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Are United States Consumers Tolerant of Genetically Modified Foods?

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Controversy surrounds the introduction of genetically modified foods. One key issue relates to tolerance levels—the impurity rate tolerated before a commodity must be labeled. Currently, the United States has not defined a tolerance level for genetically modified foods. This paper uses data from experimental auctions to test whether consumers prefer foods with 0, 1, or 5% tolerance levels for genetically modified material. We conclude consumers would pay less for food that tolerates genetically modified material, but find no evidence that consumers' place different values on foods with 1 and 5% genetically modified content.

The use of biotechnology to create genetically modified products has caused many scientists to envision a new Green Revolution. Genetically modified organisms (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 (e.g., Greenpeace International), while others believe GM foods can help feed the world (Council for Biotechnology Education, Gates). Because a complete ban on GM foods has thus far been politically infeasible, environmental and consumer groups have successfully lobbied for labeling GM foods in the

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European Union and some other countries, including Australia, Brazil, China, Japan, Korea, and New Zealand.

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—is a key issue in the labeling debate. 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% GM (Rousu and Huffman). The European Parliament recently voted for a 0.9% threshold, but member countries must ratify the new rules before they take effect (CNN.com). Australia also has defined a 1% tolerance for GM impurity. Other countries have also defined tolerance levels that must be met before GM labeling is required. Japan tolerates up to 5% impurity before a GM label is needed. Korea allows 3% tolerance, and Brazil allows 4% tolerance. Thailand has different tolerance levels for different products—5% for soybeans and 3% for corn (Shipman).

The United States currently does not require labeling of GM foods and has not defined a positive tolerance standard. Legislation to require mandatory labeling in the United States was introduced in the 2000 session of Congress in the House (H.R. 3377) and Senate (S. 2080). Although neither bill passed, they suggest the mix of policy choices being considered by some U.S. legislators. The question we address here is how U.S. consumers react to a positive tolerance standard for GM ingredients. 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% or 5% and (*b*) mean bids for the 1% GM product equal the mean bids for the 5% 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 with GM impurity by an average of about 10% relative to the GM-free baseline, irrespective of whether the GM threshold was set at 1 or 5%. This finding points to a policy recommendation worthy of future study in nationwide survey or experimental auction work—if a tolerance level is to be used in the United States, a 5% GM threshold has the potential to be more efficient than a 1% GM threshold because the 5% level is less costly to meet and demand reduction is independent of the 1 and 5% 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%. The discount could be higher (or lower), depending on the information the consumer received (Rousu et al., Tegene et al.). Lusk et al., using fifty students from the Midwestern United States, found that most subjects in an experiment were not willing to pay to upgrade a bag of GM chips to a bag of non-GM chips. Noussair, Robin, and Ruffieux (2002a) conducted experimental auctions using ninety-seven consumers in France and found that consumers valued biscuits with a 1% and a 0.1% tolerance level differently (they also were bidding on non-GM and GM biscuits—four biscuits total). They reported that consumers did not prefer 0.1% GM or 1% GM content to 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, 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, 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 or 5%, 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 choices should a standard be enacted.

The experimental design had two treatments. The treatments were randomly assigned to three experimental units, each consisting of thirteen to sixteen adult consumers drawn from households in the Des Moines, Iowa, area, and paid to participate. Our total sample size was forty-four 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 different type foods. Believing that one food item was unlikely to reveal enough information, we selected three: a 32-ounce bottle of canola oil, a 16-ounce bag of corn tortilla chips, 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. 2001).[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 a residence and asked to speak to a person in the household eighteen 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 prevaluation questionnaire.[6] The questionnaire was purposefully given to consumers before the experiment to elicit demographic information and capture the consumer's prior perception of GM foods. The questionnaire was designed to collect demographic information from participants and determine consumers' perceptions of the safety of vaccinations for diseases, eating meat from animals fed growth hormones, and irradiated and GM foods. We asked several risk-perception questions to ensure consumers would not focus exclusively on GM foods in the opening questionnaire.

In step 2, participants were given detailed oral and written instructions 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 and submitted a bid for the product in this warm-up auction round.[7]

The second practice round of bidding was run in step 4 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 were told 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 consumers reducing their bids to 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 would take place in a nearby room after the entire experiment was completed.

After step 5, the GM-food products were introduced for the next two rounds of bidding.[8] The two bidding rounds were differentiated by the food label—either a non-GM label which certified the product 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; the other product labels were constructed similarly.[9] These labels were on the front of the package and large enough for participants to easily read.[10] 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% or 5% GM-tolerance level. Consumers knew that only one round would be chosen as the binding round to determine 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. Consumers placed separate bids on each good. 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 one) and submitted their bids.[11] 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 (in addition to the non-GM 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.[12] 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.

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.

Although we followed standard experimental auction valuation procedures (e.g., Shogren et al. 1994), we made several refinements to our experimental design to better reflect consumer purchases. First, our subjects submitted only one bid per product. 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 they bid on different foods in only two trials. This avoids the

Table 1. Characteristics of the auction participants

Variable	Definition	Mean	Std. 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 household's 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

risk that an in-kind endowment effect distorts the participant's bidding behavior (e.g., Lusk and Schroeder) 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 eighteen years of age from a Midwest metropolitan area who were chosen using a random digit dialing method. Table 1 summarizes the demographic characteristics of the sample. While the demographics of our sample do not perfectly match the U.S. census demographic characteristics for this region, they are similar and provide a sufficient representation for our initial probe into labeling and information for GM products (see appendix for the demographic characteristics of the area). 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 necessarily 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, Katsaras et al. show that the share of college-age (eighteen to twenty-four years) shoppers falls far below their share in the population—8.5% of shoppers versus 12.8% 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 with older shoppers (Carlson, Kinsey, and Nadav). Although our participants are slightly skewed toward women, Katsaras et al. show that women make up a disproportional share of grocery shoppers—83% of shoppers versus 52% in the U.S. Census of Population. A sample primarily of grocery store shoppers also weakens the sometimes-stated need for having students participate in several rounds of bidding to stabilize bids for food items.

Our experimental design also minimizes Hawthorne effects in bidding (Melton et al.), which occur when participants change their behavior simply because they are in an experiment.

Data and Results

Two main results emerge from our experiment. First, consumers reduced their demand for the GM-tolerant products relative to the GM-free benchmark. Table 2 shows the mean and median bids by food type.[13] Twenty-eight participants bid in the 5% tolerance treatments; sixteen participants bid in the 1% 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.[14] Consumers on average discounted the foods with the GM-tolerance labels by an average of 7–13%. This is a significant demand reduction for 1% and 5% GM-tolerant products relative to the GM-free benchmark. In comparison, Rousu et al. and Tegene et al. observe that consumers discounted food that had a GM label without a tolerance level by an average of 14%. Pooling all observations,[15] 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 tortilla chips and potatoes, but not for vegetable oil.[16] Considering the 1% and 5% GM treatments separately, we cannot reject the null hypothesis that bids differ for five of six products.[17] This significant discount for the GM-tolerant food is consistent with Viscusi, Magat, and Huber's findings. In their study, consumers initially

Table 2. Mean bids

Food Type	*N*	Mean Bid	Std. Dev.	Median	Minimum	Maximum
Mean bids—all participants						
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
Mean bids for participants that bid on food with a 5% tolerance level						
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
Mean bids for participants that bid on food with a 1% tolerance level						
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

	Bid Non-GM	Bid w/Tolerance	Difference	*t*-Test Statistic
t-Test for null hypothesis of no difference in bids for non-GM and GM-tolerant foods—all observations (N = 44)				
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*
t-Test for null hypothesis of no difference in bids for non-GM and GM-tolerant foods—5% tolerance				
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
t-Test for null hypothesis of no differences in bids for non-GM and GM-tolerant foods—1% tolerance				
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% level.
**Significant at 5% level.

purchased a given product when told that it injured fifteen 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 sixteen 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% GM products and 1% GM food. Table 4 shows that at the 5% significance level, we cannot reject the null hypothesis that demand reduction is independent of the two GM-tolerance levels. 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% GM-tolerance level relative to a 5% level. Because of the higher segregation and handling cost of a 1% versus 5% 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% GM-tolerant food relative to a 5% GM-tolerant food.

Table 4. *t*-test on null hypothesis that participants' value foods with a 1% tolerance the same as for a 5% tolerance

	Non-GM Premium—5%	Non-GM Premium—1%	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

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 when consumers 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 reduced their demand by an average of 7–13% for each food product having 1% and 5% tolerance levels for GM material relative to GM-free food. We found no evidence, however, that consumers valued a food with a 1% GM tolerance greater than a food with a 5% GM tolerance. Our sample was small, indicating the findings should not be generalized too broadly. However, the results do not contradict the policy proposal that if the United States decides to allow a tolerance of GM material in food products, the 5% tolerance would be better socially than the 1% tolerance. Consumers do not value a product with 1% impurity significantly higher than with 5% 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 GM contamination in an uncontaminated product. The premium did not vary, however, by the amount of GM contamination in each product. An interesting extension of this work, however, would be to examine whether consumers view 10% (or 20%) impurity differently from 1 or 5% 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.

Future research remains to be done. More information is needed on the cost of producing non-GM crops at different tolerance levels. Also, it would be useful to replicate this study internationally to explore the efficiency of GM-tolerance policies in countries that already have explicit tolerance levels (e.g., the European Union 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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Endnotes

[1]Wilson and Dahl estimate the cost of testing and identity preservation in wheat, including the risk of premium associated with accidental co-mingling and being out of contract, at $3.35 which would mean a roughly doubling of the price of wheat in the United States. With the size of these transaction

costs, the wheat industry would have an incentive to find new and lower cost methods of carrying out testing, identity preservation and insurance against accidents. Also, Klein and Brester estimate the cost for a zero-tolerance directive for beef packing companies at over $3 billion dollars annually.

[2]Some argue it is impossible to claim that a product is 100% GM-free, saying that more accurate testing equipment would detect GM material on almost any food, 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 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 fresh and are generally baked or fried. Consumers might reasonably see the potential concentration of genetic modification as being different in potatoes than in processed corn chips. Consumers might see both human health and environmental risks from eating russet potatoes.

[4]The random nth-price works as follows. Each of k bidders submits a bid for one unit of a good; then each of the bids are 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. (2001) observe in an induced valuation experiment that, although the second-price auction engaged the on-margin bidders better, the random nth-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 nth-price auction with this noted caveat.

[5]The sessions were held on day, and potential participants were informed that the sessions would last about ninety 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, and a telephone number to contact for more information. After accounting for unusable numbers, the response rate was approximately 19%.

[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]Unlike several of our previous experiments (e.g., Huffman et al., Rousu et al., Tegene et al.), we gave the participants no information about genetic modification in this experiment. The reason for this design choice was that we did not have the resources to probe into the effect of information on bids for food products with different tolerance levels—so we decided that it would be better for the bids to reflect the consumer's own assessment of genetic modification rather than one that we introduced. The experiments we report herein were not used in any of our previous papers that examine genetically modified food products using experimental auctions.

[9]We conducted these experiments with labels saying "this product is made without genetic engineering" since these experiments were conducted in the United States where we do not have a mandatory labeling policy. Tolerance levels are most likely to impact who can label their products as non-GM.

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

[11]The order in which consumers see the different labeled products may cause different bids (see Huffman et al.). For participants in the 5% tolerance treatments, one experimental unit bid on foods with the non-GM labels in the first trial and the 5% 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% tolerance labels all bid on the certified non-GM foods in the first trial and the non-GM foods with the 1% tolerance in the second trial. We intended to have a second group bid on foods with the 1% 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% tolerance treatment was the same in both rounds at a 5% level of significance for any of the three products. The issue that prevented us from obtaining an additional experimental unit of people who bid on the non-GM foods with 1% tolerance did not appear to alter our results. (All results not shown in the tables are available from the authors upon request.)

[12]In the *n*th-price auction, we selected three different *n*th prices, one for each product. We also told the participants that they would at most purchase one unit of each product at the end of the experiments. We chose three food products that seemed to be neither complements nor substitutes—so an increase in the probability of winning one of the product(s) should not affect consumer demand for the others.

[13]Examining the distribution of bids, we see that some bids were greater than the average store price for a similar good while other bids were lower; which is a typical observation in experimental auctions over new products. Given the context of the experimental auction, several factors can explain the range of bids—novelty of GM tolerance levels, novelty of the good, novelty of the auction itself, differing beliefs or uncertainty about the store prices, and the perception that the store good was not a perfect outside option for the auctioned good. For a more detailed discussion, see Shogren, List, and Hayes on the distribution of bidding behavior for new and familiar goods in consecutive experimental auctions in which people re-bid as they gain experience with the product.

[14]Table 2 also shows that consumers bidding on 5% GM-tolerance discounted the vegetable oil by an average of 6 cents, the tortilla chips by 9 cents, and potatoes by 7 cents. Consumers bidding on 1% 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% and 41% of consumers bid less for the GM-tolerance food; but the percentage varied by food product.

[15]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.

[16]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% level, and the bids for the potatoes were significantly different at the 15% level.

[17]We also fitted several regressions to test the hypothesis that demographic characteristics, like consumer's gender, household income, religious affiliation when young, 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.

Appendix: Demographic Characteristics of Polk County, IA (including Des Moines area)

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

Source: U.S. Bureau of the Census.
Note: All variables are for individuals of all ages, except for married, which is for individuals eighteen or older; education, which is for individuals twenty five or older; and age, which is for individuals twenty or older.
[a]The estimate of the number of married people who are eighteen or older was obtained by taking the number of people married over fifteen and assuming that the number of people who were married at ages fifteen, sixteen, and seventeen was zero. This gives the percentage of married people who are eighteen or older.
[b]The years of schooling was estimated by placing a value of 8 for those who have not completed ninth 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.

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