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Should the United States Initiate a Mandatory Labeling Policy for Genetically Modified Foods?

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Public debate continues over whether the United States should impose a mandatory labeling policy for genetically modified (GM) foods. Favoring a mandatory labeling policy for GM foods are such groups as Greenpeace (1997), Friends of the Earth (2001), and Consumer's Union (1999). Opposing a mandatory labeling policy for GM foods are the Council for Biotechnology information (2001) and the United States Food and Drug Administration (2001). This is a contentious issue, engaging debate from all sides of the spectrum, yet there has been modest economic work done to examine the merits and pitfalls of a mandatory labeling policy for genetically modified foods in the United States.

This paper examines the welfare effects of imposing a mandatory labeling policy in the United States for GM foods. We design an experiment using the tools of survey design, statistical experimental design, and the random nth-price auction to explore whether consumers understand the signals sent from a voluntary labeling policy relative to how they read signals from a mandatory labeling policy. We show that if consumers understand correctly the signals sent in each market, a mandatory labeling policy for GM foods results in welfare losses compared to a voluntary labeling policy. Our results suggest that a representative consumer from two Midwest cities interpreted the signals sent from voluntary and mandatory markets identically. These findings do not reject the view that US should continue with its voluntary labeling policy and resist calls by the anti-biotechnology groups for mandatory labeling of genetically modified foods.

Background on GM-labels and GM-labeling policies

Caswell (1998, 2000) has shown that the list of potential GM labeling policies is sizeable, and includes mandatory labeling of GM foods, voluntary labeling of GM foods, or bans on all labeling. The policies that each country chooses are likely to be determined by competitive interest group politics (Olsen, 1965). An informed decision about labeling policies for genetically modified foods should only be done after a careful benefit/cost analysis. Caswell points out that a voluntary labeling program is likely to be a better policy option for a country that has only a small segment of the population that is concerned about GM foods, while a mandatory labeling system is likely the best policy option in countries where most of the population wants to know if their food is genetically modified. A model by Krichhoff and Zago (2001) reached a similar conclusion--mandatory GM-labeling policies may be better for more GM-averse consumers, while a voluntary GM-labeling policies may be better for a country that has more consumers who are concerned with cost savings.

The United States does not require mandatory labeling for most genetically modified foods. In January 2001, the U.S. Food and Drug Administration (FDA) issued a "Guidance for Industry" statement for labeling GM products. In this the FDA stated that the only GM foods that need to be labeled are ones that have different characteristics from the non-GM version. Labeling is not required for any other GM foods, but firms in the United States do have the option of voluntarily indicating whether their food is genetically modified. Canada also has a similar voluntary labeling policy.

The European Union (EU) requires that all foods have the label "genetically modified" if any ingredient in the food is at least one percent GM. The European Parliament voted for stricter regulations in early 2001. The new regulations call for stricter labeling and monitoring of GM products, and allows for the tracing of GM products through the food chain (CNN, 2001). The EU standards are the minimum standards that member countries must adhere to, although countries can have stricter standards. Several other countries around the world have mandatory labeling policies for GM foods, including Australia, Japan, and New Zealand. For a detailed review of labeling policies, see Rousu and Huffman (2001) or Phillips and McNeil (2000).

Benefits and Costs of Mandatory and Voluntary labeling Policies

Studies have shown that benefits from mandatory labeling of GM foods are possible. Greenpeace and Friends of the Earth both advocate labels on GM foods to give consumers the opportunity to choose whether to consume GM foods. Many environmental and consumer advocacy groups call for mandatory labeling, which they believe benefits consumers (Greenpeace, 1997; Friends of the Earth, 2001; Consumer Reports, 1999).

The United States Department of Agriculture, Economic Research Service, has analyzed the potential benefits of labels on foods (Golan *et. al.* 2000). One benefit is making it easy to find content-information on food products. Labeling of foods can lead to more informed choices by consumers. Also, some firms may want to avoid the prospect of placing a label that has negative connotations which could lead firms to improve their product.

Caswell and Padberg (1992) recommended a 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.

While benefits might exist, implementing a mandatory labeling policy for genetically modified foods could be costly. Biotechnology firms oppose mandatory labeling for all GM foods because they do not think foods should be specially labeled unless the food is inherently different from the conventional product (Council for Biotechnology Information, 2001). The United States Department of Agriculture, Economic Research Service listed costs associated with implementing a labeling policy (Golan *et al.* 2000), which are significant. Identity preservation, to determine whether a particular food is GM, has significant fixed costs. When segregation is achieved, it increases the probability that the wrong product will be delivered to a buyer. For example, in the United States GM corn that was not approved for human consumption, known as Starlink corn, got into the U.S. food system in late 2000. 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 accidentally 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.

Labeling could change an industry's structure (Golan *et. al.* 2000). 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 larger, 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 large.

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. Furthermore, labeling without independent verification is unlikely to be useful. A new labeling policy would require resources for government or third party verification.

There are relatively few estimates of the costs of GM food labeling. The accounting/consulting firm 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, 2000). Even though they commissioned the study, the Australian New Zealand Food Standards Council (2001) 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 (2000) estimated that a voluntary identity preserved production and marketing system in Canada cost from 13-15% during 1995-1996. The Philippine Chamber of Food Manufacturers warned that mandatory GM food labels would increase production costs by 15%, and that the increased costs would be passed on to consumers (AgBiotech Reporter, August 2001). One thing seems apparent; implementing a labeling policy on genetically modified foods is costly, even if the exact magnitude of the costs is unknown.

Empirical Model

We develop a single period model to examine the welfare effects of alternative labeling policies. Following the model of food certification in Crespi and Marette (2001) and the model on GM-labeling by Krichhoff and Zago (2001), our model compares the welfare of a mandatory GM-labeling policy to the welfare of voluntary GM-labeling policy. Assume a firm produces one of two products, GM food or non-GM food. Without loss of generality, assume a firm could produce the GM food at marginal cost of zero, while the marginal cost of non-GM food is $c > 0$. There are also laboratory costs to test for GM content. Assume firms that have a product tested to determine the genetically modified status of their product incur a marginal cost of $t > 0$.

Assume firms know whether their products are genetically modified. Suppose a sufficient number of firms exist such that when proper signals are available, many firms would be producing GM foods and many firms would be producing non-GM foods. Firms compete by Bertrand competition (by setting prices) so to examine the welfare effects of different labeling policies, one needs only look at the gains to consumers. This is because under Bertrand competition, firms earn zero profits so they are indifferent to labeling policies.

All consumers have a value $f > 0$ for a food product (GM or non-GM). This could be thought of as the value consumers place on not starving. In addition, tastes for non-GM foods are assumed to be uniformly distributed across consumers, denoted by $q \in [0,1]$. For consumers who buy non-GM foods at a price of p_{NGM}, their indirect utility is $q + f - p_{NGM}$. For consumers who buy GM foods at a price of p_{GM}, their indirect utility is $f - p_{GM}$. For ease of welfare analysis, simplify the mass of consumers to one. Assume no positive or negative externalities of one consumer on another.[1]

Consider a baseline case where no labeling of products is allowed. Because non-GM foods are costlier than GM foods, only GM foods will be offered. GM foods will be offered at a price of zero, because Bertrand competition brings price down to marginal cost. The reason there is no non-GM food when labeling is banned is that no way exists for consumers to distinguish between GM and non-GM foods. A premium cannot be charged for non-GM foods, which is needed to cover the higher costs of producing non-GM foods. A consumer's total surplus is f . This outcome occurs because a separating equilibrium is unavailable, and non-GM foods can not be accurately signaled, leading to the classic "lemons" problem (Akerlof, 1970). This problem could also occur in a voluntary labeling regime if testing costs are too high. We next consider the welfare effects of alternative labeling policies: a mandatory GM-labeling policy where all food products must be tested and a voluntary labeling policy, where firms wishing to label their products as non-GM must have their products tested. All cases assume the regulator incurs a per unit cost for certification and passes that cost onto firms: a discussion of fixed certification costs follows this analysis.

Mandatory labeling policy – All products must be tested

Consider a mandatory GM labeling policy where all food products must be tested to determine if they are genetically modified. Goods that are genetically modified will be labeled as "genetically modified." Foods that are not genetically modified will not be labeled (although labeling these products as non-GM does not change the analysis). A GM product has a constant marginal cost (and price) of t, and a non-GM product has a marginal cost (and price) of $c+t$.[2] The consumer surplus of individual *j* who purchases non-GM foods is:

(1) $$CS^j = q^j + f - p \, .$$

The consumer surplus for all consumers who purchase non-GM foods is then:

(2) $$CS_{ML}^{NGM} = \int_{q_{ML}}^{1} (q_{ML} + f - p)dq = \int_{q_{ML}}^{1} (q_{ML} + f - C - t)dq$$

(2A) $$CS_{ML}^{NGM} = (1-q_{ML})\left(\frac{(1+q_{ML})}{2} + f - C - t\right).$$

Where q_{ML} is the value of q where consumers are indifferent between consuming non-GM and GM foods under a mandatory labeling policy. Consumer surplus for individual *j* who purchases GM foods is:

(3) $$CS^{j} = f - p.$$

Aggregate consumer surplus of those who purchase GM foods is:

(4A) $$CS_{ML}^{GM} = \int_{0}^{q_{ML}} (f - p)dq = \int_{0}^{q_{ML}} (f - t)dq$$

(4B) $$CS_{ML}^{GM} = q_{ML} * (f - t).$$

Voluntary labeling policy, only non-GM foods need to be tested

Consider a voluntary labeling policy, where only the products that are to be labeled as non-GM need to be tested. Non-GM products are labeled as non-GM. GM products are not labeled, and consumers will see this as a signal that these foods are GM. Once again, the marginal cost of testing a product is $t > 0$. Now a GM product has a price of 0, while a non-GM product has the same price of $c + t$. Consumer surplus of an individual who purchases non-GM foods is the same under either policy, as shown in equation (1). Aggregate consumer surplus of those who will purchase non-GM foods is:

(5) $$CS_{VL}^{NGM} = \int_{q_{VL}}^{1} (q_{VL} + f - p)dq = \int_{q_{VL}}^{1} (q_{VL} + f - C - t)dq$$

(5A) $$CS_{VL}^{NGM} = (1-q_{VL})\left(\frac{(1+q_{VL})}{2} + f - C - t\right)$$

q_{VL} is the value of q when consumers are indifferent between consuming non-GM and GM foods under a mandatory labeling policy. Consumer surplus for individual *j* who purchases GM foods under a voluntary policy is:

6) $$CS^{j} = f - p = f.$$

Therefore aggregate consumer surplus of those who purchase GM foods is:

7) $$CS_{VL}^{GM} = \int_0^{q_{VL}} (f)dq = q_{VL} * f \ .$$

Consider a third possible labeling policy, where genetically modified products must be labeled as such, and non-GM products are not labeled. For this policy, however, only those products wanting to avoid the label of "genetically modified" need to be tested. Firms that do not test will be forced to label their foods as genetically modified. Once again, the marginal cost of testing a product is $t > 0$. For this case, a GM product will have a price of 0, while a non-GM product has a price of $t + a$. This mandatory labeling policy gives the same welfare as the voluntary labeling policy.

One can state that consumer welfare is greater under the voluntary labeling policy. If one considers only consumers and firms in a model (and not third party groups), then a voluntary labeling policy for GM foods Pareto dominates a mandatory policy. This is because voluntary and mandatory labeling policies send the same signal, but additional testing and segregation costs occur under a mandatory policy. This model only assumed that food testing would imply a higher marginal cost, when other costs of a mandatory labeling policy are also considered, such as a possible increase in market concentration, mistakes in labeling, and dilution of the other information on the food label (Golan *et al*. 2000), it strengthens the prediction that a voluntary labeling policy yields higher welfare than a mandatory policy.

In a market structure where firms compete by quantity (Cournot model), one gets the same result if the number of firms producing GM foods and non-GM foods stays the same when a switch is made from a voluntary policy to a mandatory policy. A change from a voluntary to a mandatory labeling policy has no effect for an individual who consumes non-GM foods and a decrease in welfare for those who consume GM-foods. Under the Cournot model however, firms that produced GM-foods would earn lower profits under the mandatory policy. The result that a voluntary labeling policy yields higher welfare than a mandatory labeling policy appears to be robust to the type of model used to analyze the problem.

Where the regulator incurs a fixed cost for testing in a mandatory labeling policy, and passes the cost along to producers, passing it along as a fixed user fee is always less efficient than passing the costs along as a per-unit user fee (Crespi and Marette, 2001). Therefore, an efficient certification process will result in the regulator splitting the fixed cost into per-unit user fees, and the analysis for the per-unit certification cost applies.

Many environmental groups are calling for a mandatory labeling policy on GM foods (Greenpeace 1997, Friends of the Earth, 2001). This is despite the fact that consumers could purchase non-GM foods under a voluntary labeling policy by looking for foods with a non-GM label on it. This model presents an explanation for this behavior. Suppose the utility of environmental groups is positively related to the number of individuals who consume non-GM foods (and negatively related to the number of individuals who consume GM foods). A mandatory labeling policy imposes additional costs for testing on GM foods, and therefore increases the number of individuals who would purchase non-GM foods. The passage of a mandatory GM-labeling law would increase the utility of environmental groups.

When will a voluntary labeling policy not allow for signals?

When testing to see if a product is made using genetic modification, no one will consume non-GM foods if the test is too costly. For any consumer that has $q - C - a < 0$, he will not purchase the non-GM food, because he is better off buying the GM food and obtaining a consumer surplus of *f*. So if the consumer who places the highest value on non-GM food ($q = 1$) finds it too costly to purchase non-GM foods, ($C + a > 1$), he/she will buy non-GM foods.

This analysis implicitly assumes that consumers can distinguish the signal that a food is GM (or non-GM) equally well. This is a contentious point that many groups, including Greenpeace (1997) and Friends of the Earth (2001), strongly disagree with. These groups are calling for a mandatory labeling policy in the United States because, as Greenpeace (1997) puts it, “customers must have the right to know.” We conduct experiment auctions to see if consumers behave as if they see the same signal under alternative labeling regimes or if consumers read the signals differently. A discussion of the experimental design follows.

Experimental Design

The on-going GM-labeling debate has been fueled by information provided by proponents and opponents of mandatory labeling. Proponents of voluntary labeling policies say they are less expensive, because only the firms that wish to label their products must incur the labeling costs. In a mandatory-labeling regime, all firms would need to incur additional costs, whether the costs are due to product testing, label design, segregation, mistakes in labeling, etc. Many proponents of mandatory labeling of GM foods say that consumers have a “right to know” what they are eating and proponents claim that governments should mandate labels for foods made through genetic modification.

With this general background in mind, we design a new set of six treatments that complement our earlier work (Huffman et al., 2002; Rousu et al., 2002) by incorporating the private-information-revealing feature of experimental auction markets and the rigorous randomized treatment design of statistical experimental design (also see Hoffman *et al*. 1993, Fox *et al*. 1998). We designed a set of experimental auctions in which adult consumers who are randomly assigned to the various treatments bid on actual foods that differed only by the types of labels on the foods. Some consumers bid on foods with *positive GM-labels*—the labels that would arise in a *mandatory* labeling regime; others bid on food with *negative GM-labels*—the labels that would arise in a *voluntary* labeling regime.

The experimental design consisted of four biotech information-labeling treatments with each treatment replicated at least twice. The treatments were randomly assigned to ten experimental units, each consisting of 13 to 16 consumers drawn from the households of two major urban areas and who were paid to participate. We anticipated that a sample size of 135 to 145 participants was necessary for finding statistically significant results, which 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 an advantage when it comes to making inferences, however cautious, from the experiments to the

Midwest or whole U.S. population (also see the comments in Lusk *et al*. 2001). Conducting experiments in two urban areas rather than one is also seen as enhancing credibility of our results by showing that the experiments can be replicated across urban areas.

We now describe the four elements in our GM labeling experiments—the GM food, the auction mechanism, the experimental units, and the specific steps in the experiment which includes the detailed information labels. Consider each in turn.

We anticipated that consumers might react differently to GM content for foods of different types. Believing that one food item was unlikely to reveal enough information, we settled on three items: vegetable oil,[3] 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. Minimal human health concerns should arise from consumption of the oil, but people might still fear that the production of GM foods 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 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. Now we will discuss the auction mechanism used for the experiment.

Valuation experiments use an auction mechanism to induce people to reveal their preferences for new goods and services (e.g., see Shogren *et al*. 1994). We again used the random nth-price auction for our GM-food experiments because it is designed to engage both the on- and off-the-margin bidders (see Shogren *et al*. 2001).[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 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 increases the probability that insincere bidding will be costly.

Auctions were planned and conducted at two Midwestern U.S. cities, Des Moines, IA, and St. Paul, MN. The Iowa State University Statistics Laboratory was paid $3,700 to identify the sample. Approximately twelve hundred randomly selected residence telephone numbers were called in the two cities by employees of the ISU Statistics Laboratory. They checked to make sure it was a real family residence, asked to speak with an adult in the household (i.e., a person who was 18 years of age or older), [3] and asked if he/she was willing to participate in a group session in Des Moines (St. Paul) that related "to how people select food and household products." They were told that the sessions were to be held on Saturday, April 7th (April 21st), 2001, and informed that the session would last about 90 minutes. They were also told that at the end of the session each participant would receive $40 in cash for their time.

The lab experiments were conducted in April and December of 2001, and potential participants were informed that the sessions would last about 90 minutes.[5] There were ten experimental units, four in April, and six in December. The four trials from April were also used in Rousu et al (2002) and Huffman et al (2001). The other six trials were conducted in December, and their results have not been included in previous papers. Individuals who were called had the option of participating at one of three starting times: 9 am, 11:30 am, and 2 pm. From the initial sample of randomly selected numbers, the percentage of people who accepted the offer to participate and then showed up to the auction was approximately eight percent – and this number is not adjusted for unusable phone numbers (which would increase the response rate percentage). Considering that many surveys have response rates that are approximately 15% (for example Lusk, Roosen, and Fox, 2002) and that our participants had to forgo a good portion of their Saturday to participate, our response rate seems quite reasonable. Our total sample size of participants is 142. Next is a step-by-step discussion of the auction.

Figure 1 shows the ten steps in each experimental unit. In step 1 when participants arrived at the experiment, they signed a consent form agreeing 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 *n*th-price auction works, including an example written on the blackboard. After the participants learned about the auction, a short quiz was given to participants to ensure that everyone understood how the auction worked. All experimental instructions are available from the authors on request.

Step 3 was the first practice round of bidding, in which 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. 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. By only round binding, we avoid problems of demand reduction that can occur in multi-unit auctions. The consumers first examined the three products and then submitted their bids.

After the two practice auction rounds were completed, the binding round and the binding *n*th-prices were revealed in step 5. All bid prices were written on the blackboard, and the *n*th-price was circled for each of the three products. Participants could see immediately what items they won, and the price they would pay. 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 6, participants received one of two potential *info-packets* that provided non-food-label information about biotechnology (for a detailed look at how information affected the demand for foods labeled as genetically modified, see Rousu et. al. 2002). These info-packets were produced as follows. We created three information sources: (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; and (3) the *independent, third party perspective*—a statement on genetic modification approved by a third party group, consisting of a variety of people knowledgeable about genetically modified goods, including scientists, professionals, religious leaders, and academics, who do not have a financial stake in genetically modified foods. We limited each information source to one full page, organized into five categories: *general information, scientific impact, human impact, financial impact,* and *environmental impact*. The actual sheets given to participants are available from the authors upon request.

These information sources were then randomized to create the two *info-packets*: (1) both pro and anti-biotechnology and (2) pro-biotechnology, anti-biotechnology, and independent verifiable[6]. These info-packets were then randomized among all ten experimental units, with each info-packet going to four experimental units. By giving all participants both positive and negative information on GM foods, and by giving some participants a third-party perspective on GM foods, we are finding out the willingness to pay for individuals who have received all sides of the story on GM foods.

Once the appropriate info-packet was distributed to the participants in a given unit, two auction rounds were then conducted. The rounds were differentiated by the food label—either the food had a standard food label or a label that indicated the status of genetic modification, as shown for potatoes in Figure 2.[7] In one round (which could be round 1 or 2 depending on experimental unit), participants were bidding on the three food products each with the standard food label. We made these labels as plain as possible to avoid any influence on the bids from the label design. In the other round, participants were bidding on the same three food products with either a GM label or a non-GM label. The GM and non-GM labels differed from the standard label only by the inclusion of only one extra sentence. The GM label said “This product is made using genetic engineering,” while the non-GM label said “This product is made without genetic engineering.” For each experimental unit, participants knew that only one round would be chosen as the binding round that determined auction winners.

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, either with the standard or label indicating the product's GM status. Six groups bid on foods with plain labels and foods with labels saying "made using genetic modification". Four groups bid on foods with plain labels and foods with labels saying "made without using genetic modification." The participants were instructed to examine the three products, and then to write down their sealed bid for each of the three goods. Participants bid on each good separately. The monitor then collected the bids from the people, and then told them they were next going to look at another group of food items. Figure 3 summarizes the ten experimental units.

Step 8 had participants examine the same three food products, each with a different label from round 1.[8] Again the participants examined the products, and bid on the three products separately. The bids were then collected from all of the individuals.

Step 9 selected the binding round, and the binding random *n*th-prices for the three goods. The winners were notified. In step 10, each participant was asked to complete a brief post-auction questionnaire and then the monitors dismissed the participants who did not win. The monitors and the winners then exchanged money for goods, and then the auction winners were also dismissed.

Data and Results

Table 1 summarizes the demographic characteristics of the 142 individuals who participated in the auctions. Sixty percent of the auction participants were female. The mean age of participants was 51.4 (about average considering we only used adult consumers). Almost two-thirds of the participants were married. The average participant had over two years of college education and the average household size was 2.56. The household income for participants was almost fifty-two thousand dollars, and ninety-two percent of auction participants were white. The demographic characteristics of our participants indicate that our experiments had a representative sample of the Midwest region of the United States.[9]

Table 2 shows the mean and median bids. Eighty-six participants were in treatments that bid on the plain-labeled and GM-labeled food products while fifty-six participants were in treatments that bid on the plain-labeled and non-GM labeled food products. For the participants who bid on the GM-labeled and plain-labeled foods, consumers discounted the GM-labeled oil by 11 cents, the GM-labeled chips by 8 cents and the GM-labeled potatoes by 8 cents. The participants who bid on the plain-labeled food and the non-GM food discounted the plain-labeled oil by 4 cents, the plain-labeled chips by 7 cents and the plain-labeled potatoes by 9 cents.

Our main goal is to determine whether consumers can accurately decipher which food is GM irrespective of the labeling treatment. To determine whether consumers perceive the GM-signals differently in the two markets, we first examine the difference in bids for the *perceived-GM product* to the *perceived-non-GM product*. In the treatment with GM-labels, the GM-labeled food is the perceived-GM product; the plain-labeled food is the perceived-non-GM product. In the treatment with non-GM labels, the plain-labeled food is the perceived-GM product; the non-GM labeled food is the perceived-non-GM product.

Table 3 presents results from a test of the null hypothesis that no difference in bids for the perceived-GM and the perceived-non-GM bids exist. For all three products, *we reject* the null hypothesis that consumers' bids for the perceived-GM and the perceived-non-GM foods are equal. This result suggests that the average consumer bids less for the food that is signaled as genetically modified, which supports earlier finding reported by Huffman et al., 2001 and Lusk et al., 2001.

Table 4 presents results from tests of the null hypothesis that the bids for the perceived-GM and non-GM products are equal across the two treatments. Did consumers bid the same for the plain-labeled product in the GM-labeled treatment as they did for the non-GM labeled product in the non-GM treatment? For each product, we test two separate null hypotheses:

(8) $$H_0 : Bid_{pos\_label}^{GM-labeled} = Bid_{neg\_label}^{non-labeled}$$

(9) $$H_0 : Bid_{neg\_label}^{non-GM-labeled} = Bid_{pos\_label}^{non-labeled} .$$

The null hypothesis in expression (8) tests the hypothesis that the bids for the perceived-GM foods are the same in either labeling treatment. The superscripts indicate the type of food product, the subscript indicates the labeling treatment. The null hypothesis in expression (9) tests the hypothesis that the bids for the perceived-non-GM labeled foods are the same in both trails. Table 4 shows that one cannot reject the null hypothesis that the average bids are identical. This suggests that consumers act as if they accurately read the signals for which food is genetically modified under either a mandatory or a voluntary labeling regime.

The size of the discount for the perceived-GM food provides additional evidence about consumers perception of the signals from the two labeling regimes. Null hypotheses that consumers did not discount the perceived-GM food in the two markets differently were tested. Table 5 shows the results. The first column shows the difference in bids in the GM-label trials, the second column shows the difference in bids in the non-GM-label trials. The third column is the difference between these columns. The absolute difference is 7 cents for vegetable oil; 1 cent for the tortilla chips; and 1 cent for the potatoes. At the five percent significance level, the tests show that one cannot reject the null hypothesis that the difference in bids is zero for any of the three food products.[10] While none of the differences are statistically significant, at first glance it is curious that the mean discount under positive or negative labels is virtually identical for the tortilla chips and potatoes, yet it is considerably larger for the vegetable oil. A possible explanation for the vegetable oil having a 7-cent difference is the fact that we had to use two different types of vegetable oils.[11]

By consumers placing the same discount on the perceived GM food, whether the market used positive GM food labels or negative GM food labels, provides additional evidence that consumers receive the same signals in a voluntary labeling regime as in a mandatory labeling regime. This adds validate to the findings from the empirical analysis---a voluntary GM-labeling policy yields higher welfare than a mandatory GM-labeling policy. Hence, the United States has been prudent in avoiding calls to initiate a mandatory GM-labeling policy.

Conclusion

GM-food labeling remains an important and politically contentious issue in the US. Many groups call for mandatory labeling of GM foods; while many others want to keep labeling voluntary. This paper provides evidence, which supports the view that a voluntary labeling policy is more efficient than a mandatory labeling policy in the United States. The reason is that voluntary labeling policies are less expensive and still give consumers the choice to consume GM or non-GM foods. This result hinges on consumer's ability to read signals identically in either market, a conclusion that our auctions could not reject. One further avenue for research would be to examine the international dimension to GM food labels, say in Europe or Australia. For example do they read the same signals of genetic modification in voluntary labeling markets as in mandatory labeling markets. The key issue is relevance and usefulness of the mandatory labeling policies throughout the world.

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Figure 1: Steps in the experiment

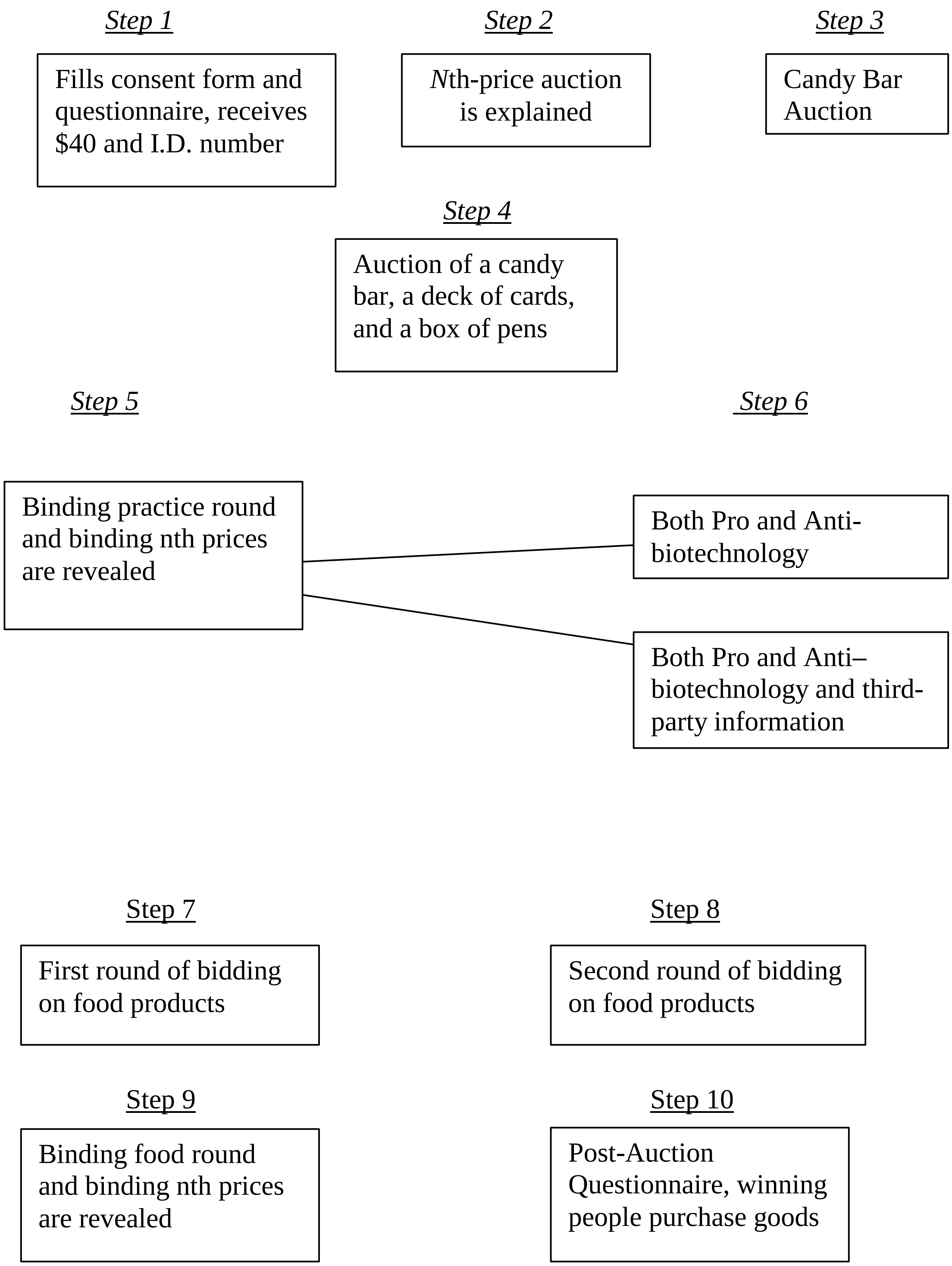

Figure 2: The three types of labels used for the potatoes

Russet Potatoes

Net weight 5 lb.

Russet Potatoes

Net weight 5 lb.

This product is made without
using genetic modification

Russet Potatoes

Net weight 5 lb.

This product is made using
genetic modification (GM)

Figure 3: Information and labeling given to experimental units one through ten

Exp. unit	GM Label Type	Third-party	Round with GM labels
1.	negative label	Yes	1
2.	negative label	Yes	2
3.	negative label	No	1
4.	negative label	No	2
5.	negative label	No	1
6	negative label	No	2
7	positive label	Yes	1
8	positive label	Yes	2
9.	positive label	No	1
10.	positive label	No	2

Table 1. Characteristics of the Auction Participants

Variable	Definition	Mean	St. Dev
Gender	1 if female	0.60	0.49
Age	The participant's age	51.4	18.1
Married	1 if the individual is married	0.65	0.48
Education	Years of schooling	14.74	2.36
Household	Number of people in participant's household	2.56	1.49
Income	The households income level (in thousands)	51.6	33.4
White	1 if participant is white	0.92	0.27
Read_L	1 if never reads labels before a new food purchase	0.02	0.14
	1 if rarely reads labels before a new food purchase	0.11	0.32
	1 if sometimes reads labels before a new food purchase	0.32	0.47
	1 if often reads labels before a new food purchase	0.36	0.48
	1 if always reads labels before a new food purchase	0.18	0.39

Table 2. Mean Bids

A. Mean bids when participants bid on food with positive GM food labels.

	n	mean bid	std. dev.	Median	Minimum	Maximum
GM OIL	86	0.63	0.65	0.50	0	2.75
OIL	86	0.74	0.75	0.50	0	3.29
GM CHIPS	86	0.61	0.70	0.43	0	3.25
CHIPS	86	0.69	0.72	0.50	0	2.89
GM POTATOES	86	0.59	0.54	0.50	0	2.00
POTATOES	86	0.67	0.54	0.50	0	2.25

B. Mean bids when participants bid on food with negative GM food labels.

	n	mean bid	std dev	Median	Minimum	Maximum
NGM OIL	56	0.80	0.80	0.50	0	4.75
OIL	56	0.76	0.68	0.50	0	3.00
NGM CHIPS	56	0.75	0.81	0.50	0	4.00
CHIPS	56	0.68	0.77	0.50	0	4.00
NGM POTATOES	56	0.84	0.75	0.75	0	4.00
POTATOES	56	0.75	0.70	0.68	0	4.00

Table 3. T-Test to examine whether bids for the "perceived" GM product are statistically different than those for the perceived non-GM food
n=142

	Difference	T-Test Statistic
OIL	0.08	2.04 **
CHIPS	0.07	2.64 **
POTATES	0.09	3.31 **

Table 4. T-Test to examine whether bids for "perceived" GM and non-GM foods are different under alternative labeling regimes
n=142

Perceived GM/non-GM food	Mean bid – positive labels	Mean bid – negative labels	Difference	T-Test Statistic
GM OIL	0.74	0.80	0.06	1.10
NON-GM OIL	0.63	0.76	0.13	0.45
GM CHIPS	0.69	0.75	0.06	0.56
NON-GM CHIPS	0.61	0.68	0.07	0.53
GM POTATES	0.59	0.75	0.16	1.53
NON-GM POTATOES	0.67	0.84	0.17	1.57

Table 5. T-Test to determine whether difference in bids are statistically different

	Diff – GM	Diff – Non GM	Difference	T-Test Statistic
Oil	0.11	0.04	0.07	0.90
Chips	0.08	0.07	0.01	0.03
Potatoes	0.09	0.08	0.01	0.20

Endnotes

[1] There may also be fixed costs associated with testing food products for GM content, we, however, are abstracting away from these costs. They would introduce non-linearity into the decision process but would not alter the predictions of the model.

[2] This is where our model differs substantially from Kirchoff and Zago (2001) in the respect that we assume that under a mandatory GM-labeling policy that firms producing products would need to pay a per unit charge, while Kirchoff and Zago assume the government would pay for all testing charges in a mandatory labeling regime.

[3] For the oil, soybean oil was used for the positive GM label treatments, and canola oil was used for the negative GM label treatments. The soybean oil was initially used in the April experiments – we then tried to find non-GM soybean oil in 32 oz. bottles and were unsuccessful. The bids for the vegetable oil follow the same trend as the other products, and will be discussed in the results section of the paper. The other products (and packaging) were absolutely identical, except for the presence or absence of genetic modification.

[4] The auction combines elements of two classic demand-revealing mechanisms: the Vickrey auction and the Becker-DeGroot-Marschak (1964) 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; the endogenous price guarantees that the market-clearing price is related to the bidders' private values.

[5] We considered the possibility that the demand for genetically modified foods may change over the 8 months between auctions, so we replicated two experimental units, using the exact same procedures. We found no evidence that willingness to pay for GM-labeled foods had changed over time. Note that subjects were also told that at the end of the session each participant 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 (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 am, 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. 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, directions for getting there, and a telephone number to contact for more information.

[6] The order of the positive information and negative information was randomized across consumers. Participants who received the third party, verifiable information always received it after the other information sources.

[7] Note that our labels are all on the front of the package, where consumers would surely see them. Read Noussair *et al* (2002) for evidence how consumers are not always likely to read labels on the back of packages.

[8] By replicating treatments and having one group bid on the plain-labeled foods in round one and the GM (or non-GM) labeled foods in round two, we are controlling for any potential round effects. The null hypothesis that the round the consumer bid on foods led to the same bids could not be rejected at a 5% percent level for any of the three goods under both a t-test and a Wilcoxon Rank-Sum test. The order consumers saw the items did not appear to matter.

[9] Demographic information for both the St. Paul area (Ramsey County) and the city of Des Moines can be found at Midwest Profiles (2001), at http://www.profiles.iastate.edu/.

[10] Regression models were also run, testing whether any of the demographic characteristics made a difference on the discount for the perceived GM food. No demographic characteristics appeared to impact the discount for the perceived GM food

[11] To check the robustness of the results, we also ran Wilcoxon rank-sum tests to see if one could reject that consumers had different behavior for the different label types. The results for the Wilcoxon rank-sum tests are similar to those of the t-test results, showing that one cannot reject the null hypothesis that consumers perceive the signals from the two labeling policies the same.