chips—Tolerance	28	0.90	0.69	0.73	0	2.00
Potatoes	28	0.83	0.64	0.75	0	3.00
Potatoes—Tolerance	28	0.76	0.65	0.75	0	3.00

C. Mean bids when participants bid on food with a 1 percent tolerance level

Food Type	N	Mean Bid	Std. Dev.	Median	Minimum	Maximum
Oil	16	1.06	1.12	0.75	0	3.50
Oil—Tolerance	16	0.97	0.85	0.88	0	2.39
Chips	16	1.38	1.28	1.13	0	5.00
Chips—Tolerance	16	1.13	0.98	0.77	0	3.49
Potatoes	16	1.15	0.81	1.00	0	3.00
Potatoes—Tolerance	16	1.03	0.69	0.99	0	2.00

Table 3. T-test—Non-GM foods with and without GM tolerance levels

A. T-test on whether differences in bids for non-GM and GM-tolerant foods are different—all observations (N = 44)

	Bid Non-GM	Bid w/Tolerance	Difference	T-Test Statistic
Oil	0.99	0.92	0.07	1.24
Chips	1.13	0.99	0.14	2.44**
Potatoes	0.95	0.86	0.09	1.70*

B. T-test on whether differences in bids for non-GM and GM-tolerant foods are different—5 percent tolerance.

	Bid Non-GM	Bid w/Tolerance	Difference	T-Test Statistic
Oil	0.94	0.88	0.06	1.05
Chips	0.99	0.90	0.09	1.51
Potatoes	0.83	0.76	0.07	1.33

C. T-test on whether differences in bids for non-GM and GM-tolerant foods are different—1 percent tolerance

	Bid Non-GM	Bid w/Tolerance	Difference	T-Test Statistic
Oil	1.06	0.97	0.09	0.71
Chips	1.38	1.13	0.25	1.93*
Potatoes	1.15	1.03	0.12	1.08

* Significant at 10 percent level

** Significant at 5 percent level

Table 4. T-test on whether consumers value foods with a 1 percent tolerance differently than foods with a 5 percent tolerance

	Non-GM Premium—5 percent	Non-GM Premium—1 percent	Difference	T-Test Statistic
Oil	0.06	0.09	–0.03	–0.20
Chips	0.09	0.25	–0.16	–1.33
Potatoes	0.07	0.12	–0.05	–0.47

Appendix Demographic Characteristics of Polk County, IA (including Des Moines area) and Ramsey County, MN (including St. Paul area)

Variable	Definition	Polk	Ramsey	Average
Gender	1 if female	0.52	0.52	0.52
Age	Median age	45.7	45.7	45.7
Married	1 if the individual is married[a]	59.5	51.4	55.5
Education	Years of schooling[b]	13.52	13.76	13.64
Income	The median household's income level (in thousands)	46.1	45.7	45.9
White	1 if participant is white	0.9	0.8	0.85

All variables are for individuals of all ages, except for married, which is for individuals 18 or older; education, which is for individuals 25 or older; and age, which is for individuals 20 or older.

[a]The estimate of the number of married people who are 18 or older was obtained by taking the number of people married over 15 and assuming that the number of people who were married at ages 15, 16, and 17 was zero. This gives the percentage of married people who are 18 or older.

[b]The years of schooling was estimated by placing a value of 8 for those who have not completed 9th grade, 10.5 for those who have not completed high school, 12 for those who have completed high school but have had no college, 13.5 for those with some college but no degree, 14 for those with an associate's degree, 16 for those with a bachelor's degree, and 18 for those with a graduate or professional degree.

[1] Although no literature exists on the costs of a low tolerance for GM foods, Klein and Brester estimate the cost for a zero-tolerance directive for beef packing companies. They found that a zero-tolerance beef directive might cost society over $3 billion dollars annually.

[2] Some argue it is impossible to claim that a product is 100 percent GM-free, saying that more accurate testing equipment would detect GM material on almost any food that was made, even non-GM foods. In our valuation experiments, we auctioned foods that were tested and found to not contain GM material; thus, we claimed in the auctions that the foods were certified to have no GM content.

[3] In the distilling and refining process for vegetable oils, essentially all of the proteins, which are the components of DNA and source of genetic modification, are removed, leaving pure lipids. Minimal human health concerns should arise from consumption of the oil, but people might still fear that genetic modification could harm the natural environment. Tortilla chips are highly processed foods that may be made from GM or non-GM corn, and consumers might have human health or environmental concerns or both. Russet potatoes are purchased as a fresh product and are generally baked or fried before eating. Consumers might reasonably see the potential concentration of genetic modification as being higher in potatoes than in processed corn chips. Consumers might see both human health and environmental risks from eating russet potatoes.

[4] The random *n*th-price works as follows. Each of *k* bidders submits a bid for one unit of a good; then each of the bids is rank-ordered from highest to lowest. The auction monitor

then selects a random number—the n in the nth-price auction, which is drawn from a uniform distribution between 2 and k, and the auction monitor sells one unit of the good to each of the n–1 highest bidders at the nth-price. For instance, if the monitor randomly selects n = 4, the three highest bidders each purchase one unit of the good priced at the fourth-highest bid. Ex ante, bidders who have low or moderate valuations now have a nontrivial chance to buy the good because the price is determined randomly. This auction attempts to increase the probability that insincere bidding will be costly. Shogren et al. observe in an induced valuation experiment that, although the second-price auction engaged the on-margin bidders better, the random n^{th}-price auction worked better at engaging off-margin bidders relative to the second-price auction. Because we are interested in estimating the entire demand curve with greater precision not just the bidders near the market-clearing price, we selected the random n^{th}-price auction with this noted caveat.

[5] The sessions were held on 1 day, and potential participants were informed that the sessions would last about 90 minutes. Participants were also told that at the end of the session they would receive $40 in cash for their time. The sessions were held at the Iowa State University Learning Connection, 7th and Locust Street, Des Moines. Three different times were available—9 am, 11:30 am, and 2 pm—and willing participants were asked to choose a time that best fit their schedule. The Statistics Laboratory followed up by sending willing participants a letter containing more information, including a map and instructions on when and where the meeting would be held, directions for getting there,

and a telephone number to contact for more information. After accounting for unusable numbers, the response rate was approximately 19 percent.

[6] All experimental instructions are available from the authors on request.

[7] Throughout the auctions, when the participants were bidding on items in a round, they had no indication of what other items they may be bidding on in future rounds. They, however, were told that they would not be expected to pay for more than one unit of any commodity at the end of the session.

[8] See Noussair, Robin, and Ruffieux (2002b) for evidence of how consumers frequently do not read food-labels that are on the back of packages.

[9] The order in which consumers see the different labeled products may cause different bids (see Huffman et al.). For participants in the 5 percent tolerance treatments, one experimental unit bid on foods with the non-GM labels in the first trial and the 5 percent tolerance labels in the second trial, while another experimental unit viewed the food labels in the opposite order. The participants who bid on the 1 percent tolerance labels all bid on the certified non-GM foods in the first trial and the non-GM foods with the 1 percent tolerance in the second trial. We intended to have a second group bid on foods with the 1 percent labels in the first trial and the certified non-GM labels in the second trial, but we were unable to because of a technical difficulty. A Wilcoxon rank-sum test failed to reject the null hypothesis that the discount for the GM-tolerant food in the 5 percent tolerance treatment was the same in both rounds at a 5 percent level of significance for any of the three products. Therefore, the problem that prevented us from obtaining an additional experimental unit of people who bid on the non-GM foods with 1

percent tolerance did not appear to alter our results. (All results not shown in the tables are available from the authors upon request.)

[10] Table 2 also shows that consumers bidding on 5 percent GM-tolerance discounted the oil by an average of 6 cents, the tortilla chips by 9 cents, and the potatoes by 7 cents. Consumers bidding on 1 percent-GM tolerance on average discounted the vegetable oil by 9 cents, the tortilla chips by 25 cents, and the potatoes by 12 cents. A test of the null hypothesis that the bids for the non-GM foods are equal across treatments could not be rejected using a t-test. This is a good consistency check and does not reject the hypothesis that the bidding behavior was reasonable. Between 32 percent and 41 percent of consumers bid less for the GM-tolerance food; but the percentage varied by food product.

[11] Because the participants in the three separate treatments were independent of each other, one can pool the data to test whether consumers discounted the GM-tolerant food.

[12] We also ran Wilcoxon Signed-Rank tests and the results were similar: the bids on the vegetable oil were not statistically different at any conventional significance level, the bids for the tortilla chips were significantly different at the 5 percent level, and the bids for the potatoes were significantly different at the 15 percent level.

[13] We also fitted several regressions to test the hypothesis that demographic characteristics, like consumer's gender, household income, race, or age, could explain the difference in bids for the certified non-GM labeled food and the GM-tolerant food. No demographic characteristic has a statistically significant impact on the difference in bids.