

## Valuing Information on GM Foods in a WTA Market: What Information is Most Valuable?

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Many markets for novel food products are characterized by a lack of information. To counter a lack of information, governmental and non-governmental entities often want to provide consumers with information but do not know exactly what information would be most valuable. In this article, we examine the value of information about genetically modified food (as related to the environment, health, and the impact on the Third World) to determine which source of information provides the most value to consumers. We find that more consumers change consumption behavior when provided with environmental information, but information on benefits to the developing world provides consumers the greatest increase in surplus.

**Key words:** GM foods, experimental auctions, WTA, value of information.

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### Introduction and Background

Many markets for novel food products are characterized by a lack of information. In these types of markets, accurate information has value to consumers, as it can lower search costs and help them make better decisions. One such market is that for genetically modified (GM) food products. Genetic modification is a relatively new process that has been adopted quickly in many countries. Despite the widespread adoption of GM technology, consumers often only have partial information to make decisions about GM foods, which could cause less-than-optimal decisions (e.g., see Hausman, 1997).

Several recent studies have estimated the value of information about novel goods to consumers in experimental markets. Rousu, Huffman, Shogren, and Tegene (2007) estimated the value of verifiable, third-party information on GM foods to consumers using experimental auction markets. They found a public good value of approximately \$2.6 billion annually to consumers for verifiable information. Rousu and Shogren (2006) used experimental auctions to examine the value of information on irradiated foods. They focused on the value of conflicting sources of scientific information. The research found that both pro- and anti-irradiation information have value to consumers when presented in isolation, but that only anti-irradiation information has value to consumers when both are provided. Marette, Roosen, Blanchemanche, and Verger (2008) examined the value of information on fish species using choice experiments. They found that consumers concerned about risks gain value from information, while those not concerned are worse off. While all of these studies examined the value of information for food products, none examined several alternative types of information

(or messages) to examine which information source would be most valuable to consumers. It is this type of knowledge that advertisers or policy makers need, however, if they are to determine which types of information strategies are more effective in changing behavior.

In this article, we estimate the value of different types of positive information on biotechnology in a willingness-to-accept (WTA) market for a GM cookie. We use data from Lusk, House, et al. (2004) and Lusk, Traill, et al. (2006), where experimental auctions were used to examine the effects value of health, environmental, and world impact information based on consumer preferences for GM cookies. We expand on these findings and translate the *effects* of information into estimates of the *value* of information. We estimate the public good value of information “through the eyes” of the groups providing the information (pro-biotechnology groups). Our article makes two contributions to the literature. First, we examine the difference in the value of information from competing positive messages. This methodology is useful to government or non-governmental groups when faced with the problem of determining *which* types of information to distribute to consumers when different options are available. Second, we present a methodology and then estimate the value of information in a WTA market. This is important, because while there is controversy over what causes WTA estimates to be higher than willingness to pay (WTP) (see Plott & Zeiler, 2005), numerous studies have shown a divergence between a consumer’s WTP and WTA (see Horowitz & McConnell, 2002). Research has also found this disparity specifically for decisions about GM foods (see Moon, Balasubramanian, & Rimal, 2007). Previous studies estimating the value of

information have used data on people's WTP, whereas we estimate the value of information in a WTA market. We begin with a discussion of the data.

## Data

The data used in this article come from Lusk et al. (2004). Because the experimental design is thoroughly described in that article, we provide only a brief overview here. Experimental auctions were conducted in three US locations and two European locations. In particular, 284 participants from California, Texas, Florida, England, and France participated in the experiments. All subjects were females between the ages of 25-65.

In each location, people participated in groups of approximately 10 to 20. Each participant was endowed with a non-GM cookie and was asked to state a bid corresponding to the minimum amount of compensation demanded in order for the participant to be willing to exchange their endowed non-GM cookie for a GM cookie. A "consumption requirement" was enforced, meaning that all persons had to eat the cookie in their possession at the end of the experiment; auction winners ate the GM cookie and non-winners ate the non-GM cookie. The bids were organized in a 5<sup>th</sup>-price auction, where the four lowest bidders won the auction and were paid an amount equal to the 5<sup>th</sup> lowest bid amount to give up their non-GM cookie and instead eat the GM cookie. People submitted bids over ten rounds with the ID numbers of the four lowest bidders and the 5<sup>th</sup> lowest bid posted in the front of the room at the conclusion of each round.<sup>1</sup> Participants were informed that only one of the rounds would be randomly selected as binding at the conclusion of the experiment.

For the first five rounds, people had no access to information about GM food other than what they brought into the experiment.<sup>2</sup> After the conclusion of the fifth round, participants were given a piece of paper containing additional information on genetic modification. In addition to a control treatment where no additional information was provided, there were three different information treatments, each describing a

potential benefit of GM food production. There was an environmental information treatment, a health information treatment, and a world information treatment. The information provided to consumers can be found in the Appendix. After the "information shock," participants bid in the last five rounds of the experiment.

## Modeling the Value of Information in a WTA Framework

Consider the method used to value information in a WTA exchange auction. Similar to Rousu et al. (2007) and Rousu and Shogren (2006),<sup>3</sup> we use an *ex post* approach, where observed consumer behavior after receiving information is assumed to be the consumers' "informed" behavior. This behavior is then compared to the consumers' "uninformed" behavior before receiving information to determine if they behaved differently.

To determine the value of information, we first need to estimate whether a participant would purchase the GM or the non-GM product if in a conventional market. In these auctions, participants are given a non-GM cookie and were asked to place a bid for how much money they required to exchange their non-GM cookie for a GM cookie. For simplicity and consistency with the auction market, we make the assumption in our model that all consumers would purchase either a non-GM cookie or a GM cookie, but not both.

Participant  $j$ 's decision of whether to consume the GM cookie is described in Equations 1 and 2.

$$CONSUME\_GM^j = 1 \text{ if } WTA^j - disc < 0 \quad (1)$$

$$CONSUME\_GM^j = 0 \text{ if } WTA^j - disc > 0 \quad (2)$$

Equation 1 indicates that when the participant's ( $j$ ) WTA an exchange of the GM cookie for the non-GM cookie is less than the discount for the GM product (*disc*), then the participant will want to consume the GM cookie. Equation 2 indicates that when the participant's WTA an upgrade to the GM cookie is greater than the market discount, the participant will not consume the GM cookie (and will instead consume the non-GM cookie).

When would information about GM food products cause a consumer to switch which product they want to consume? Since positive information about GM is presented, information could cause a consumer who would

1. *There are divergent opinions about the pros and cons of using repeated trial auctions with posted prices. Those who oppose are concerned that bids may be influenced by other bidders and particularly aberrant bidders (e.g., see Corrigan & Rousu, 2006), while those who support repeated trial auctions with posted prices like the fact that participants get feedback in a market setting (e.g., see List & Shogren, 1999).*
2. *An analysis of the "pre-information" bids can be found in Lusk, Traill, et al. (2005, 2006).*

3. *Similar methods to value non-experimental data were used by Foster and Just (1989) and by Teisl, Bockstael, and Levy (2001).*

consume the non-GM product to want to consume the GM product after receiving the information, as shown in Equation 3.

$$SWITCH\_GM^j \text{ if } CONSUME\_GM^j_{pre-info} = 0 \text{ and } CONSUME\_GM^j_{post-info} = 1. \quad (3)$$

If the consumer would switch consumption (start consuming GM cookies) after receiving information about GM, the information has value to the consumer. To assess this value to consumers, we must determine the difference in consumer surplus yielded from consuming one product relative to consuming the other.

We determine the consumer surplus by looking at the relative preferences for GM versus non-GM cookies. Thus, we are actually determining the “relative consumer surplus” for the products, but this is adequate to determine the value of information. Note that the relative consumer surplus for the GM version of a product will be a relative consumer “deficit” for the non-GM version.

$$Consumer\_surplus^j = |disc - WTA^j| \quad (4)$$

The relative consumer surplus is the absolute difference between the consumer’s WTA and the discount for GM food products.<sup>4</sup> This is because the WTA represents the price discount the consumer places on the GM product, and that is compared to the market discount. If the individual consumes the GM product, then the WTA would be higher than the market price discount. If the individual consumes non-GM products, then the WTA would be lower than the market price discount.

Simply examining the consumer surplus, while useful in determining whether new goods should be introduced (e.g., Lusk et al., 2005), it is not enough to determine the value of information. While all consumers receive a non-negative consumer surplus, the surplus only represents the value of information when the consumers switch their consumption from the non-GM to the GM cookie. Thus, even if consumers have higher consumer surplus when informed, they do not value the

4. This is given that there was no market data available to estimate the discount for the GM cookie. For our model, we approximated the discount for the GM cookie at \$0.10, which would be approximately 15% of the purchase price for a \$0.70 cookie. This is the approximate discount used in Rousu et al. (2007). We also used alternative discounts of \$0.05 and \$0.10 to examine the sensitivity of the results to the discount. We discuss this in the results section.

Table 1. Pre and post information bids.

	Pre-information bids		Post-information bids	
	Mean	Median	Mean	Median
<b>Environmental information (N=88)</b>	0.95 (1.63) <sup>#</sup>	0.22	0.92 (1.63)	0.13
<b>Health information (N=102)</b>	1.08 (2.38)	0.20	0.90 (2.29)	0.13
<b>World information (N=66)</b>	2.03 (2.03)	0.17	1.82 (4.4)	0.13

Note. <sup>#</sup> Standard deviation in parentheses. All mean bids are statistically different from zero at the 1% level using a 2-sided t-test.

information as a “corrective” instrument if they did not switch consumption; their behavior is the same. We measure two welfare gains. The first is the average welfare gain to persons who gain value from information (i.e., those who switched consumption):

$$Value\_switchers = \frac{\sum_{j \in switched} Consumer\_surplus^j}{N^{switchers}}. \quad (5)$$

The average value to a person who gains from information is just the total value of information divided by the number of people who gained value from that information. The other measure that is useful to estimate is the average welfare gain to a person in the population (regardless of whether they switched):

$$Value\_person = \frac{\sum_{j \in switched} Consumer\_surplus^j}{N^{population}}. \quad (6)$$

Because the experimental design employed repeated trials, we have pre-and post-information bids from each participant, which allows us to determine which participants gained value from information. This allows further econometric analysis to determine what factors make it likely that someone would gain value from information.

## Results

Table 1 presents the pre- and post-information bids. We follow the practice of Lusk et al. (2004) and define the pre-information bid as the average bid from consumers in rounds 4 and 5 and define the post-information bid as the average bid from consumers in rounds 6 and 7. As shown and discussed in Lusk et al. (2004), the compensation required by consumers to eat the GM food decreased when positive information about genetic

**Table 2. What products would participants consume without and with information?**

	Percentage of participants who would consume a GM cookie prior to receiving information	Percentage of participants who would consume a GM cookie after receiving information	Percentage of participants who switched products after receiving information
<b>Environmental information treatment (N=88)</b>	29.5%	45.5%	17.0% <sup>+</sup>
<b>Health information treatment (N=102)</b>	44.1%	47.1%	7.8% <sup>++</sup>
<b>World information treatment (N=66)</b>	33.3%	47.0%	13.6%

Note. <sup>+</sup> 1.1 % of participants switched to purchasing the non-GM cookie after receiving environmental information.

<sup>++</sup> 4.9% of participants switched to purchasing the non-GM cookie after receiving health information.

\* The percentages that switched when receiving environmental information and health information are statistically different at the 5% level using a t-test.

**Table 3. Probit model: What impacts the probability a consumer would start purchasing a GM cookie only after receiving information? (N=256)**

	Estimate	Chi-square
<b>Intercept</b>	-1.13	1.95
<b>Health information</b>	-0.45 <sup>*</sup>	3.05
<b>World information</b>	0.01	0.00
<b>Age</b>	0.01	0.21
<b>Education level</b>	-0.26	1.27
<b>Income</b>	0.26	1.11
<b>Child</b>	0.02	0.01
<b>US</b>	-0.04	0.01
<b>UK</b>	-0.56	1.40
<b>Non-white</b>	0.04	0.02

Note. Dependent variable=1 if consumer switched purchases after receiving information?

<sup>\*</sup>, <sup>\*\*</sup>, <sup>\*\*\*</sup> Statistically significant at the 10%, 5%, and 1% level, respectively, using a t-test.

modification was disseminated. A participant who changed his/her bid, however, does not necessarily gain value from information. We compare bids to the difference in market prices between the products (i.e., the discount one would find for a GM cookie) to determine which consumers would gain value from information.

Estimates of the percentage of participants that would switch consumption after being presented information about GM foods are presented in Table 2. For all three types of information—environmental, world, and health impacts—the percentage of participants that would be willing to consume the GM cookie increases after the information is disseminated. The percentage of participants that would switch to the GM cookie ranges from 7.8% for the health information to 17% for the environmental information.

Table 3 shows results from a probit model examining what exogenous variables influence a participant's

**Table 4. The value of information.**

	Average value of information for a participant who changed purchases	Value of information to average person
<b>Environmental information treatment (N=88)</b>	\$0.027 <sup>***</sup> (0.16)	\$0.0046 <sup>***</sup> (0.012)
<b>Health information treatment (N=102)</b>	\$0.07 <sup>***</sup> (0.02)	\$0.0055 <sup>***</sup> (0.020)
<b>World information treatment (N=66)</b>	\$0.058 <sup>***</sup> (0.04)	\$0.0078 <sup>***</sup> (0.025)

<sup>\*</sup>, <sup>\*\*</sup>, <sup>\*\*\*</sup> Statistically significant at the 10%, 5%, and 1% level, respectively, using a t-test.

probability of switching. It shows that those who received health information were less likely to switch than those who received environmental information (which was the excluded dummy variable). We find no evidence of other variables affecting the probability of switching, including the location of the experiments.

While Tables 2 and 3 show that some participants gain value from information (because they switch consumption), these tables do not show *how much* value participants gain. Table 4 quantifies the value of information using two metrics. One is the value of information *per switcher*. The other is the value of information for *all individuals*. For participants that would switch consumption and start consuming the GM cookie after information is disseminated, environmental information has a value of about \$0.03 per cookie. Both health and world information appear to have a greater value to participants of \$0.07 and \$0.06 per cookie, respectively. All three estimates of the information's value are statistically significant at the 1% level using a t-test. The value of information for the average consumer varies between \$0.0046 and \$0.0078 per consumer. While these numbers appear small, if the cookies have a value of \$0.25

**Table 5. Distribution of the value of information for those who changed purchases. (N=32)**

	Maximum	75 <sup>th</sup> percentile	50 <sup>th</sup> percentile	25 <sup>th</sup> percentile	Minimum
Environmental information treatment	\$0.05	\$0.0447	\$0.025	\$0.0131	\$0.005
Health information treatment	\$0.10	\$0.085	\$0.078	\$0.053	\$0.03
World information treatment	\$0.10	\$0.10	\$0.07	\$0.02	\$0.002

**Table 6. OLS regression: What affects the value switchers receive from information? Dependent variable=value of information. (N=32)**

	Estimate	T-value
Intercept	0.120	1.55
Health information	0.05**	2.81
World information	0.04*	1.87
Age	-0.00	-1.31
Education level	0.01	0.43
Income	0.00	0.21
Child	-0.02*	-1.77
US	-0.03	-0.95
UK	-0.05*	-1.95
Non-white	-0.03	-1.58

Several characteristics of individuals were included in the regressions that were not statistically significant. Those coefficients are not reported.

\*, \*\*, \*\*\* Statistically significant at the 10%, 5%, and 1% level, respectively, using a t-test.

each, the average value of information per person is approximately 2-3% of the purchase price.<sup>5</sup> The distribution of the value of information for those who switch is shown in Table 5.

Table 6 uses an OLS regression to examine the factors that affect the value of information for switchers (i.e., for those who gained value from information). The results indicate that both world and health information increase the value that switchers receive from information relative to environmental information. It is worth noting that while environmental information seemed to prompt the greatest number of consumers to switch to purchasing the GM cookie, those who switched gained the least amount of value from environmental information. This is consistent with the unconditional results

5. Note that we also used alternative discounts for the GM cookie to examine how that would affect results. Using \$0.05 and \$0.15 discounts give similar qualitative results, with between 4.5-18.1% of consumers switching to the GM cookie after receiving information. With a larger discount, environmental information again prompts more people to switch than health information; however, that result does not emerge with a \$0.05 discount. These results are available from the authors upon request.

and provides evidence that if groups are interested in providing information that has the most value to consumers, world or health information may be preferable to environmental-impact information. Participants with children and those from the UK who switched gained a smaller value from information.

### Conclusion

Data from experimental auctions detailed in Lusk et al. (2004) and Lusk et al. (2006) estimate the value of several types of information on GM cookies. This type of analysis and these methods could be important to policy makers who are attempting to determine which type of information to disseminate to consumers. We examined the impact of three types of information about genetic modification (health, environmental, and world) on consumption decisions for consumers from the United States, England, and France. Results indicate that information touting the environmental impact of GM foods is most effective at prompting consumers who would otherwise consume a non-GM cookie to start consuming a GM cookie. However, while more consumers change their behavior by receiving environmental information, those that do change their behavior gained more value from both health and world information.

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## Appendix

### Information Treatments

**Treatment 1: Environmental Benefit.** Recently, biotechnology has been used to develop new types of crops. The cookie that you are bidding on was made from vegetable derived from crops that were genetically modified to contain a special protein. This protein allows the plant to be resistant to certain insects, potentially allowing farmers to reduce pesticide usage.

Environmental groups claim that pesticide use damages the environment and threatens the survival of many birds, fish, and insects. These groups contend that pesticides reduce species diversity in the animal kingdom and contribute to population declines in animals and plants by destroying habitat, reducing food supplies, and impairing reproduction.

So, the cookie you have been given was made with **NO** genetically modified ingredients. The cookie you are bidding on was made **with** genetically modified seeds that potentially allowed farmers to reduce pesticide usage.

**Treatment 2: Health Benefit.** Recently, biotechnology has been used to develop new types of crops. The cookie that you are bidding on was made from vegetable oil derived from crops that were genetically modified to contain a special protein. This protein allows the plant to be resistant to certain insects, potentially allowing farmers to reduce pesticide usage.

Pesticides may be harmful to human health. Residues from several chemical pesticides have been linked to cancer and other human health problems such as Parkinson's disease.

So, the cookie you have been given was made with **NO** genetically modified ingredients. The cookie you are bidding on was made **with** genetically modified seeds that potentially allowed farmers to reduce pesticide usage.

**Treatment 3: World Benefit.** Recently, biotechnology has been used to develop new types of crops. The cookie that you are bidding on was made from vegetable oil derived from crops that were genetically modified to contain a special protein. Suppose this protein allows the plant to grow at faster rates and be resistant to drought.

As a result: (a) farmers can produce a greater quantity of crops, which should result in a decline in food prices, and (b) consumers in Third World countries would benefit because of the increased abundance of the food supply. Corn, soybean, rice, and wheat can all be modified in a similar manner to increase world food supply.

So, the cookie you have been given was made with **NO** genetically modified ingredients. The cookie you are bidding on was made **with** genetically modified ingredients that potentially allowed farmers to increase the amount of food they produce.