The Value to Consumers of GM Food Labels in a Market with Asymmetric Information: Evidence from Experimental Auctions

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The growing GM food controversy and consumers' attempts to make better food purchasing decisions have pressed GM food labeling into an important public policy issue. Truthful labeling has been used to provide consumers with information on calories, nutrients, and food ingredients in the United States. In 1997, the European Commission adopted GMO food labeling which requires each member country to enact a law requiring labeling of all new products containing genetically modified organisms. In some EU countries, information technologies have made it economically feasible to encrypt large amounts of information on food package bar codes. Japan has also passed a law requiring GM labels for major foods. Labeling involves real costs--fixed costs of designing labels and testing and variable costs of monitoring for truthfulness. One key issue is whether the social benefits from labeling exceed the cost.

The objective of this paper is to present empirical evidence on consumers' willingness to pay for foods with and without GM labels using laboratory auction experiments for three food items. The participants are actual consumers randomly chosen in two major Midwestern U.S. cities by the ISU Statistics Department and who were paid to participate in experiments on food and household products. In this paper we report tests of the following hypotheses: Holding consumer tastes constant, (H1) no difference exists in consumers' willingness to pay for food items due to the GM-food-label treatment sequence, i.e., whether consumers first bid with or without GM food labels, (H2) the effects of GM food labels on willingness to pay for food items are the same for male and female consumers, and (H3) GM labels have no effect on consumers willingness to pay for food items.

Literature Review

Labeling of genetically modified foods is one of the most controversial issues in agriculture today. Currently, the United States does not require GM foods to be labeled, unless the new food product is substantially different from the original product (FDA). The United States Food and Drug Administration has issued a statement on the types of labels that are permissible in the United States. Two things are of note: First, when a genetically engineered product has different properties than the conventional product, it must be labeled as genetically engineered. Second, when labeling is voluntary, it is not permissible to have labels that imply that GM foods are different than the conventional varieties. Hence, companies cannot say "this food is not genetically modified," because that would imply GM foods are different. An example of an approved voluntary label is "this food is not genetically engineered."

The European Union, Australia, and New Zealand are among the areas that are now requiring mandatory labeling of genetically modified foods. Australia and New Zealand have new policies that will come into effect on December 7, 2001. They call for mandatory labeling of GM foods. Foods that do not have to be labeled under the new rules are refined foods (such as oils), GM foods where no single ingredient is more than 1% genetically modified, and food prepared at the point of purchase (such as restaurants). The European Union also requires labeling on foods that are genetically modified (cnn), and they have more stringent standards on the types of GM foods that can be allowed in the food supply. Certain types of GM foods, which critics fear may cause allergic reactions, will be phased out.

Caswell (1998 and 2000) has shown that there are many possible policies that could be implemented, including mandatory labeling of GM foods, voluntary labeling of GM foods, or bans on all labeling to indicate whether or not a food is genetically modified. The policies that each country chooses are likely to be determined by the information demanded by the consumers of each country. An informed decision on whether or not to implement a labeling policy on genetically modified foods should only be done after a benefit/cost analysis.

Benefits of GM labels

Greenpeace and Friends of the Earth both advocate labels on GM foods to give consumers the right to choose whether or not to consume GM foods. Many environmental and consumer advocacy groups call for mandatory labeling, which they believe benefits consumers.

The United States Department of Agriculture, Economic Research Service, has analyzed the potential benefits of labels on foods. One benefit is making it easy to find information, e.g. on nutritional content of foods. Thus, labeling of foods can lead to more informed choices on food and health by consumers. Also, some firms may want to avoid the prospect of placing a label that has negative connotations, and required labeling could lead them to improve their product.

Caswell and Padberg recommended a more comprehensive view of the benefits of labels on food products. These benefits can be above and beyond what are normally considered the typical benefits from labels. The benefits from food labels include increased consumer information, improved product design, and more consumer confidence in product quality. Also, labels can provide an option value, even for consumers who do currently read food labels. This option value exists because if a food is labeled, consumers always have the option to view the label, either now or in the future, and that option has some value.

Costs of GM labels

Implementing a labeling policy could be quite costly. The United States Department of Agriculture (USDA), Economic Research Service listed many costs associated with implementing a labeling policy. If a mandatory labeling policy on genetically modified foods is enacted, significant costs would be incurred. Identity preservation, to determine whether a particular food is GM, has significant fixed costs. When separating GM from non-GM foods, mistakes in delivery of the product are always a possibility. In the United States, GM corn that was not approved for human consumption, known as Starlink corn, got into the U.S. food system. Another possible cost is accidental contamination of non-GM crops by their GM counterpart. Farmers have to go to great lengths to ensure that non-GM crops are not contaminated with the GM variety. Among the things farmers need to do to ensure there is no contamination is to have buffer zones, that is zones between the GM and non-GM crops to prevent contamination. Farmers also need to make sure planting and harvesting equipment are not contaminated with any residue from GM crops. All of these items imply real costs when a labeling policy is implemented.

These added labeling and storage costs would lead to higher prices for consumers (and possibly lower prices to producers). The higher prices would affect all consumers, and therefore would be like a regressive tax, because the poor spend a larger share of their income for food than do high-income households. In addition to the poor having to pay for labeled food, the poor and less educated are less likely to benefit from food labels. This leads to what the USDA labeled, a “reverse Robin Hood effect” of taking money from the poor to benefit the rich.

The USDA suggests that labeling could change an industry’s structure. With some fixed costs associated with labeling, small firms may have higher per unit labeling costs than large firms. This would mean increasing returns to scale, and an incentive for firms to get bigger, or close down. A labeling policy that decreases the number of firms could decrease competition and might increase prices for consumers. Another cost firms could face is reformulation costs, which could be quite high

The USDA suggests that adding more information to food labels dilutes the other information given on the label. This concern seems most important when the labeling policy being considered would inform consumers of an attribute that may not impact human health, e.g. genetic modification. Labeling without independent verification is not likely to be useful. Hence, a new labeling policy would require resources for government or third-party verification.

There are relatively few estimates of the costs due to labeling of GM foods. KPMG was commissioned for a study in Australia and New Zealand to examine the costs of complying with a new labeling law. They estimated that the costs of the labeling laws could mean an increase in consumer prices from 0.5% to 15%, and that firms could also face lower profits (Phillips and Foster). Even though they commissioned the study, the Australian New Zealand Food Standards Council disregarded KPMG's input, citing two flaws. Whether this council had legitimate problems with the study, or were doing the easy thing politically, we do not know. Phillips and Smyth estimated that a voluntary identity preserved production and marketing system in Canada cost from 13-15% during 1995-1996. One thing seems apparent; implementing a labeling policy on genetically modified foods is costly, even if the exact magnitude of the costs is unknown.

Experimental Design

The on-going GM food debate has been fueled by information provided by interested parties, i.e., a positive perspective on agricultural biotechnology given by the biotech industry and negative perspective given by environmental or anti-technology groups. Each of these perspectives is trying to affect the demand for GM foods and inputs in a particular direction.

Also, an independent, third party perspective providing verifiable information to consumers and farmers might be social welfare improving (Huffman and Tegene 2000). It, however, would be costly to produce and to manage effectively.

With this background, a research project was designed to incorporate the private-information-revealing feature of experimental auction markets and the rigorous randomized treatment design of statistical experimental design.[1] The primary purpose of the project was to identify the effects of positive, negative, and verifiable information about biotechnology on consumers' willingness to pay for food items that might be genetically modified. The impact of these different types of information on willingness to pay seemed likely to be affected by the presence or absence of GM-food labels. Hence, the experimental design consisted of six biotech information-labeling treatments with two replications. The treatments were to be randomly assigned to twelve experimental units, each consisting of 13 to 16 consumers drawn from the households of two major urban areas and paid to participate. It was anticipated that a sample size of 165 to 190 participants was necessary for finding statistically significant results, but was not prohibitively costly. Using randomly chosen consumers from the population of an urban area, rather than undergraduate college students at a university, is seen as a major advantage when it comes to making inferences from the experiments to the Midwest or whole U.S. population. Conducting experiments in two urban areas rather than one is also seen as enhancing credibility of generalizations and showing that the experiments can be replicated across urban areas. Because major fixed costs exist of setting up and conducting a set of experimental auctions in a location and the budget for the project was modest, we did not have the resources to go to more than two urban locations (or include a larger number of participants at each location).

We anticipated that consumers might react differently to GM content for foods of different types. Hence, using only one food item seemed unlikely to reveal enough information. We settled on three food items: vegetable oil (made from soybeans), tortilla chips (made from yellow corn), and Russet potatoes. 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. Hence, minimal human health concerns should arise but GM soybeans might affect the environment. Tortilla chips are highly processed foods that may be made from GM or non-GM corn, and consumers might have human health and/or environmental concerns. Russet potatoes are purchased as a fresh product and 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.

Random *n*th-price auction

Auctions have been a popular mechanism in laboratory valuation experiments of economists over the past decade. In particular, Vickery's (1961) second-price auction has been used frequently. These economic experiments use the auction mechanism to induce individuals to reveal private information contained in their preferences for new goods and services, e.g., see Shogren et al. 1994, Fox et al. 1998, and Shogren et al. 2000. The popularity of the second-price auction is largely due to the mechanism being demand revealing in theory, relatively simple to explain, and having an endogenous market-clearing price. In this auction, bids for a good are ranked from highest to lowest, and the highest bidder pays the second highest price. Participants have an incentive to tell the truth about their valuation for a good because the auction separates what they say from what they pay.[2] Sincere bidding is the weakly dominant strategy. When a participant underbids he/she risks foregoing a profitable purchase, and overbidding risks making an unprofitable purchase. Furthermore, evidence from induced value experiments suggests the auction mechanism can produce efficient outcomes in the aggregate (Kagel 1995).

The second-price auction, however, has problems in that it does not accurately reveal the complete demand curve for a good by all participants. Individuals who anticipate being *off the margin*, i.e., bidders whose value for a good is far below or above the market-clearing price, frequently bid insincerely. Hence, it is not possible to measure the demand curve for a real-world good, and this may be very important information for new goods like GM food. For instance, based on bidding behavior in second- and ninth-price auctions, Knetsch et al. (1998) conclude that "contrary to common understanding the Vickrey auction may not be demand revealing." They contend that an auction is problematic if it fails to engage off-the-margin bidders. A second-price auction might not engage low-value bidders who think they will never lose by insincere bidding, and laboratory evidence by Miller and Plott (1985) and by Franciosi et al. (1993) does not contract this conjecture, i.e., off-the-margin bidders often do not reveal their lab-induced private values. Insincere bidding can be sustained if the behavior is undetected and unpunished by the institutional structure of the auction mechanism (e.g., see Cherry et al 2000).

We choose the random *n*th-price auction for our GM food experiments because it is designed to engage otherwise disengaged off-the-margin bidders and thereby reveal a greater section of the demand curve. The auction combines elements of two classic demand-revealing mechanisms: the Vickrey auction and the Becker-DeGroot-Marschak random pricing mechanism. The key characteristic of the random *n*th price auction is *a random but* *endogenously determined* market-clearing price. Randomness is used to give all participants a positive probability of being a purchaser of the auctioned good, thereby engage all bidders, and to reduce any incentive for bidders to fixate on a stable market-clearing price. The endogenous price guarantees that the market-clearing price retains some relation to bidders' private values. Each bidder should bid sincerely because he/she cannot use a random market-clearing price as a marker, and they all should be engaged because everyone has a chance to buy a unit of the good.

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 *n*th-price auction, which is drawn from a uniform distribution between 2 and *k*; and the monitor sells one unit of the good to each of the (n-1) highest bidders at the *n*th-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 increases the odds that insincere bidding will lead to a loss (Shogren et al 2000).

The Experiments

Auctions were planned and conducted at two Midwestern U.S. cities, Des Moines, IA, and St. Paul, MN. Participants in the auctions were consumers in these two areas that the Iowa State University Statistics Laboratory contacted and obtained agreement to participate. The Statistics Laboratory obtained 1,200 to 1,500 randomly selected residence telephone numbers from each of the metropolitan areas. These numbers were called by an employee of the ISU Statistics Laboratory to make sure that it was in fact a residence, and then asked to speak to an adult in the household (individual who was 18 years of age or older).[3] They were told that Iowa State University was looking for people who are willing to participate in a group session in Des Moines (St. Paul) that relates to how people select food and household products. The sessions were held on Saturday, April 7th (April 21st) and people were informed that they would last about 90 minutes. They were also told that at the end of the session each participant will receive $40 in cash for their time. The sessions were held at the Iowa State University Learning Connection, 7th and Locust, Des Moines (and lower level of the Classroom Office Building, University of Minnesota, St. Paul). Three different times were available each auction day, 9 am, 11:30 pm, and 2 pm, and willing participants were asked to choose a time that best fit their schedule. Participation per household was limited to two adult individuals, and they were assigned to different groups.[4] To willing participants, the Statistics Laboratory followed up by sending a letter containing more information, including a map and instructions on when and where the meeting would be held, how to get there, and a telephone number to contact for more information.

There were twelve experimental units, six in Des Moines, and six in Minneapolis. Individuals who were called had the option of participating at one of three different times: 9 am, 11:30 pm, and 2 pm. Twelve hundred people in Des Moines were called and 99 of them agreed to participate. Of those 99 people who agreed to participate, 78 did indeed show up. For the Minneapolis experiments, 1500 people were called and 118 people agreed to participate. Of those 118, we had 96 participants in the Minneapolis experiments. Our total sample size is 174, which is large compared to most experimental auctions that are held.

Steps in the Experiment

Each auction has ten steps, that are summarized in figure 1.[5] When participants arrived at the experiment, they signed a consent form to agree to participate in the auction. After they signed this form, they were given $40 for participating and an ID number, to preserve the participants anonymity. The participants then read brief instructions, and filled out a questionnaire.

In step 2, participants were given detailed instructions about how the random nth-price auction works, including an example written on the board. After the participants learned about the auction, a short quiz was given to participants to ensure that everyone understood how the auction worked.

Step 3 was the first practice round of bidding, where participants bid on a brand-name candy bar. The participants were all asked to examine the product, and then place a bid on the candy bar. The bids were collected and the first round of practice bidding was over. 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.

Step 4 was the second practice round of bidding, and in this round the participants bid separately on three different items. The products were the same brand-name candy bar, a deck of playing cards and a box of pens. Only one of the two rounds were chosen as binding (valid), so that participants would not take home more than one of any product. The reason was to eliminate price reduction due to the consumer buying a higher quantity (i.e., lower prices due to moving down a consumer's demand curve).[6] The consumers were asked to examine the three products in practice round two, then the bids were collected.

After the two practice auction rounds were completed, the binding round and the binding nth-prices were revealed in step 5. All of the prices participants bid were written on the board, and the nth-prices were circled for each of the three products. This way, people could see what items they won immediately, and what price they won the items for. For convenience, the participants were notified that all purchases of goods would take place after the experiment was over, so that everything could happen in one exchange.

In step 6, participants received information about biotechnology, separate from GM labels. The possible types were (1) the industry perspective—a collection of statements and information on genetic modification provided by a group of leading biotechnology companies, including Monsanto and Syngenta; (2) the environmental group perspective—a collection of statements and information on genetic modification from Greenpeace, a leading environmental group; (3) the independent, third party perspective—a statement on genetic modification approved by a third party group, consisting of a variety of individuals knowledgeable about genetically modified goods, including scientists, professionals, religious leaders, and academics, who do not have a financial stake in genetically modified foods. To assist the participants process these different sources of information, the volume of information from each source was limited to one full page, and it was organized into five categories: general information, scientific impact, human impact, financial impact, and environmental impact.

The information was randomized, so there were six combinations of information participants could receive. The six information combinations are as follows: pro-biotechnology information, anti-biotechnology information, both pro and anti-biotechnology information,[7] pro-biotechnology and independent, verifiable information,[8] anti-biotechnology and independent, verifiable information, and pro-biotechnology, anti-biotechnology, and independent verifiable information. These six combinations of information were randomized among all twelve experimental units, with each information combination going to two experimental units. How the information impacted the decision process has not yet been examined and is beyond the scope of this paper.

There were two auction rounds that followed the distribution of information. One of the two rounds had the participants bid on food products with just a standard food label. The other round had participants bid on the same food products with the same label except that there was a sentence indicating that the food had been genetically engineered. These labels were made as plain as possible, to avoid any influence on the bids from the label design. The labels used can be found on figure 2. The genetic modification labels were constructed so as to comply with the U.S. Food and Drug Administration regulations of GM food labels (FDA). The sequencing of GM labels was randomized across experimental units. Each combination of information was given to two experimental units. One of these experimental units bid on food with the standard label in round one, and the food with the label indicating genetic modification in round two. The other experimental unit bid on food with the label indicating genetic modification in round one, and the standard label in round two. For each experimental unit, only one of the two food rounds was chosen as the binding (valid) round. This avoided the problem of bid prices being reduced as consumers moved along their demand curve.

In step 7, participants bid on three different food products, a bag of potatoes, a bottle of vegetable oil, and a bag of tortilla chips. The participants were instructed to examine the three products, and then they wrote down their sealed bid for each of the three goods. Participants bid on each good separately. Then the bids were collected from the individuals, and the participants were informed that they were about to look at another group of food items.

Step 8 had participants come examine the same three food products, but with the different label. After the participants examined the products, they were instructed to bid on the three products. Each good was bid on separately. The bids were then collected from all of the individuals

Step 9 consisted of the selection of which of the two food rounds would be chosen as binding, along with the binding nth-prices. After the binding round and binding nth prices were chosen, the winners were notified and the participants were asked to fill out a brief post-auction questionnaire. In step ten, the participants who did not win any products were informed that they were free to leave, and the participants who won products exchanged money for their goods, and then they were free to leave.

Data and Results

A summary of the demographic background of the 172 participants can be found in table 1. Sixty-two percent of the participants in the auctions were female, and the mean age of our participants was 49.5 years. Two thirds of the participants were married, and on average, the participants were well educated, with the mean education level being more than two years in college. The participants had a mean total household income level (before taxes) of $57,000. Most of the participants in the experiments were white (ninety percent), and most people indicated that they read labels before they buy a new food product. The demographic characteristics of our participates indicate that our experiments had a representative sample of the Midwest region of the United States.

Table 2 shows the mean bids for each of the three products, the 5 pound bag of potatoes, the 32 ounce bottle of vegetable oil, and the 1 pound bag of tortilla chips. Part A of table 2 shows the mean bids for all participants. For all three products, participants were willing to pay less for the product labeled as genetically modified than for the unlabeled product. Part B of table 2 shows the bids for the subset of auction participants who bid on food products with GM food labels in round one, and part C shows the bids for participants who bid on food products with GM labels in round two. The bids for the GM labeled food and the unlabeled counterpart are much closer for the participants who bid on GM labeled food in round one than for those who bid on food with GM food labels in round two. One possible explanation for this is that when participants who bid on food with GM food labels in round one, they know the products are genetically modified. Then when they see very similar food products in round two with a plain food label, some might assume that the products are genetically modified in round two, also (correctly so). On the other hand, participants who bid on unlabeled food in round one probably assumed that the food products they were bidding on in round one were non-GM, and then lowered their bids on the food with GM food labels in round two.

We report on a set of regression results where consumer tastes for each of the three products are held constant. This is accomplished by making the dependent variable the difference in bid prices for a given commodity without and with GM food labels. To formalize a simple model consider:

$$P_i^{non-labeled} = b_1^{non-labeled} + b_2^{non-labeled} X_{i2} + m_i^{non-labeled} \quad (1)$$

$$P_i^{labeled} = b_1^{labeled} + b_2^{labeled} X_{i2} + m_i^{labeled} \quad (2)$$

Where equation (1) is the regression equation for the non-GM-labeled products and equation (2) is a regression equation for the GM-labeled products. P_i represents the price bid for a good by participant i; b_1 is an intercept term; X_{i2} is a vector of demographic characteristics, and b_2 is the associated vector of coefficients. m_i is a random error term. Equations (1) and (2) can be rearranged to obtain an equation for bid price difference:

$$P_i^{non-labeled} - P_i^{labeled} = b_1^{non-labeled} - b_1^{labeled} + \left(b_2^{non-labeled} - b_2^{labeled}\right)X_{i2} + m_i^{non-labeled} - m_i^{labeled} \quad (3)$$

$$P_i^{non-labeled} - P_i^{labeled} = b_1^* + b_2^* X_{i2} + m_i^* \quad (4)$$

To analyze the results, we run a series of least squares regressions. Hence, when equation (3) is fitted by least squares, b_1^* and b_2^* are estimates of differences for coefficients in equations (1) and (2). The dependent variable in all of the regressions is the individual differences in bids between the food that was not labeled as genetically modified and the food that was labeled as genetically modified. Three sets of tables of regressions are reported, one set for each of the three products, the potatoes, the tortilla chips, and the vegetable oil. Labels1 is a dummy variable taking a value of 1 if an experimental unit bid on food with GM-labels in round one (and plain-labeled foods in round two). The other two independent variables used are household income and gender. Gender is a dummy variable taking a value of 1 if a person is female.

Table 3, table 4 and table 5 have the regression results for the vegetable oil, tortilla chips and potatoes respectively. Regression (1) reports on a test of the difference in bid prices due to GM labels. The intercept is positive implying that on average, participants were willing to pay 14 cents less for a 32 ounce bottle of vegetable oil labeled as genetically modified, 15 cents less for a 1 pound bag of tortilla chips labeled as genetically modified, and 13 cents less for a 5 pound bag of Russet potatoes labeled as genetically modified. All three intercept terms are statistically significant at the 1% level.

In regression (2), the difference in bid prices is regressed on an intercept term and the variable “labels1.” The coefficient of this dummy variable is negative for all three products, indicating that participants who bid on the GM labeled food in the first round paid a smaller premium for unlabeled food than the other participants. The premium for oil was 17 cents smaller, for tortilla chips the premium was 11 cents smaller, and for potatoes the premium was 19 cents smaller for participants who bid on food products with GM labels in round one. This would indicate that the sequence in which consumers bid on the food items matters. The coefficient of the dummy variable for “labels1” was statistically significant for two of the three products.

Regression (3) tested for household income effects on bid price difference. For these regressions, the coefficient of income was positive but not statistically significant. Regression (4) included gender as an independent variable. The coefficient of gender turned out to be negative for all three products, indicating that women pay a smaller premium for non-GM foods. This variable is not statistically significant. Regression (5) includes both income and gender as independent variables, and neither coefficient was significant in these equations. Several other variables were tested using least squares regressions and found to be statistically insignificant. These variables include marital status, race, education and age.

The results of the regressions are important. Individuals, on average, paid about a fourteen percent premium to purchase the food they perceived as non-GM. The premium did not vary much among the three different food products, indicating that most individuals seemed to perceive the same risk from genetic modification in all three goods. The fact that such a large premium exists could have major implications.

There are two possible interpretations from this. One interpretation is that without the labels, consumers are paying an implicit tax by spending more on food than they otherwise would have spent. This would indicate that GM food labels on products could have major benefits to consumers, informing consumers of a product they would not want to buy. A different interpretation is that consumers do not understand genetic modification, and that since genetically modified products are deemed as substantially equivalent to their non-GM counterparts, consumer's ignorance would result in the premium for non-GM foods. If this is the case, more information on the risks or benefits of GM foods could help consumers make more informed decisions. Whatever the explanation for this might be, it is apparent that consumers demand for GM foods is significantly lower than the demand for the non-GM counterpart.

Conclusion

With the growing controversy over the issue of labels on genetically modified foods, countries around the world are considering or implementing policies regarding labels on GM foods. This study has shown that consumer's willingness to pay for a food product decreases when they are certain the product is genetically modified. Consumers were willing to pay about a 14% premium for the good they perceived as non-GM. In addition, gender, income, and other demographic characteristics do not appear to alter a consumer's willingness to pay for genetically modified foods.

This paper has also shown that the order in which consumers bid on food, i.e., whether they bid on the food with GM labels in round one or round two has a significant impact on the willingness to pay for GM foods. Participants who bid on food with GM labels in round one had a much higher willingness to pay for GM food than the participants who bid on food with GM food labels in round two. This information arises because we randomized the treatments

The implications of this study are significant. With consumers placing such a high premium on the goods they perceive as non-GM, if a mandatory labeling policy is enacted in the United States, many firms may decide to go "GM-free" in order to increase profits. Future research will examine the impact of biotechnology information from different sources on consumer willingness to pay for foods that might be genetically modified. Another avenue for future research could examine how consumers would react to GM foods that posed benefits. All of the food products in these auctions were modified and deemed substantially equivalent to the conventional commodity. There are some GM foods that were modified to enhance the quality of the product. Two such products are flavor saver tomatoes that were genetically engineered to have a longer shelf life, and golden rice, which was genetically modified to provide more vitamin A, which could provide great benefits to people in third world countries.

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ENDNOTES

[1] Phil Dixon and Wayne Fuller, Department of Statistics, Iowa State University, provided assistance with the statistical design part of the project.

[2] A key distinction between experimental economics and experimental psychology is that participants in economics experiments must be willing to back their stated preferences for a good by actually paying cash for it. In psychological (and sociological) experiments, participants are only asked to give their preferences.

[3] In addition to a participant's age, the Statistics Laboratory also asked for gender.

[4] When two adults in a household participated, the Statistics Laboratory talked to both of them separately to obtain a commitment to participate and they were told that they would be assigned to different groups.

[5] The complete set of information given to participants is available from the authors.

[6] If one assumes that there is little or no income effect from the deck of cards and box of pens, the two bids on the candy bar should be the same. The reason is that since the deck of cards and box of pens are neither complements nor substitutes to the candy bar, they should not impact the bids on the candy bar.

[7] When a participant received both pro-biotechnology and anti-biotechnology information, the order was randomized, so that some people got the pro-biotechnology information first, and some people got the anti-biotechnology information first.

[8] When verifiable information was distributed, it always was distributed after the other information sources.

Figure 1: Steps in the experiment

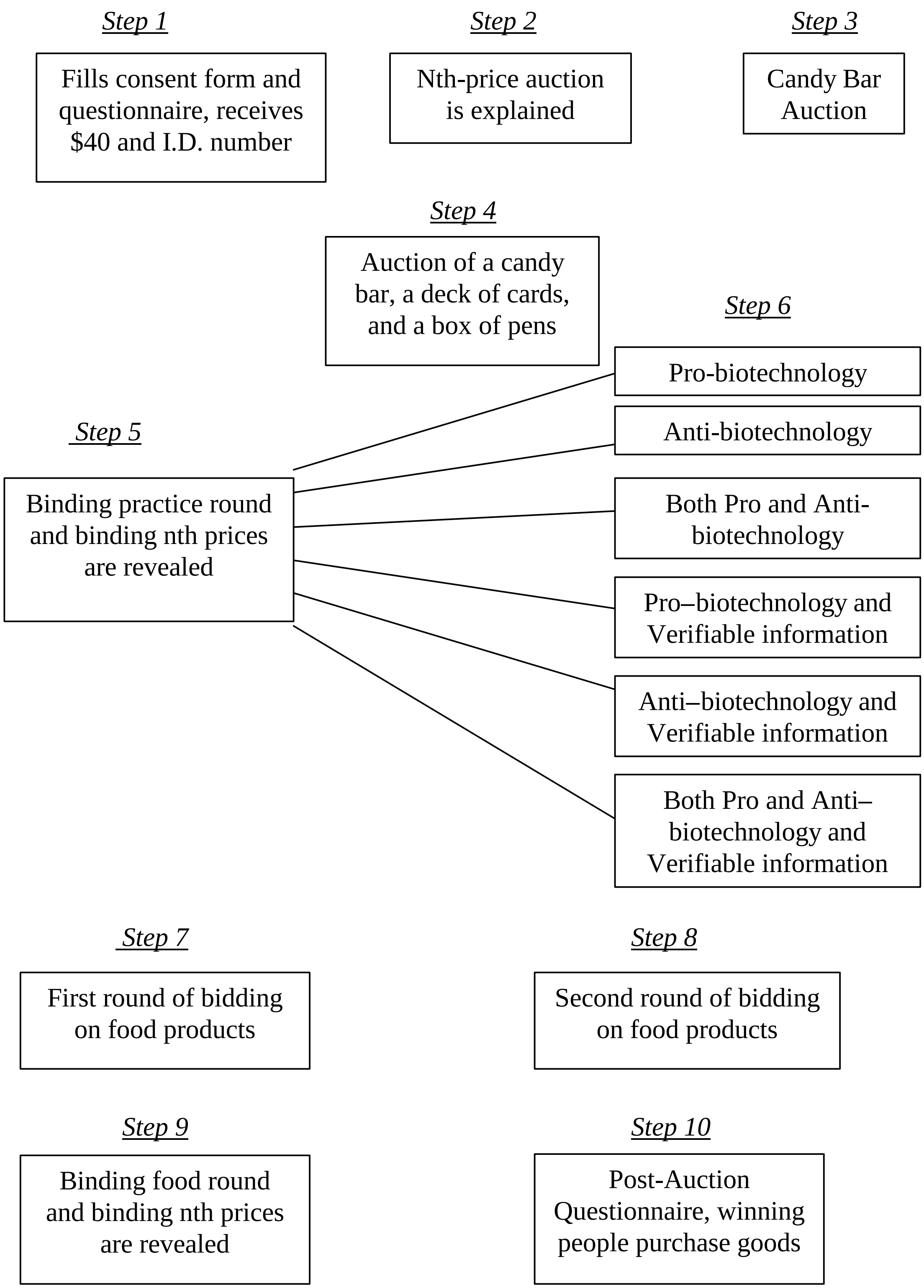

Figure 2: Labels used for the three food items

Russet Potatoes *Net weight 5 lb.* **This product is made using genetic modification (GM)**	**Russet Potatoes** *Net weight 5 lb.*
Tortilla Chips *Net weight 16 oz.* *Fresh made Thursday April 5th* **This product is made using genetic modification (GM)**	**Tortilla Chips** *Net weight 16 oz.* *Fresh made Thursday April 5th*
Vegetable Oil *Net weight 32 fl. oz.* **This product is made using genetically modified (GM) soybeans**	**Vegetable Oil** *Net weight 32 fl. oz.*

Table 1. Characteristics of the Auction Participants

Variable	Definition	Mean	St. Dev
Gender	1 if female	0.62	0.49
Age	The participant's age	49.5	17.5
Married	1 if the individual is married	0.67	0.47
Education	Years of schooling	14.54	2.25
Household	Number of people in participant's household	2.78	1.65
Income	The households income level (in thousands)	57.0	32.6
White	1 if participant is white	0.90	0.30
Labels	1 if never read labels before a new food purchase	0.01	0.11
	1 if rarely read labels before a new food purchase	0.11	0.31
	1 if sometimes read labels before a new food purchase	0.31	0.46
	1 if often read labels before a new food purchase	0.37	0.48
	1 if always read labels before a new food purchase	0.20	0.40

Table 2. Mean bids

A. Mean bids – all participants

	Observations	mean bid	std dev	Minimum	Maximum
GM OIL	172	0.91	0.84	0	3.99
OIL	172	1.05	0.85	0	3.79
GM CHIPS	172	0.93	0.86	0	3.99
CHIPS	172	1.08	0.85	0	4.99
GM POTATOES	172	0.78	0.67	0	3
POTATOES	172	0.91	0.67	0	3.89

B. Mean bids when participants bid on food with GM food labels in round one.

	Observations	mean bid	std dev	Minimum	Maximum
GM OIL	88	0.98	0.91	0	3.99
OIL	88	1.04	0.89	0	3.79
GM CHIPS	88	0.95	0.87	0	3.25
CHIPS	88	1.05	0.81	0	2.99
GM POTATOES	88	0.90	0.69	0	2.5
POTATOES	88	0.94	0.63	0	2.51

B. Mean bids when participants bid on food with GM food labels in round two.

	Observations	mean bid	std dev	Minimum	Maximum
GM OIL	84	0.83	0.77	0	3.25
OIL	84	1.06	0.80	0	3
GM CHIPS	84	0.90	0.86	0	3.99
CHIPS	84	1.11	0.89	0	4.99
GM POTATOES	84	0.65	0.63	0	3
POTATOES	84	0.88	0.72	0	3.89

Table 3. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled vegetable oil
(n=172, standard errors are in parentheses)

Dependent variable: Bid price non-labeled food – bid price GM-labeled food

Regressors	(1)	(2)	(3)	(4)	(5)
Intercept	0.143 **	0.231 **	0.028	0.207 **	0.093
	(0.043)	(0.061)	(0.087)	(0.070)	(0.106)
Labels1		-.173 *			
		(0.085)			
Income			0.0020		0.0019
			(0.0013)		(0.0013)
Gender				-0.104	-0.0947
				(0.089)	(0.089)
R^2	N.A.	.024	.014	.008	.020

** indicates that a variable is significant at 1%
* indicates that a variable is significant at 5%

Table 4. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled tortilla chips
(n=172, standard errors are in parentheses)

Dependent variable: Bid price non-labeled food – bid price GM-labeled food

Regressors	(1)	(2)	(3)	(4)	(5)
Intercept	0.152 **	0.206 **	0.088	0.173 **	0.108
	(0.037)	(0.053)	(0.075)	(0.061)	(0.092)
Labels1		-0.106			
		(0.075)			
Income			0.0011		0.0011
			(0.0012)		(0.0012)
Gender				-0.034	-0.0285
				(0.077)	(0.0775)
R^2	N.A.	.012	.006	.001	.006

** indicates that a variable is significant at 1%
* indicates that a variable is significant at 5%

Table 5. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled potatoes
(n=172, standard errors are in parentheses)

	Dependent variable: Bid price non-labeled food – bid price GM-labeled food				
Regressors	(1)	(2)	(3)	(4)	(5)
Intercept	0.132 **	0.229 **	0.09	0.139 **	0.094
	(0.032)	(0.045)	(0.065)	(0.053)	(0.080)
Labels1		-0.189 **			
		(0.630)			
Income			0.0007		0.0007
			(0.0010)		(0.0010)
Gender				-0.0103	-0.0067
				(0.0666)	(0.0668)
R^2	N.A.	.050	.003	.000	.003

** indicates that a variable is significant at 1%
* indicates that a variable is significant at 5%