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Effects and Value of Verifiable Information in a Controversial Market: Evidence from Lab Auctions of Genetically Modified Food

By

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Abstract

Public and private R&D have been a steady source of new goods in the United States during the 20th century. New products of all types, some having new and unknown attributes, create an opportunity for major conflicts to erupt between interested parties that use private information in an attempt to affect the future course of the market for these products. One example of a highly visible new good is genetically modified (GM) foods. The first GM-foods became available in the US in the late-1990s, and the biotech industry has promoted the positive attributes of GM-foods to society. In contrast, international NGOs have advertised their negative attributes. This diverse information has increased the demand by consumers for objective information. We introduce the concept of independent, third-party information and develop a methodology for valuing it. Using data generated from a project that employs a hybrid methodology using data collected from real rather than natural experiments, we analyze laboratory auction data collected from randomly selected adult consumers in two large metropolitan areas. Verifiable information is shown to be a moderating force on willingness to pay in a market with conflicting information. Although the average value of third-party information per lab participant is small, the public good value is shown to be quite large to US consumers. Our methodology is applicable to other new consumer goods.

Key Words: Value of information, verifiable information, economic experiments, genetically modified foods, willingness to pay.

JEL Categories: C91, D12, D82

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Public and private R&D have produced a steady stream of new goods in the United States during the 20th century. New products, having new and sometimes unknown attributes, create an opportunity for major conflicts to erupt between interested parties that use private information to attempt to affect the future course of market for these products. Genetically modified foods, which are made from materials developed used modern gene-splicing technology, are an example of just such a product. They first became available in the US in the late-1990s. Pro- and anti-GM factions have and are attempting to affect the market equilibrium by presenting to the public two very different images about the benefits and risks of this technology. Agribusiness companies (e.g., Monsanto, Syngenta) report that GM foods will help protect the environment, increase nutrition, and help end world hunger (Council for Biotechnology Information, 2001), but environmental NGOs like Greenpeace and Friends of the Earth counter that GM foods will cause allergic reactions, degrade the environment, and increase the power and profits of multinational companies (Greenpeace, 2001a, b, c, Friends of the Earth, 2003). Such diverse information can confuse consumers and producers about what is the best course of private and social actions on GM foods, which affects short and long-run social welfare (Hausman 1996, 2003).

In principle, society can recapture some of these losses if decision makers have access to independent, third-party or *verifiable information* on the new technology, which in this case is the tangible risks and benefits of genetic modification (Milgrom and Roberts, 1986; Huffman and Tegene, 2002). This study examines the impacts of verifiable information on genetic modification for the demand for foods within a market where the biotech industry and

international NGO perspectives have been released and develops a methodology for estimating the social value of this information. The study uses a unique data set. Information was obtained from adult consumers in two large metropolitan areas who were selected randomly and contacted by an independent agency to determine their willingness to participate in a project to examine how consumes make food and household good purchases.[1] They were asked to come to a common location, a laboratory or classroom, and to place bids on three unrelated food products, which are available in US grocery stores and supermarkets and might be made using the new technology. We address two key issues: (1) does verifiable information affect consumer's willingness to pay for these new food items; and, (2) if consumers are affected, how should we value this information? The story unfolds in the following four sections.

I. Background

With two interested parties injecting diverse information into in a controversial market, what are rational consumers likely to do? Ideally, these buyers will make informed decisions provided they are (a) sophisticated enough to understand the technical processes at work and to recognize that interested parties' supply information tainted by a political agenda and private information, and (b) they can verify all the information provided (Milgrom and Roberts). Unfortunately, this full and verifiable information environment does not define the market for GM products (also see Mendenhall and Evenson).

Genetic modification is a relatively new and complex process, which involves taking genes from one organism and placing them into another. The process is sometimes referred to as genetically engineered, genetically modified, bioengineered, GMO, or just GM. Since the beginning of farming, farmers and other have been genetically modifying plants to enhance the quantity of desirable attributes. However, since the early 1990s, genetic modification has been

associated with a much narrower set of techniques that use recombinant DNA or gene splicing technology which facilitates the transfer of genes across species.[2] Foods made using this type of genetically modified material have become known commonly as GM.

Most consumers do not know the intricate details of this process. In addition, not all GM information is currently verifiable. The search costs for most consumers to find independent, third-part information seems quite high, because there are contradictory messages about GM-foods, e.g., “food to feed the planet” versus “frankenfood” (see, for example, Gates, 2001) and no institution currently exists to provide verifiable information on this topic. Because of these high search costs, an independent institution has been recommended by Huffman and Tegene (2002) for providing third-party or verifiable information about genetic modification. A key issue is its social or public good value.

Limited evidence from earlier studies suggests that consumers behave as if they hear only “bad” news in a controversial market with diverse information where positive and negative information are released. Viscusi (1997) and Fox et al. (2002) concluded that individuals amplify the risks of a neoteric product and discount its benefits. Using a survey in which consumers receive divergent information on environmental risks, Viscusi showed that consumers put greater weight on the expert who provided a high-risk assessment. They did so regardless of whether the low-risk assessment came from a government or an industry source. A similar “alarmist” reaction to a new product was observed by Fox, Hayes, and Shogren’s (2002) in lab auctions of irradiated meat. Some of their results followed intuititively: a favorable description of irradiation increased demand and an unfavorable description decreased demand. But when consumers were presented both favorable and unfavorable descriptions, they bid as if they had received only the negative information—the anti-irradiation perspective “covered up” the pro-irradiation

perspective and pushed down dramatically the demand for irradiated meat, despite the fact that the negative information was presented by a consumer advocacy group and was presented in a non-scientific manner.

Consistent with several models of choice under risk (e.g., loss aversion, status quo bias, Bayesian updating), this result illustrates the incentive for partisan groups to promote unscientific claims for their private gain and general social welfare loss of others. The open question that neither the Viscusi nor Fox, Hayes, and Shogren studies address is the potential social value of introducing third-party, verifiable information in a market where a controversial product is for sale.

Stigler (1960), Hirshleifer and Riley (1992), Molho (1997), and Morris and Shin (2002) provide general frameworks for placing an economic value on information. Foster and Just's (1989) drew upon this general framework when they devised a methodology for assessing the value of government information about insecticide contamination (heptachlor) of milk for human consumption in Hawaii. They calculated the value of government information as the difference between rational consumers' choices under incomplete and more complete information. Foster and Just used actual market information rather than experimental data in their computations. Since GM-labeled foods are not in U.S. grocery stores, the methodology of experimental economics seems ideal for obtaining information from consumers about how they might respond to the introduction of these products into the market. Further, Foster and Just did not control for the type of information as a treatment variable. Hence, our work is a major advance from theirs.

II. Data

We use data from a hybrid methodology which combines sample survey, statistical experimental design, and experimental economics. See Huffman et al. (2003), in which three

GM-labeled and plain-labeled food products are auctioned to consumers in experimental units of 13-16 individuals under different information treatments. We briefly review the experimental design now (see Huffman et al. or Appendix C for the full experimental design). In the design, three types of information about GM and biotechnology were defined: (1) *industry perspective*—provided by a group of leading biotechnology companies, including Monsanto and Syngenta; (2) *environmental group perspective*—from Greenpeace, a leading environmental group or biotech antagonists; and (3) *verifiable perspective*—from a independent, third-party group of scientists, professionals, religious leaders, and academics, none with a financial stake in GM foods.

These three information sources were used to create six information treatments for our laboratory experiments. An experimental unit could receive: (1) only the biotech industry perspective; (2) only the environmental group perspective; (3) both biotech industry and environmental perspectives; (4) both biotech industry and third-part perspectives; (5) both the environmental group and third-party perspectives; or (6) all three perspectives. These six information treatments, each with two replications, were randomly assigned to twelve experimental units, each containing 13 to 16 participants.

Adult consumers over 18 years of age from two different Midwestern metropolitan areas that were chosen using a random digital dialing method. Table 1 summarizes the demographic characteristics. The demographics of the sample do not perfectly match the U.S. census demographic characteristics for these regions, but they are similar and provide a sufficient representation for our initial probe into labeling and information for GM products (see Appendix A for the demographic characteristics of the areas). In addition, because we use common food items available to shoppers in grocery stores and supermarkets, we wanted adults rather than

students to better reflect a typical household of consumers. Although several studies have used college undergraduates in laboratory auctions of food items (including Lusk et al., 2001 and Hayes et al., 1995), they are not the best choice for participants when the items being auctioned are ones sold in grocery stores or supermarkets. Using a national random sample of grocery store shoppers, Katsaras et al. show that the share of college-age (18 to 24 years) shoppers falls far below their share in the population—8.5 percent of shoppers versus 12.8 percent in the U.S. Census of Population. College students obtain a large share of their food from school cafeterias and a small share from grocery stores and supermarkets compared to older shoppers (Carlson et al., 1998). Although our participants are slightly skewed toward women, Katsara et al. show that women make up a disproportional share of grocery shoppers—83 percent of shoppers versus 52 percent in the U.S. Census of Population.

The data presented in table 2 show that most participants in our willingness to pay experiments bid a positive amount for the food items, but a few chose to bid zero in both trials, i.e., for both the GM-labeled and the plain-labeled variety of a particular food product. Mean bids for participants, segregated by information treatment, but excludes bids for consumers who bid zero for both the GM-labeled and plain-labeled varieties of a product.[3] These participants provide no information about their taste for genetic modification; they were willing to pay zero for one unit, indicating they were "out of the market" for particular food product. In Table 2, the number of participants who bid a positive amount for a product is different for each of the three goods. This arises because more consumers chose to bid zero for the GM-labeled and plain-labeled vegetable oils than for the GM-labeled and plain-labeled bags of tortilla chips, and the fewest number of consumers chose to bid zero for the GM-labeled and plain-labeled bags of

potatoes. Many participants who bid zero for both varieties of one product, bid a positive amount for the other products.[4]

II. Effects of Verifiable Information

We first examine bidding behavior for GM-labeled foods with and without verifiable information on genetic modification. Following Viscusi and Evans (1990), we expect that bidders will react rationally to biotech industry and environmental group perspectives. Without verifiable information, we expect participant's demand for GM-foods to shift rightward when the biotech industry perspective is released to participants and leftward when environmental group perspective is released.

Part A of table 2 displays the mean bid prices across all treatments for the participants. On average, participants discounted GM-labeled foods by 14 percent relative to foods having a plain label. Part B shows that participants who received only the biotech industry perspective were willing to pay a small premium for GM-labeled food for two of the three products. This occurred despite the fact that genetic modification was only used to enhance attributes that might be expected to lower production costs but not to enhance consumer attributes. Part C shows that when participants received only the environmental group perspective, they discounted the GM-labeled foods by an average of approximately 35 percent relative to the plain-labeled foods. Part D shows that participants who received both the biotech industry and environmental group perspectives discounted GM-labeled foods by an average of 17 to 29 percent, depending on the food product.

The size of the effect on bids due to introducing verifiable information is an empirical question. Part E shows that participants who received the biotech industry and environmental group perspectives discounted GM-labeled foods slightly relative to the plain-labeled foods.

These are not statistically significant differences relative to the bids for participants who only received the biotech industry perspective. In contrast, participants who received only the biotech industry perspective valued GM-labeled foods more than their plain-labeled counterpart. Part F shows participants who received environmental group and third-party perspectives discounted the GM foods but by less than those who received only the environmental group perspective. The effects of verifiable information on those who received the environmental group perspective are statistically significant at the 5%, 10% and 5% level for the vegetable oil, tortilla chips, and potatoes, respectively, using a one-sided Wilcoxon Rank-Sum test. Part G shows participants who received environmental group and third-party perspectives discounted the GM-labeled foods by an average of 17 to 22 percent, depending on the product. Participants who received all three perspectives were more accepting of the GM-labeled foods than those who received only biotech industry and environmental group perspectives. The participants who received all three perspectives discounted the GM-labeled food by an average of 0 to 11 percent, depending on the product. The differences in bids when verifiable information is introduced for those who previously received both the biotech industry and environmental group perspectives are statistically significant at the 10% level using the Wilcoxon Rank-Sum test for potatoes, but are not significantly different from zero for tortilla chips or vegetable oil.

Our results are consistent with Viscusi (1997), who found that individuals placed slightly greater weight on negative than positive information. In our auction, participants who received only the biotech industry perspective were willing to pay considerably more on average than the overall sample mean price across treatments. Those who received only the environmental group perspective discounted the GM-labeled food by an average of 35 percent relative to the plain-labeled foods. Those who received both information sets put slightly more weight on the

environmental group perspective (negative information), discounting the GM-labeled foods by 20 percent relative to the plain-labeled foods.

Our results are in contrast to Fox et al.'s (2001) who found that negative information "covered up" positive information. They argued that one reason could be due to a "status quo bias," in which people were originally endowed with a regular pork sandwich and could bid to upgrade to an irradiated pork sandwich. Participants may have their bids biased due to being endowed with one type of sandwich.[5] An alternative interpretation is that the negative information about irradiation mentioned that consumers might get cancer from consuming irradiated meat. In contrast, no such harm to human health was suggested in the environmental group perspective (negative information) on genetic modification, where a serious outcome involves only an allergic reaction to a newly inserted foreign agent. Our auction had participants bid on items in two randomly assigned rounds (trials), and thus our results are not influenced by a "status quo bias."

IV. The Value of Verifiable Information

We have shown that independent, third-party information affects participants bids on food products that might be genetically modified. We now summarize the methodology used to place a value on this information. First, we define the empirical specification of the model leading to the public good value of verifiable information. Our approach is similar to the approach taken by Foster and Just (1989) and Teisl et al. (2001). Information has social value if a participant/consumer changes their behavior as a result of receiving the information, i.e., *they "switch" products---they change their purchases from GM-labeled to plain-labeled foods, or vice versa*.[6]

Two types of individuals gain from verifiable information. First, some individuals will purchase GM-labeled foods before receiving verifiable information, but then switched to plain-labeled foods after they received verifiable information. Second, some individuals will purchase plain-labeled foods before receiving verifiable information, but will switch to GM-labeled foods after they received verifiable information.

The task is to approximate the welfare change for participants who switch after verifiable information is provided. First, consider the welfare gains for a participant who switches from the plain-labeled food to the GM-labeled food. He/she originally purchases the plain-labeled food, and the surplus he/she receives from that purchase is the difference between his/her willingness to pay and the price for the "market price" of plain-labeled food. Participant *j*'s surplus from purchasing plain-labeled food or GM-labeled food is shown in (1) and (2):

(1) $$surplus^{j}_{non-labeled} = WTP^{j}_{non-labeled} - P^{j}_{non-labeled}$$

(2) $$surplus^{j}_{labeled} = WTP^{j}_{labeled} - P^{j}_{labeled}\ .$$

Because we are examining the case in which a participant originally purchases plain-labeled foods, he/she perceives a greater surplus from consuming the plain-labeled food than from consuming the GM-labeled food. For participants who switch after receiving verifiable information, the surplus from purchasing the GM-labeled food is now greater than the surplus from purchasing the plain-labeled food. The welfare gain to the participant who switches is the surplus they receive from purchasing the GM-labeled food minus the surplus they would receive if they purchased the plain-labeled food. Participant *j's* increase in welfare from verifiable information due to switching from the plain-labeled product to the GM-labeled product is summarized as:

(3) $$PREMGAIN^{j}_{labeled} = surplus^{j}_{labeled} - surplus^{j}_{non-labeled} .$$

The welfare gain of an individual *j* who switches from the GM-labeled product to the plain-labeled product is:

(4) $$PREMGAIN^{j}_{non-labeled} = surplus^{j}_{non-labeled} - surplus^{j}_{labeled} .$$

All participants, however, do not enjoy the premium gained by consuming one product instead of another, as shown in expressions (3) and (4). The premium gained represents increased welfare (i.e., the value of information) only for those *who switch products*. We discuss the methodology for determining who switches purchases in Appendix B. The total welfare gained for each product where the third-party perspective changed behavior can be approximated by summing the welfare gains over all participants. The total value of information is obtained by summing the value of information for all participants who switched to GM-labeled foods and all individuals who switched to plain-labeled foods and is summarized as:

(5) $$SUMVAL = \sum_{j \in switched} PREMGAIN^{j}_{non-labeled} + \sum_{j \in switched} PREMGAIN^{j}_{labeled} .$$

In valuing verifiable information, we used "market" prices that we paid for plain-labeled vegetable oil, yellow tortilla chips and russet potatoes as the market price for plain-labeled product: $1.65 for the 32 ounce bottle of vegetable oil, $2.99 for the 16 ounce bag of tortilla chips, and $1.79 for the 5 pound bag of potatoes as the prices for the plain-labeled products. For market price of GM-labeled product, we adjusted the market price of plain-labeled price for the average GM-discount in our experiment.[7]

To determine the value of third-party information to a consumer who switches, we divide the total value of verifiable information, as computed in equation (5), by the number of consumers who switched products:

(6) $$switchervalue = \frac{SUMVAL}{N^{buy-switchedproduct}} .$$

In equation (6), *switchervalue* is the average value of third-party information *to a consumer that switches* his/her purchase of a product either to or from the GM-labeled food after they receive the third-party information. We compute this value for each of the three products. To extent our results to the whole U.S. population, the average value of third-party information for a product *to an individual in society*. This is computed as follows: divide the total value of third-party information by the total sample size of the experiment:

(7) $$valueperson = \frac{SUMVAL}{N^{pop}} .$$

In summary, our experimental auction data and econometric design allow us to calculate the percentage of participants who switch in each of the information settings: receiving the biotech industry perspective, the environmental group perspective, and both the biotech industry

and environmental group perspectives. We then estimate an average value of third-party information per consumer in the whole U.S. population for each product.

Now consider the estimated value of verifiable information. Table 3 presents for each commodity the marginal percentage of participants who switch, the value to a person who switches, and the average value to a person in society. When an individual received only the biotech industry perspective, one would expect the third-party perspective to cause some individuals to switch to plain-labeled foods. Among those participants who received both biotech industry and third-party perspectives, some were more likely to purchase GM-labeled potatoes, but they were less likely to purchase the GM-labeled tortilla chips than individuals who received only the biotech industry perspective. The share of consumers who switched to either of these goods, however, is small. *The average value of the third-party perspective per person was about one-half cent per product.*

While the third-party perspective brought about virtually no change in bidding behavior for tortilla chips and potatoes, participants who received biotech industry and third-party perspectives were much more likely to purchase GM-labeled vegetable oil than participants who receive only the industry perspective. Approximately 15 percent of the participants that received the biotech industry perspective switched from plain-labeled vegetable oil to GM-labeled vegetable oil after the introduction of the third-party perspective. This is consistent with third-party information revealing that vegetable oils do not contain any DNA because all the protein carrying DNA is boiled off in the refining of raw vegetable oils. Hence, vegetable oils made from GM and non-GM soybeans are indistinguishable. For participants who are worried about their own health, they now become more likely to purchase GM-labeled vegetable oil, even if they do not change their attitude towards other GM-labeled products. *The value per person who*

switches to the GM-labeled vegetable oil is almost 21 cents per switcher, and the average value per person is just over 3 cents per bottle. This is interesting because consumers who receive the third-party perspective obtain virtually no gain from this information except when purchasing the vegetable oil.

While interesting, only a small share of the sample of participants heard only positive information about GM foods during our experiment. Therefore, the other two groups; those who received only the environmental group perspective and those who received both biotech industry and environmental group perspectives are more representative of the whole sample. We expect that participants who initially received only the environmental group perspective on GM foods but later were given the third-party perspective to be more likely to purchase GM-labeled foods. Our results confirm this hypothesis. For all three products, a significant portion of the sample switched from plain-labeled to the GM-labeled food: 18.6 percent to 28.2 percent of participants switch to the GM-labeled food, depending on the product. The value of the third-party perspective for each participant who switches ranged from 17 to 25 cents per item and *the average value of information per person is 4.7 cents per bag of tortilla chips, 6.7 cents per bottle of vegetable oil, and 4.3 cents per bag of potatoes*.

Participants who received all three perspectives are more likely to purchase GM-labeled foods than individuals who received only biotech industry and environmental group perspectives. The share of participants who switched from plain-labeled foods to GM-labeled foods is smaller for each of the three goods in this auction when compared to the participants who received the environmental group perspective but greater for each food than for individuals who receive only the biotech industry perspective.

Only 8.7 percent of participants switched to the GM-labeled tortilla chips, while 15.9 percent and 21.5 percent switched to the GM-labeled vegetable oil and GM-labeled potatoes, respectively. The value per person who switched from the plain-labeled to GM-labeled food ranged from 23 to 29 cents per product. *This implies an average value per sample participant of 2 cents per bag of tortilla chips, 4.3 cents per bottle of vegetable oil, and 6.3 cents for each bag of potatoes*.[8]

Generalizing our results from this experiment to the whole U.S. population is not without some risks, but the generalization is also instructive. It can be viewed as providing a bound on the value that verifiable information on GM-technology might provide to the United States. Our estimate is that the value of verifiable information is about 4 cents per product for participants who have heard either the environmental group perspective or both environmental group and biotech industry perspectives on GM foods. Because the prices for these three food products in the units that we used in our experiment are typically between $1.50–$2.50, verifiable information has a value of approximately 2 percent of the purchase price for products that could be genetically modified.

Estimates of the share of grocery store foods that are genetically modified vary. Some observers suggest that two-thirds of *all processed foods* in the United States contain some GM material (Jeanie Davis, 2001). Others argue that one-third of *all products* in a grocery store contain GM material (Friends of the Earth, 2001). To provide a conservative estimate, we approximate the aggregate value of verifiable information by assuming that only one-third of all products on a grocer's shelf were genetically modified at the time of our experiments in April, 2001.

In 1997, U.S. citizens spent $390 billion for food at home (Putnum and Allshouse, 1999). Appling the one-third rule, we suggest that Americans spent roughly $130 billion on foods that might be genetically modified. If verifiable information has a value of about 2 percent of price for these foods, and if one generalizes these results, our estimate of the potential public good value to U.S. consumers of verifiable information is about $2.6 billion annually.

While large, the aggregate value does not seem totally unrealistic.[9] Two and six tenths billion dollars is only an average value of approximately $9.00 per year for every man, woman, and child. As a reference point, Foster and Just reported a value of government information about pesticide contaminated milk in Hawaii of approximately $10.00 per person, per month ($120.00 per year), using similar techniques.

We believe our estimate is a lower bound estimate because the environmental group lobby has in some cases been successful in getting large reductions in the demand for GM products and grocery stores which have resulted in supermarkets removing GM-labeled items from their shelves (or failed to stock them on). For example, “Flavr-Savr” tomatoes and Bt-potatoes are approved by the FDA for sale, but because of the environmental group lobby there is no market for them in 2001 or currently (in the U.S. or EU). This holdup has much greater social welfare cost than the marginal effects projected by our experiment (see Hausman 1996 for a discussion of welfare effects of new goods). A second reason why our aggregate estimate might be a lower bound is that information has international public good attributes (Huffman and Tegene, 2002). If information is an international public good, consumers in other developed and developing countries would benefit too, which would increase total social value worldwide.

V. Concluding Comments

Our results showed that the perspectives of interested parties affect the demand for a new good that is surrounded with controversy. Also, verifiable information on genetic modification was shown to be a moderating force on demand. We argued that verifiable information had its greatest impact on lab participants who received only the environmental group perspective—they viewed GM-foods more favorably and increased their willingness to pay or demand. For this example, we concluded that independent, third-party information has very large public good value to U.S. consumers. Given this value, Huffman and Tegene (2002) have shown how a new institution might be designed to provide this type of information.

The methodology that we have developed in this paper is especially applicable when a new good has quite different attributes relative to those currently available in the market. In this situation, not enough data exist to apply Hauman's (1996) approach. Hence, it can be used to access the value of objective information and labeling for a wide range of new consumer goods, e.g., new fortified foods, new drugs. In particular, policy makers could use the methodology to assess the public good benefit of new information about controversial commodities to see if it exceeds the expected social cost.

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Footnotes

[1] In designing the experiments, we combine the best attributes of surveys, statistical experimental design, and experimental economics to obtain a superior overall experimental design. Our methodology differs significantly from the telephone survey employed by Mendenhall and Evenson (2002) to solicit information about consumers' risk perceptions of GM-foods and hypothetical willingness to pay a premium for non-GM foods.

[2] In 1973, Cohen and Boyer discovered the basic technique for recombinant DNA, which launched a new field of genetic engineering. The Cohen-Boyer patent on gene-splicing technology was awarded in 1980 to Stanford University and the University of California (Office of Technology Assessment 1989). They built on the 1953 discovery by Watson and Crick of the structure of DNA and of the suggestion about how it replicates.

[3] The percentage discount of foods is similar to the percentage when all bids are included.

[4]Only 7 out of the 172 participants bid zero for all six products.

[5] Recall that our participants are only given money and no physical commodity, and this minimizes the endowment effects.

[6] Note that our model does not assume an auction market, but a conventional market. But, auctions are essential for this analysis because our auction market elicits the non-hypothetical WTP under different information treatments that is not obtainable in a conventional market.

[7] For robustness, we also examine the value of information for two other discount levels for GM-labeled products. We assume the discount for GM-labeled products is equal to 1.5 times the mean discount participants had for GM-labeled food products in our experiment for one alternative set of prices. For the other alternative set of prices, we assume the discount for GM-

labeled products is equal to 0.5 times the mean discount consumers had for GM-labeled food products in our experiment.

[8] Recall that we had to use estimated prices for the GM-labeled products to compute the value of information, and we used the mean discount for GM-labeled foods to estimate these prices. We also used alternative prices, one alternative set of prices yielded a greater premium for plain-labeled foods, and one that yielded a smaller premium for plain-labeled foods. The average value of information for the three food products was 5 cents and 3 cents per product for the greater and smaller plain-labeled premiums, respectively. Thus, our results are relatively robust to the estimated prices.

[9] One might argue that our estimate is an underestimate of the true world value for two reasons. First, we presume participants who did not change their consumption habits for genetic modification obtain no value from new information. This is a strong assumption, because some people may feel better about their consumption decision if verifiable information confirms that they were making the correct choices, relative to their preferences. Second, we are considering the aggregate value to U.S. consumers only. But this information would also be freely available to people in other countries that make up 19/20th of the world population, which implies a potentially larger aggregate world value of the GM information.

Table 1. Characteristics of the Auction Participants

Variable	Defintion	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
Read_L*	1 if never reads labels before a new food purchase	0.01	0.11
	1 if rarely reads labels before a new food purchase	0.11	0.31
	1 if sometimes reads labels before a new food purchase	0.31	0.46
	1 if often reads labels before a new food purchase	0.37	0.48
	1 if always reads labels before a new food purchase	0.20	0.40
Informed*	1 if an individual considered themselves at least somewhat informed regarding genetically modified (GM) foods	0.42	0.49
Labels1	1 if the treatment bid on foods with GM labels in round 1	0.52	0.50

* Pre-experiment information.

Table 2. Mean bids for participants, excluding double-zero bids

A. Mean bids—all participants and treatments

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	146	1.07	0.81	0.99	0	3.99
OIL	146	1.24	0.78	1.00	0	3.79
GM CHIPS	155	1.03	0.85	0.99	0	3.99
CHIPS	155	1.20	0.81	1.00	0.05	4.99
GM POTATOES	159	0.84	0.66	0.75	0	3
POTATOES	159	0.98	0.65	0.89	0	3.89

B. Mean bids when participants received only positive information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	26	1.56	0.73	1.50	0	2.99
OIL	26	1.54	0.79	1.55	0	3.50
GM CHIPS	30	1.31	0.72	1.13	0	2.99
CHIPS	30	1.36	0.72	1.18	0.05	2.99
GM POTATOES	27	1.30	0.71	1.25	0	2.50
POTATOES	27	1.26	0.67	1.25	0	2.00

C. Mean bids when participants received only negative information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	26	0.79	0.82	0.50	0	3.25
OIL	26	1.22	0.65	1.00	0.25	2.49
GM CHIPS	29	0.81	0.94	0.50	0	3.99
CHIPS	29	1.25	1.02	1.00	0.05	4.99
GM POTATOES	29	0.61	0.68	0.50	0	2.75
POTATOES	29	0.98	0.88	0.75	0.05	3.89

D. Mean bids when participants received both positive and negative information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	24	0.68	0.55	0.50	0	1.79
OIL	24	0.90	0.72	0.85	0	3.00
GM CHIPS	23	0.68	0.74	0.35	0	2.25
CHIPS	23	0.81	0.79	0.49	0.05	2.75
GM POTATOES	26	0.50	0.39	0.50	0	1.50
POTATOES	26	0.70	0.43	0.50	0.05	1.60

E. Mean bids when participants received positive and third-party information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	26	1.12	0.62	1.00	0	2.39
OIL	26	1.14	0.57	1.00	0.10	2.39
GM CHIPS	25	1.24	0.77	1.19	0	2.79
CHIPS	25	1.33	0.73	1.16	0.20	2.89
GM POTATOES	26	0.92	0.45	0.99	0	1.85
POTATOES	26	0.93	0.39	0.99	0.25	1.90

F. Mean bids when participants received negative and third-party information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	21	1.33	1.05	1.25	0	3.99
OIL	21	1.60	0.97	1.50	0.49	3.79
GM CHIPS	25	1.12	0.97	0.99	0	3.50
CHIPS	25	1.38	0.77	1.01	0.49	3.00
GM POTATOES	27	0.89	0.77	0.89	0	3.00
POTATOES	27	1.14	0.67	0.99	0.50	3.00

G. Mean bids when participants received positive, negative, and verifiable information

	n	mean bid	standard deviation	Median	Minimum	Maximum
GM OIL	23	0.94	0.77	0.95	0	2.75
OIL	23	1.06	0.82	1.00	0.05	3.29
GM CHIPS	23	0.95	0.81	0.85	0	3.25
CHIPS	23	0.95	0.66	0.99	0.1	2.89
GM POTATOES	24	0.82	0.61	1.00	0	1.99
POTATOES	24	0.84	0.55	0.84	0.01	2.00

Table 3. Value of Verifiable Information about Genetic Modification and GM-Foods to Participants

A. Value to participants who originally received positive information*

	Percent who switch to GM	Value per switcher	Average value per person
Tortilla Chips	–3.3 percent	$0.108/bag	$0.004/bag
Vegetable Oil	15.4 percent	$0.209/bottle	$0.032/bottle
Potatoes	3.3 percent	$0.183/bag	$0.006/bag

B. Value to participants who originally received only negative information**

	Percent who switch to GM	Value per switcher	Average value per person
Tortilla Chips	18.6 percent	$0.250/bag	$0.047/bag
Vegetable Oil	28.2 percent	$0.236/bottle	$0.067/bottle
Potatoes	25.0 percent	$0.172/bag	$0.043/bag

C. Value to participants who originally received both positive and negative information***

	Percent who switch to GM	Value per switcher	Average value per person
Tortilla Chips	8.7 percent	$0.233/bag	$0.020/bag
Vegetable Oil	15.9 percent	$0.276/bottle	$0.043/bottle
Potatoes	21.5 percent	$0.293/bag	$0.063/bag

* On average, more individuals purchased the GM-labeled potatoes and GM-labeled vegetable oil when they received positive and verifiable information as opposed to just getting positive information, but fewer individuals purchased the GM-labeled tortilla chips than their plain-labeled counterpart when they received positive and verifiable information.

** Consumers who received negative and verifiable information were more accepting of GM foods than individuals who only received negative information.

*** Consumers who received positive, negative, and verifiable information were more accepting of GM foods than individuals who only received positive and negative information.

Appendix A. Table 1. Demographic Characteristics of Polk County, IA (including Des Moines area) and Ramsey County, MN (including St. Paul area)

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

Note: All variables are for individuals of all ages, except for Married, which is for individuals 18 or older, Education, which is for individuals 25 or older, and age, which is for individuals 20 or older.

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

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

Appendix B. Who switches purchases when verifiable information is introduced?

To determine the net change in the percentage of participants who purchase GM-labeled foods, we need an estimate of the prices a consumer would face in the market. We use the prices we paid for the products: $1.65 for the 32 ounce bottle of vegetable oil, $2.99 for the 16 ounce bag of tortilla chips, and $1.79 for the 5 pound bag of potatoes as the prices for the plain-labeled products. For the GM-labeled products, we adjust the price of the plain-labeled product by the average price-discount in the experiment. Because we are trying to assess the average value of information for each product, we will assume that all participants purchase either the GM-labeled version or the plain-labeled version of a product. Participants purchase the product that gives him/her the greater surplus, as shown in equations (3) and (4). The net change in the percentage who purchase the GM-labeled product is the (absolute) difference between the "percentage who purchase GM-labeled foods when treated to third-party perspective" and the "percentage who purchase GM-labeled foods but do not receive the third-party perspective;" given the other information they have received:

(8) $$Percentswitch = \left| percentbuyGM^{\,thirdparty} - percentbuyGM^{\,no-thirdparty} \right|.$$

The net percentage change is the absolute value of the difference in the percentage who purchase the GM-labeled food with and without third-party information.

Which specific participant switch purchases once third-party information is introduced? Because individuals who receive separate information treatments are in distinct experimental units, we do not know the specific persons who switch, but we do know the percentage of the sample who would switch after the introduction of third-party information. We assume that the individuals who switched had relative preferences for the food products that are evenly distributed throughout the population who consume the good that has been abandoned. For

example, if third-party information causes a number of participants to switch purchases and start buying GM-labeled foods, we assume these participants who switched had relative valuations of plain-labeled foods that were evenly distributed throughout the population of consumers who purchase the plain-labeled foods before information is introduced. Thus, without verifiable information, we are assuming that treated and untreated individuals have the same behavior.