2002

Information on genetically modified foods and how it affects consumers: evidence from experimental auctions

Matthew Christopher Rousu
Iowa State University

Information on genetically modified foods and how it affects consumers:

Evidence from experimental auctions

by

Matthew Christopher Rousu

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Economics

Wallace E. Huffman, Major Professor
Philip Dixon
Arne Hallam
Helen H. Jensen
Peter F. Orazem

Iowa State University

Ames, Iowa

2002

UMI Number: 3073478

UMI®

UMI Microform 3073478

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

Graduate College

Iowa State University

This is to certify that the doctoral dissertation of

Matthew Christopher Rousu

has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Major Professor

Signature was redacted for privacy.

For the Major Program

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

First and foremost, I want to thank my wife Mandy and my son Jacob. My wife made me realize that Economics was not everything when things did not go well and was always the first to congratulate me when things went well. Everybody would find graduate school easier if they had a wife as great as mine. Jacob (who is not old enough to read this yet) kept me from fixating on the problems that could have arisen when completing a dissertation and always had a smile for me. My parents and in-laws were also supportive, for which I am grateful.

Wally Huffman generously provided his time and the resources for me to conduct the auctions and work as his research assistant. He did not just advise me on how to complete this dissertation, but how to become an economist – and answered many technical, ethical, and procedural questions from me. Peter Orazem helped with the theoretical modeling during a stretch of time when Wally was unavailable. Jason Shogren helped immensely with the auction design, and was a great sounding board for some ideas that became chapters 3 and 5. My friend Dan Monchuk generously gave his time as an auction monitor for ½ of the experimental units, and that included a trip to Minneapolis - this project ran much smoother because of Dan. Terry Hurley and Abe Tegene assisted with conducting the auctions. Philip Dixon assisted with the experimental design and econometrics. Helen Jensen and Arne Hallam provided assistance to many questions I asked over the past year and a half.

Thanks to the group of friends at ISU who would participate in poker nights, Super Bowl parties, BBQ's, and anything else that was an excuse to get together. Over the years the people changed, leaving too many people to name – but they know who they are. Thanks to everyone else who helped during the past four years – I appreciated your support!

ABSTRACT

Genetically modified (GM) foods have been at the center of a contentious debate. One side of the debate includes environmental groups like Greenpeace and Friends of the Earth, who are opposed to GM foods – these groups would like GM foods banned, or at the very least they want GM foods to be clearly labeled as such. On the other side of the debate are agribusiness companies like Monsanto and Syngenta, who view GM foods positively. They think GM foods help the environment and could help feed the malnourished. Both groups actively disseminate information on genetically modified foods.

This dissertation reports on several results from experimental auctions where consumers actually had to purchase food products if they won the auctions. Consumers were able to accurately read the signals for which food was GM in experimental markets that emulated mandatory and voluntary GM-labeling regimes. This shows evidence that the U.S. has been prudent in not implementing a mandatory labeling policy for GM foods. Consumers place a large value on keeping non-GM foods free from any GM-material (not allowing a small "tolerance" for GM-material). Consumers did not place extra value, however, on a 1% tolerant food relative to a 5% tolerant food. This provides evidence that if the United States chooses a tolerance policy for GM-material, a 5% GM-tolerance may be better than a 1% tolerance.

Currently the information available to consumers on GM foods is from interested parties. Chapter 4 shows that a third party source that provides verifiable information on GM foods could have a large annual value to U.S. consumers. This value is due to helping consumers make more informed choices. Verifiable information can also have value by preventing the non-adoption of socially useful inventions.

This dissertation also shows that a majority of consumers would either trust the government, or an independent third party source for information on GM foods – so if a body is created to disseminate this information, a quasi-governmental organization may be the most trusted. This dissertation provides a look at many aspects of how information on genetically modified foods affects consumer behavior.

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Information is central to decision making. Correct decisions depend on accurate information. Whether to bring an umbrella to work might depend on the weather forecast. Buying or selling a stock might depend on information on a company's performance. Which food products to buy can also be decided based on current information, especially for new products. Genetically modified foods have moved from an abstract concept to reality in a very short time. During this short time frame, there has been a number of controversial issues regarding genetically modified foods in the United States, Europe, and elsewhere.

This dissertation examines the effects of diverse information on the demand for genetically modified foods for a set of randomly chosen adult consumers from two Midwestern cities who agreed to participate in a group session dealing with household purchase decisions on food and household products. The group sessions were actual laboratory auction experiments with randomized information and labeling treatments. Each experimental unit consisted of 12-15 adults who were paid $40 to participate in the project, which consumed about 90 minutes of their time and required them to make real purchases of food items won in the laboratory auction setting. Three food items—vegetable oil, Tortilla chips, and Russet potatoes—which might be genetically modified were auctioned. The change in demand for genetically modified foods is examined when interested parties and a third party provides information and the value of third party, verifiable information source is also determined. The effect of the type of food label on the demand of GM foods is also examined. Labeling policies and issues of who consumers trust for information are also examined in this dissertation.

The following delineates the organization of this dissertation. The remainder of this chapter reviews the literature on genetically modified foods, the benefits and costs of labeling policies, and the impact and value of information. Chapter 2 presents the general experimental design that was used. Several issues are discussed in chapter 2, including the participants, the auction mechanism, the food products used, and several steps in the experiment. Chapter 3 examines whether the United States should impose a mandatory labeling policy for genetically modified foods or should continue to use the current voluntary system. Chapter 4 examines the impact of information from third party groups and the impact and value of information from an independent, third party source of verifiable information on genetically modified foods. Chapter 5 examines the consumer demand for non-GM foods with a small degree of tolerance for GM-material and non-GM foods that are certified to be free of GM-material. Chapter 6 examines the impact of negative and verifiable information on resistance to technology. Chapter 7 looks at the economics of trust formation, focusing on who consumers trust for information about genetically modified foods. Finally, chapter 8 offers some concluding comments, chapter 9 contains the references, and chapter 10 contains the appendix, which contains the packet and information that was handed to the auction participants.

1.2. Literature Review

1.2.1. Types of Labeling Policies that Could be Implemented

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

1.2.2. Labeling Policies of Various Countries

The U.S. government has been supportive of biotechnology and has assumed that the regulation of biotechnology should examine the safety of the product and focus less on the process. By examining the product, the U.S. issued regulations in 1992 (Department of Health and Human Services, 1992) saying that GM food did not have to be labeled if the food product had the same characteristics as their non-GM counterparts.

In January 2001, the U.S. Food and Drug Administration (FDA, 2001) issued a "Guidance for Industry" statement for labeling GM products. In this statement the FDA stated that the only GM foods that need to be labeled are foods that have different characteristics than the non-GM version. Labeling for GM foods is not required for any other GM foods. Firms need to notify the FDA at least four months before putting a new GM food on the market, and the scientific description of the product is posted on the Internet for review during this time (AgBiotech Reporter, February 2001).

Firms also have the option of voluntarily indicating whether or not their food is genetically modified. For firms that choose to label their GM foods, the FDA has mandated certain guidelines that must be followed. Foods that are labeled should not use the phrase, "genetically modified." Consumer surveys by the FDA found that this misleads consumers into thinking the product has different characteristics. The FDA prefers that foods be labeled as "genetically engineered" or "made through biotechnology" instead.

For countries in the European Union (EU), the EU sets the minimum standards that any country should implement. Some countries have implemented stricter standards, but no country has more lenient standards (Bernauer, 2001). The European Union has a de facto moratorium on the approval of any new GM foods which has been in place since April 1998.

The European Union first implemented a mandatory labeling policy on GM foods in 1997 with the Novel Foods Regulation. The standards defined by this act required that any GM food on the market be shown to not harm human health and required labeling if GM content could be detected. The Novel Foods Regulation left several exemptions to labeling and did not define a standard for the percentage of a product that could be made with GM material before it must be labeled. For these reasons, the Commission of the Council modified this standard in January 2000 by requiring that all foods require the label "genetically modified" if any ingredient in the food is at least one percent GM.

In February 2001, the European Parliament voted for stricter regulations. The new regulations call for stricter labeling and monitoring of GM products, and allow for the tracing of GM products all through the food chain (CNN, 2001). These new regulations do not eliminate the moratorium on new approvals, and the moratorium will not be removed until voted upon. Six countries, Austria, Denmark, France, Greece, Italy, and Luxembourg claim that they will veto any approval of new GM products until stricter rules are enacted.

Several years ago, Australia, like much of the rest of the world, had no labeling policy for GM foods. In order to assess some of the costs that would accompany a labeling policy, Australia New Zealand Food Authority (ANZFA), the food governing board, commissioned a study by the U.S. accounting/consulting firm KPMG to determine what effects a mandatory labeling policy would have on consumer costs for foods. KPMG concluded that consumers would have to pay from 0.5 percent to 15 percent more for products with such a policy (Phillips and Smith, 2000). Despite commissioning this study, ANZFA disregarded it, citing two flaws (Tambling, 2001).

Australia and New Zealand implemented standards that took effect in December 2001 (Australia New Zealand Food Authority, October 2000). The new standards require "labeling of food and food ingredients where novel DNA and/or novel protein is present in the final food." Similar to the policy of the European Union, labeling is not required if no ingredient in a food product is more than one percent genetically modified. Labeling is also not required for highly refined foods, foods that used GM processing aids that are not present in the final food, or food served in restaurants. If it is an ingredient in a product that is genetically engineered, the ingredient that is modified must be labeled as "genetically modified" in the list of ingredients. For a single ingredient GM food, the phrase "genetically modified" must be listed on the front of the packet, next to the name.

While Australia has a nationwide food standard, states within Australia are suing to develop stricter policies to handle GM foods (AgBiotech Reporter, May 2001). If successful, the system in Australia could be similar to that of Europe, where the nationwide standard for GM foods is the minimum regulations in place regarding GM foods; and many areas have stricter regulations.

Before April 2001, no labeling was required for GM products in Japan. On April 1, 2001, a new policy was implemented. This new policy requires labeling for twenty-eight products, including a number of soy products, many corn products, and unprocessed tomatoes and potatoes. Products do not have to be labeled if the GM content is less than five percent, but could voluntarily be labeled as GM if the producer chooses (this would be unlikely). For products that are labeled, producers must label the product as "genetically modified," "inseparable," or "no GMOs present" (Bernauer, 2001).

While Japan has allowed many GM products to be approved, it is strict in dealing with unapproved GM foods. Changes to Japan's Food Sanitation Law now make it illegal to either sell or import GM foods that have not been approved, or inspected. In June 2001, there were three recalls of food products that tested positive for unapproved GM foods (Hur). Despite the new Japanese policy, Americans remain hopeful that trade with Japan will continue to run smoothly. U.S. Agriculture Secretary Ann Veneman said she was "hopeful there will be no disruption of trade" between the two countries (AgBiotech Reporter, May 2001). This appears to be the case, as Japanese approved a plan to label processed potatoes (and allow them on the market). GM potato chips not approved for consumption caused many of the recalls.

Canada currently only requires labeling for GM foods if those foods have health or safety issues. At the Codex-Alimentarius Meetings in May of 2001, Canadian government officials reiterated their position but also talked of compromises in order to make trade easier. Margaret Kenny from the Canadian Food Inspection Agency said, "Canada supports mandatory labeling for health and safety matters." She also said, "we're also very supportive of the need for uniform international standard. We're certainly hopeful at this meeting there's going to be some ideas on the table, where we can talk about getting the best of both proposals" (CBC News, 2001). In late 2001, Canada's House of Commons rejected a bill that would have required mandatory labeling of GM foods by a vote of 126-91 (AgBiotech Reporter, November 2001).

Up until early 2001, China supported biotechnology. Many thought that China was more supportive of biotechnological crops than any other country, except the U.S. In 2001, China's policy towards GM foods became more reserved. First, China banned GM rice, wheat, maize, tomato, cotton, and soybeans (AgBiotech Reporter, May 2001). China did this to avoid having their crops banned from other nations, according to Chen Zhangliang, Vice President of Peking University.

On May 23, 2001, China issued a new, 56-article regulation policy on biotechnology. This article aimed at strengthening control over all aspects of agricultural biotechnology. A report by the U.S. Foreign Agricultural Service stated that "the regulation is vaguely worded, leaving a great deal to the discretion of the department responsible for drafting and enforcing the implementing regulations." The report goes on to say that there will be safety certification for all GM food, and all GM foods will have to be labeled (AgBiotech Reporter, July 2001).

China issued a new regulation on June 6, 2001 on the management of agricultural GMOs which requires safety certification and labeling of all GM foods. A senior Chinese official stated that GM crops would not be banned (AgBiotech Reporter, October 2001). China's ascension into the World Trade Organization in 2001 and the threat of complaints before the WTO did not keep the Chinese from enacting biotechnology trade barriers. In early 2002, China used whatever means they could to implement trade barriers against GM foods (AgBiotech Reporter, February 2002).

Many other countries also have GM-labeling policies. These policies vary from the type of wording needed on the label to the amount of genetically modified material that will be tolerated in the product before a label of "genetically modified" is mandatory. For example, Korea allows a 3% tolerance of genetically modified material while Brazil allows a 4% tolerance. Thailand actually has different tolerance levels for different products. They allow a 5% tolerance for soybeans, but only a 3% tolerance for corn (Shipman, 2001).

1.2.3. Why do Different Countries have Different Policies?

Different countries have different experiences regarding food and food safety. Because of these experiences it should not be surprising that countries have developed different policies to deal with GM foods. There are four main reasons why countries and individuals could oppose GM foods. There are ethical reasons, environmental concerns, human health concerns, or worries about trading with other countries. Different countries emphasize different concerns, which causes different policies.

Europeans are more likely than Americans (and the rest of the world) to oppose GM foods on ethical grounds. Among those who oppose GM foods for ethical reasons is Prince Charles, who has said that God is the only one who should be allowed to genetically engineer food. Europeans are also more likely to avoid GM foods due to environmental concerns. Environmental groups have significant power in European politics, and the biggest environmental groups have expressed their opposition to GM foods (Friends of the Earth 2001, Greenpeace, 2001).

The safety of GM foods is a major concern for many countries. Australia, China and Japan are requiring labeling of GM foods to allow consumers to decide whether or not they wish to consume genetically engineered foods. This indicates that these countries are worried about health issues. European consumers are also worried about the safety of GM foods. Many human safety scandals have arisen recently in Europe where the governments did not do a good job, including the BSE (bovine spongiform encephalopathy) crisis, the HIV/AIDS tainted blood scandal in France, and the dioxin scandal in Belgium. These issues, and the recent foot-and-mouth disease outbreak, have caused Europeans to distrust regulators. Now, when scientists and regulators try to assure the European public that GM foods are safe, many Europeans have doubts. The Starlink controversy, where GM corn that was unapproved for human consumption got into the food supply, added to the European's GM food safety concerns.

China has issues with GM crops in large part because they are afraid that they may lose Europe as an export market. While there are individual farmers who have decided to go GM-free to enhance trade possibilities, it seems unusual that a whole country would ban planting of GM crops due to export worries. Ascension to the World Trade Organization did not keep China from implementing their barriers on GM foods.

Canada has approximately the same standards as the U.S., which seems logical due to the close proximity of the two countries, and NAFTA allowing products to flow freely from the U.S. to Canada and vice versa. Both Canada and the U.S. view potential threats from genetic modification as minor compared to the potential rewards.

The United States' policies towards GM foods are far less stringent than the standards in Europe and most of the rest of the world. What is odd is that the U.S. has had far stricter standards than Europe in areas of food safety and environmental protection in the past. It is only a recent occurrence that Europe is catching up to the U.S. in terms of safety regulations, and Europe still has more lenient regulations than the U.S. does for many things (Vogel, 2001).

1.2.4. Benefits and Costs of Food Labels

Many have shown that there could be benefits from mandatory labeling of GM foods. Greenpeace and Friends of the Earth both advocate labels on GM foods to give consumers the right to choose whether or not to consume GM foods. Many environmental and consumer advocacy groups call for mandatory labeling, which they believe benefits consumers (Greenpeace 2001, Friends of the Earth, 2001).

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 information, e.g. on nutritional content of foods. Thus, labeling of foods can lead to more informed choices on food and health by consumers. Also, some firms may want to avoid the prospect of placing a label that has negative connotations, and required labeling could lead them to improve their product.

Caswell and Padberg (1992) recommended a more comprehensive view of the benefits of labels on food products. These benefits can be above and beyond what are normally considered the typical benefits from labels. The benefits from food labels include increased consumer information, improved product design, and more consumer confidence in product quality. Also, labels can provide an option value, even for consumers who do currently read food labels. This option value exists because if a food is labeled, consumers always have the option to view the label, either now or in the future, and that option has some value.

While there might be benefits, implementing a labeling policy could be quite costly. Biotechnology firms oppose mandatory labeling for all GM foods because they do not think foods should be specially labeled unless the food is different from the conventional product (Council for Biotechnology Information, 2001). The United States Department of Agriculture, Economic Research Service listed many costs associated with implementing a labeling policy. If a mandatory labeling policy on genetically modified foods were enacted, significant costs would be incurred. Identity preservation, to determine whether a particular food is GM, has significant fixed costs. When separating GM from non-GM foods, mistakes in delivery of the product are always a possibility. In the United States, GM corn that was not approved for human consumption, known as Starlink corn, got into the U.S. food system. Another possible cost is accidental contamination of non-GM crops by their GM counterpart. Farmers have to go to great lengths to ensure that non-GM crops are not contaminated with the GM variety. Among the things farmers need to do to ensure there is no contamination is to have buffer zones, that is zones between the GM and non-GM crops to prevent contamination. Farmers also need to make sure planting and harvesting equipment are not contaminated with any residue from GM crops. All of these items imply real costs when a labeling policy is implemented.

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

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

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

There are relatively few estimates of the costs due to labeling of GM foods. 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). 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.

1.2.5. The Impact of Information from Interested Parties

With many different sources giving information to consumers, what are consumers likely to do? Milgrom and Roberts (1986) have shown that if decision makers are strategically sophisticated, and are well informed of the interested parties' preferences, they can arrive at the correct conclusion about a good. Genetic modification is a complex process, which involves taking genes from one product and placing them into another product. Most people do not know the intricate details of this process and many people do not know the underlying preferences of the interested parties.

Viscusi (1997) studied consumer reaction to environmental risks. He showed that when consumers receive divergent information on environmental risks, they tend to put a greater weight on the high-risk assessment. The individual's reaction was similar for information from both government and industry sources of information.

Fox, Hayes, and Shogren (2001) examined the effects of positive and negative information on the willingness to pay for irradiated pork sandwiches. They found that when consumers were presented with both positive and negative information on food irradiation, the negative information dominated their decision making. This was despite the fact that the negative information was presented by a consumer advocacy group and was presented in a non-scientific manner.

1.2.6. Information from Third Parties

Recent research has shown that there may be a need for third party, verifiable information on GM foods, so consumers would not have to rely on the information from biotechnology companies and environmental groups (Huffman and Tegene, 2002). They hypothesized that such a third party group could be welfare improving. Recent research on organic foods reached a similar conclusion, in that there may be benefits from a third party monitor to help reduce false claims by interested parties (McClusky, 2000).

1.2.7. The Value of Information

Foster and Just (1989) determined a way to value information that is given to consumers. They examined the heptachlor crisis in Hawaii, which drastically reduced milk consumption. They derived a model where consumers were acting optimally given all of the information available to them, but they did not have the information on the milk contamination. Foster and Just then examined how consumer behavior changed once they received the new information and calculated the cost of consumers' ignorance. This cost of ignorance can be equivalently thought of as the value of information. The value of information was computed by comparing the ex post utilities (when the consumer was acting optimally and when the consumer was unknowingly purchasing a bundle they would not have purchased had the consumer been given all relevant information). For this case, consumers were not informed about the milk contamination and continued buying milk. However, many of these consumers would have needed a payment to consume milk if they had known about the contamination. Foster and Just found that the cost of ignorance (value of information) was almost $10.00 per month, per person.

Teisl, Bockstael, and Levy (2001) used the same model to estimate the value of information on nutritional labels. They found that household's valued the nutritional information, on average, from $0.096 to $0.542 per product each month. Like the Foster and Just study, consumers were always acting in their best interest given the information available, but there was some information that consumers did not have prior to the nutritional labels.

CHAPTER 2: EXPERIMENTAL DESIGN

2.1. Introduction

These experiments are designed to incorporate the private-information-revealing feature of experimental auction markets and the rigorous randomized treatment design of statistical experimental design (see for example Hoffman *et al.* 1993, Fox *et al.* 1998, Shogren *et al.* 2000, Lusk *et al.* 2001B).[1] This set of experimental auctions had consumers bidding on actual foods that differed only by the presence or absence of a food label that indicated whether or not a food was genetically modified.

Each experimental unit consisted of 13 to 16 consumers drawn from the households of two major urban areas and who were paid to participate. 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.* 2001B). 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.

In this chapter, I will describe the food products, the auction mechanism, and the general description of the experimental units. I will also discuss the steps in the experiment. The steps in the experiment that are discussed are the exact steps involved in the experiment in chapters 4 and 6. For the experiments described in chapters 3 and 5, a supplemental section will describe how the experiments in those chapters differ from the general experimental design. Chapter 7 does not analyze results from the experiment itself, but the survey given before and after the experiment.

2.2. The Food Products

It was 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, three food items were used: vegetable oil, 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 genetically modified 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. Also, using three items allows for the determination of a consumer's taste for genetic modification even if they have no demand for one of the particular products. For example, if a consumer does not like potatoes, their preference towards genetic modification can still be elicited if they have a positive demand for either tortilla chips or vegetable oil.

2.3. The Random *n*th-price Auction

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, Fox *et al.* 1998, and Shogren *et al.* 2000). In particular, Vickery's (1961) sealed bid, second-price auction has been a popular mechanism. The popularity of the second-price auction mechanism is largely due to it being demand revealing in theory, being relatively simple to explain, and having an endogenous market-clearing price. Also, evidence from induced value experiments suggests the auction mechanism can produce efficient outcomes in the aggregate (Kagel 1995).

The second-price auction, however, has problems in that it does not accurately reveal the complete demand curve for a good by all participants. Individuals who anticipate being off the margin, i.e., bidders whose value for a good is far below or above the market-clearing price, frequently bid insincerely. This is because if a consumer perceives no realistic chance of winning, they can change their bid slightly with no repercussions. A second-price auction might not engage low-value bidders who think they will never lose by insincere bidding, and laboratory evidence by Miller and Plott (1985) and by Franciosi et al. (1993) supports this conjecture, i.e., off-the-margin bidders often do not reveal their lab-induced private values. Insincere bidding can be sustained if the behavior is undetected and unpunished by the institutional structure of the auction mechanism (e.g., see Cherry *et al.* 2002).

The Becker-DeGroot-Marschak mechanism is also demand revealing in theory (Becker *et al.* 1964). It requires all auction participants to bid for the product in the auction, and consumers will win if their bid price is higher then a predetermined price that is not known to the consumer. If the consumer's bid price is higher then the predetermined price, the consumer will purchase the product for the predetermined price. If the consumer's bid price is lower than the predetermined price; they do not purchase the product. This method has the advantage of a random pricing method. Unfortunately, the predetermined price could be such that no one wins the auction.

The random *n*th-price auction is chosen for these GM-food experiments because it is designed to engage both the on- and off-the-margin bidders (see Shogren *et al.* 2001). 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.

The random *n*th-price works as follows. Each of *k* bidders submits a bid for one unit of a good; then each of the bids is rank-ordered from highest to lowest. The auction monitor then selects a random number—the *n* in the *n*th-price auction, which is drawn from a uniform distribution between 2 and *k*, and the auction monitor sells one unit of the good to each of the $n-1$ highest bidders at the *n*th-price. For instance, if the monitor randomly selects $n = 4$, the three highest bidders each purchase one unit of the good priced at the fourth-highest bid. *Ex ante*, bidders who have low or moderate valuations now have a nontrivial chance to buy the good because the price is determined randomly. This auction increases the probability that insincere bidding will be costly (Shogren *et al.* 2001).

2.4. The Participants

Auctions were planned and conducted at two Midwestern U.S. cities, Des Moines, IA, and St. Paul, MN. Participants in the auctions were consumers that the Iowa State University Statistics Laboratory contacted and obtained agreement to participate. The Statistics Laboratory randomly selected residence telephone numbers from each of the metropolitan areas. Individuals reached by the statistics laboratory were told that Iowa State University was looking for people who were willing to participate in a group session in Des Moines (St. Paul) that related to how people select food and household products. The sessions were held in April and December 2001. People were informed that the sessions 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 sessions were held at the Iowa State University Learning Connection, 7th and Locust Street, Des Moines (and the lower level of the Classroom Office Building, University of Minnesota, St. Paul). 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. Two treatments were run at each time slot, and the treatments were randomly assigned to a time slot without replacement. Participation per household was limited to two adult individuals, and they were assigned to different groups.[3] 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.

The phone numbers were called by employees of the ISU Statistics Laboratory to make sure that it was an eligible number, i.e., one with household members greater than 18 years of age.[2] Some telephone numbers were invalid, some numbers were valid but nobody was home, some numbers were valid but the individual did not want to participate, and some people agreed to participate. Among eligible households reached, 21 percent agreed to participate and 90 percent of these people actually showed up. Hence, there was a response rate of 19 percent. There were a total of 22 experimental units, and 318 participants.

Table 2.7.1. summarizes the demographic characteristics of the 318 auction participants. To compare the demographic characteristics of the auction participants with the demographic characteristics of the area, a table in the appendix has the demographics of the Polk and Ramsey county areas (the counties Des Moines and St. Paul are in). This

information is taken from the 2000 U.S. Census (U.S. Census, 2002). The individual demographics of each county are presented, and then a weighted average is taken to compare with our auction participants, with a weight of 16/22 on Polk County and 6/22 on Ramsey Country, since 16 of the 22 experimental units were in Des Moines. This weighted average is what one would expect for the demographic characteristics of our sample.

Sixty-two percent of the participants in the auctions were female. This is slightly higher than the number of females in the two areas. The median age of a participant was 48 years, which is similar to the median age of 45.7 years for individuals 20 or older in the two areas. Two-thirds of the auction participants were married – this is higher than the number of married people in the two areas (57.3). On average, the participants were well educated, with the mean education level being more than two years in college. This compares favorably with the two areas, as the mean schooling is almost 2 years of college in the general population of these two areas. The participants had a median total household income (before taxes) of almost $45,000 – this is similar to the median household income of $46,000 in the areas. Most of the participants in the experiments were white (ninety-three percent), a slightly higher percentage than the general population (87%). Most people indicated that they read labels before they buy a new food product. Participants were asked how informed they thought they were about genetically modified foods. Forty-eight percent of the auction participants thought that they were at least somewhat informed about GM foods. Even though the people were solicited randomly and getting an accurate representation of the demographic characteristics of the area was not a goal, the demographic characteristics of our participants indicate that our experiments had a representative sample of the Midwest region of the United States.[4]

More demographic characteristics are presented in tables 2.7.2-2.7.4. Individuals were asked to indicate their religious upbringing. These results are reported in table 2.7.2. Fifteen percent of the participants were raised as Baptists. Slightly more than twenty-six percent of participants were raised as Catholics. Over seventeen percent of the participants were raised as Lutherans and almost sixteen percent as Methodists. Almost twenty percent indicated they were raised with a different religious upbringing, while almost six percent were not raised with any religious upbringing.

Table 2.7.3. reports results from a question asked in the survey: "How many people do you think get sick from genetically modified foods each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)" The mean perceived number of illnesses annually due to GM foods is over 14.5 million. This number is extremely large, and much larger than the median, due to a handful of people who thought that everybody (or almost everybody) in the United States would get ill because of GM foods. The median number of perceived illnesses annually due to GM foods was almost twenty-four thousand. Twenty-five percent of the participants thought that fewer than one hundred people get sick annually in the U.S. because of GM foods. What is interesting about these responses is that there has never been a confirmed case of an individual getting sick from GM foods – yet many perceived large numbers of people getting sick annually.

Table 2.7.4. reports on the highest education level the participants attained. Six percent of the participants did not complete high school; fewer than nineteen percent of the participants did complete high school, but did not attend college. Almost thirty-five percent of the participants attended college but did not get a four-year degree. Just over twenty

percent of the participants attained a four-year college degree, and about nineteen percent of the participants completed at least some graduate school work.

2.5. Steps in the Experiment

Figure 2.7.5. shows a graphical representation of the steps in this experiment. 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. The packet that was given to auction participants (specifically the packet used for the experiments described in chapter 4 and 6) is in the appendix.

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. This random binding round eliminates the threat of demand reduction due to potentially buying more than one unit (List and Lucking-Reiley, 2000).[5] 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 six potential info-packets that provided non-food-label information about biotechnology. These info-packets were produced as follows. Three information sources were created: (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. This information is called verifiable information since the third party group is only reporting verifiable information to the participants. Each information source was limited to one full page, organized into five categories: general information, scientific impact, human impact, financial impact, and environmental impact. The exact format and wording of the three information sources can be found in the appendix.

These information sources were then randomized to create the six info-packets: (1) pro-biotechnology, (2) anti-biotechnology, (3) both pro and anti-biotechnology,[6] (4) pro-biotechnology and independent, verifiable,[7] (5) anti-biotechnology and independent, verifiable, and (6) pro-biotechnology, anti-biotechnology, and independent verifiable. These info-packets were then randomized among the experimental units.

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 GM-label, as shown in Figure 2.7.6. In one round (which could be round 1 or 2 depending on experimental unit),[8] 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 a GM-label, which differed from the standard label by the inclusion of only one extra sentence: "This product is made using genetic modification (GM)." We constructed the GM-labels to comply with the U.S. Food and Drug Administration regulations of GM-food labels. 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 GM-label. 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.

Step 8 had participants examine the same three food products, each with a different label from round 1. 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 nth-prices for the three goods. Winners were notified. In step 10, each participant was asked to complete a brief post-auction questionnaire, then the monitors dismissed the participants who did not win. The monitors and the winners then exchanged money for goods, and then the winners were dismissed.

2.6. Notes

1. Philip Dixon and Wayne Fuller, Department of Statistics, Iowa State University, provided assistance with the statistical design part of the project.
2. In addition to a participant's age, the Statistics Laboratory also asked for gender.
3. When two adults in a household participated, the Statistics Laboratory talked separately to them to obtain a commitment to participate, and they were told that they would be assigned to different groups.
4. Demographic information for both the St. Paul area (Ramsey County) and the city of Des Moines (Polk County) can be found at www.census.gov.
5. If one assumes that there is little or no income effect from the deck of cards and box of pens, the two bids on the candy bar should be the same. The reason is that because the deck of cards and box of pens are neither complements nor substitutes to the candy bar, they should not impact the bids on the candy bar. A Wilcoxon signed-rank test confirmed that the bids for the candy bars are not significantly different in the two rounds, with a test statistic of 0.03. This result does not contradict the notion that the subjects' bidding behavior was reasonable.
6. When a participant received both pro-biotechnology and anti-biotechnology information, the order was randomized, so that some people got the pro-biotechnology information first, and some people got the anti-biotechnology information first.
7. When verifiable information was distributed, monitors always distributed it after the other information sources.

8. I randomized the sequencing of the standard food and GM-labels across experimental units. One unit had the standard label in round 1, and GM-label in round 2. The second unit had the GM-label in round 1 and the standard label in round 2.

2.7. Tables and Figures

2.7.1. Characteristics of the Auction Participants

N=318

Variable	Definition	Median	Mean	St. dev.
Gender	1 if female		0.62	0.49
Age	The participant's age	48.0	50.1	17.5
Married	1 if the individual is married		0.67	0.47
Education	Years of schooling		14.5	2.28
Household	Number of people in participant's household		2.73	1.47
Income	The households income level (in thousands)	45.0	54.7	34.1
White	1 if participant is white		0.93	0.26
Read_L	1 if never reads labels before a new food purchase		0.02	0.14
	1 if rarely reads labels		0.09	0.29
	1 if sometimes reads labels		0.32	0.47
	1 if often reads labels		0.36	0.48
	1 if always reads labels		0.21	0.41
Informed	1 if an individual considered themselves at least somewhat informed regarding genetically modified foods		0.48	0.50
Labels1	1 if the treatment bid on foods with GM labels in round 1		0.55	0.56

Table 2.7.2. ***Religious upbringing of individuals in the survey***
N=318

Religious upbringing	Percent
Baptist	15.0
Catholic	26.1
Lutheran	17.6
Methodist	15.7
Other	19.7
None	5.9

Table 2.7.3. ***Perceived number of illnesses due to GM-foods***
N = 264

	Perceived number of people who get sick annually from GM foods
Mean	14,696,257
Maximum	300,000,000
75th percentile	1,000,000
Median	23,750
25th percentile	100
Minimum	0

Table 2.7.4. ***Education of individuals in the survey***
N=318

Highest level of schooling completed	Percent
Did not complete high school	6.0
Completed high school	18.6
Attended some college	22.6
Two-year college degree	12.3
Four-year college degree	21.4
Some graduate college work	19.2

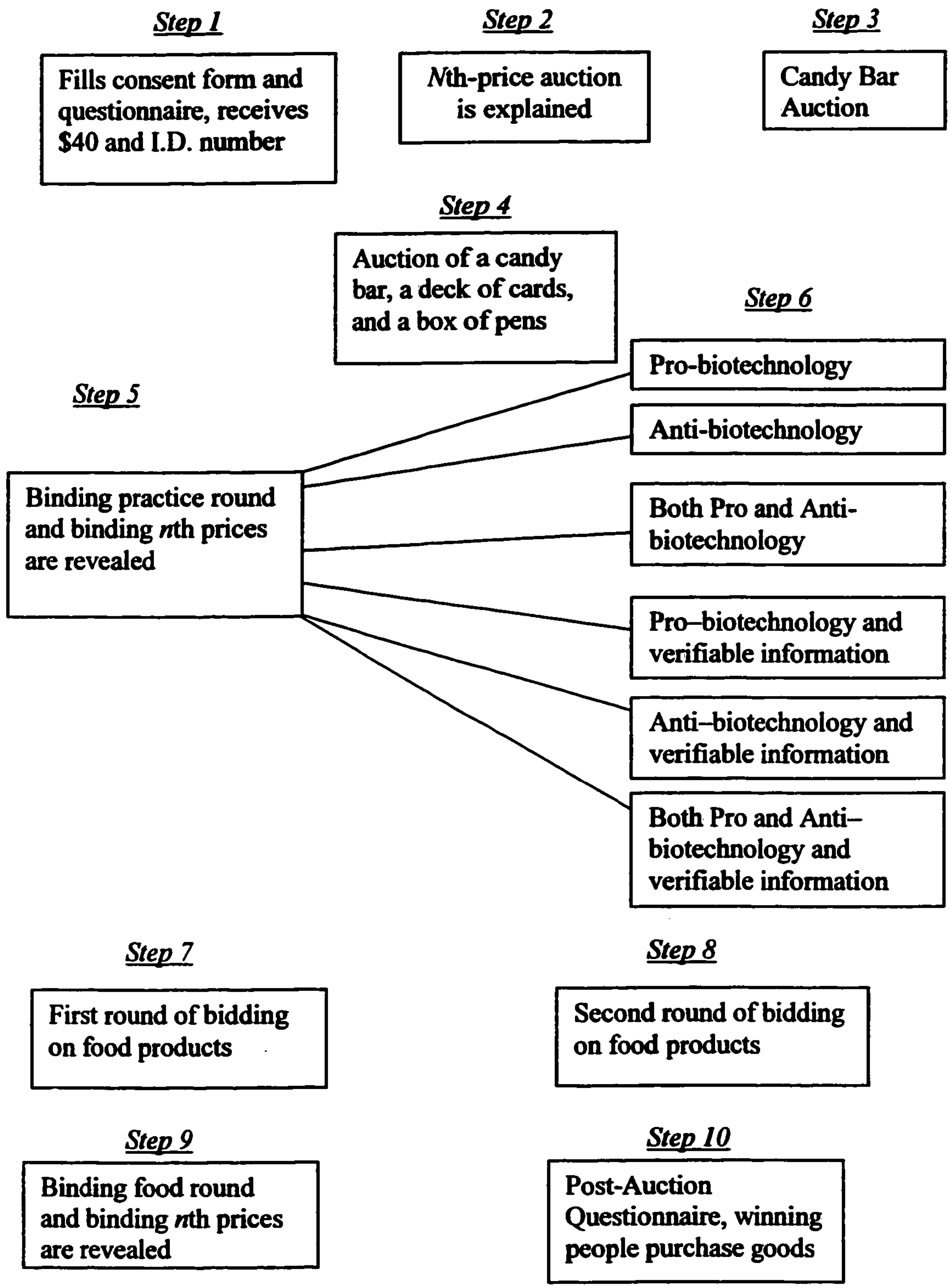


Figure 2.7.5. Steps in the experiment

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

Figure 2.7.6. Labels used for the three food items

CHAPTER 3: SHOULD THE UNITED STATES INITIATE A MANDATORY LABELING POLICY FOR GENETICALLY MODIFIED FOODS?

3.1. Introduction

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 Reports (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 potential welfare effects imposed by a mandatory GM labeling policy in the United States. I first show that mandatory labeling policy for GM foods results in welfare losses relative to a voluntary labeling policy—assuming consumers understand perfectly the signals sent in each market. Then an experimental auction is designed to test the critical presumption that consumers do indeed interpret the market signals identically. For a sample of likely consumers living in two major Midwest cities, the results support the assumption that people can interpret voluntary and mandatory market signals identically. These findings do not reject the view that it would be more efficient if the US continued its voluntary labeling policy and resisted calls for mandatory labeling of genetically modified foods.

3.2. Empirical Model

3.2.1. Basic Framework

I 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), the model compares the welfare of a mandatory GM-labeling policy to the welfare of a 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 $\theta \in [0,1]$. For consumers who buy non-GM foods at a price of p_{NGM}, their indirect utility is $\theta + f - p_{NGM}$.

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. I 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.

3.2.2. A Mandatory Labeling Policy

Consider a mandatory GM labeling policy where all food products must be tested to determine if they are genetically modified. Foods 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) $CS^{j} = \theta^{j} + f - p \cdot$

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

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

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

Where θ_{ML} is the value of θ 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) $CS^{j} = f - p \cdot$

Aggregate consumer surplus of those who purchase GM foods is:

(4A) $CS_{ML}^{GM} = \int_{0}^{\theta_{ML}} (f - p) d\theta = \int_{0}^{\theta_{ML}} (f - t) d\theta$

(4B) $CS_{ML}^{GM} = \theta_{ML} * (f - t) \cdot$

3.2.3. A Voluntary Labeling Policy

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:

$$(5) \qquad CS_{VL}^{NGM} = \int_{\theta_{VL}}^{1} (\theta + f - p) d\theta = \int_{\theta_{VL}}^{1} (\theta + f - C - t) d\theta$$

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

θ_{VL} is the value of θ 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:

$$(6) \qquad CS^{j} = f - p = f \cdot$$

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

$$(7) \qquad CS_{VL}^{GM} = \int_{0}^{\theta_{VL}} (f) d\theta = \theta_{VL} * f \cdot$$

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 alternative 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 labeling 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 is 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.

3.2.4. 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 $\theta - C - t < 0$, 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 ($\theta = 1$) finds it too costly to purchase non-GM foods, ($C + t > 1$), nobody will buy non-GM foods because the signal is too costly.

This analysis implicitly assumes that consumers can distinguish the signal that a food is GM (or non-GM) equally well under different labeling regimes. 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." I 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 and the differences from the experimental design described in chapter 2 follows.

3.3. Experimental Design

3.3.1. Differences from Experimental Design in Chapter 2

The specific purpose of this experiment is to test whether consumer bidding behavior for GM and GM-free food is the same in two experimental markets—one within a mandatory labeling policy and one with a voluntary labeling policy. If bidding behavior for GM and GM-free food were similar across the two markets, the results would not contradict the thesis that consumers accurately read the signals in both markets. The empirical model suggested that a voluntary labeling is a more efficient policy – provided consumers accurately assess which food is genetically modified. If the behavior for GM foods differed across labeling regimes, one could reject the thesis that labeling is irrelevant to choice. Here a mandatory labeling might not necessarily lead to a welfare loss. But if bidding behavior for GM foods is independent of the labeling policy, one could not reject the implications of the empirical model – that a voluntary labeling policy is more efficient for consumers than a mandatory labeling policy. In this experiment, 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.[3]

The experimental design consisted of four biotech information-labeling treatments with each treatment replicated at least twice. One of the treatments was replicated four times, twice in April and twice in December. This allowed an examination of whether the bids were the same over time – which could not be rejected by t-tests and Wilcoxon rank-sum tests. These experimental units are summarized in table 3.7.1. The same three food items that were used in the experimental design that was described in chapter 2 are used here: vegetable oil,[4] tortilla chips (made from yellow corn), and Russet potatoes.

3.3.2. The Information/Labeling Treatments

Participants received one of two potential *info-packets* that provided non-food-label information about biotechnology. 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. These info-packets were then randomized among all ten experimental units, with each info-packet going to five 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. Table 3.7.1. summarizes the 8 treatments.

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 3.7.2. 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.[5] 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 modification," while the non-GM label said "This product is made without using genetic modification." For each experimental unit, participants knew that only one round would be chosen as the binding round that determined auction winners.

3.4. Results

Table 3.7.3. 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.

The 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, I first examine the difference in bids for the *perceived-GM product* to the *perceived-non-GM product*. In the mandatory-labeling trials, the GM-labeled food is the perceived-GM product; the plain-labeled food is the perceived-non-GM product. In the voluntary-labeling trials, the plain-labeled food is the perceived-GM product; the non-GM labeled food is the perceived-non-GM product.

Table 3.7.4. 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, *I 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 Lusk *et al.*, 2001.

Table 3.7.5. 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, I test two separate null hypotheses:

(8) $H_0 : Bid^{GM-labeled}_{mand\_treat} = Bid^{non-labeled}_{mand\_treat}$

(9) $H_0 : Bid^{non-GM-labeled}_{vol\_treat} = Bid^{non-labeled}_{vol\_treat}$.

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 trials. Table 3.7.5. 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 3.7.6. shows the results. The first column shows the difference in bids in the mandatory- labeling trials, the second column shows the difference in bids in the voluntary-labeling 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.[6] 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 two different types of vegetable oils were used.[7]

Consumers discounted the perceived GM food the same irrespective of whether the market had mandatory or voluntary GM-labeling. This result provides additional evidence that consumers receive the same signals either regime. By not rejecting the thesis that consumers know GM from non-GM food regardless of the labeling regimes, the results support the empirical analysis—less-expensive voluntary GM-labeling policy could yields greater overall welfare than a mandatory GM-labeling policy. Without speculating beyond the reach of the lab, this finding supports those who believe the United States has been prudent in avoiding calls to initiate a mandatory GM-labeling policy.

3.5. 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 the 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.

3.6. Notes

1. There may also be fixed costs associated with testing food products for GM content, this model, however, is 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 my model differs substantially from Kirchoff and Zago (2001) in the respect that I 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. These experimental markets were chosen to emulate the mandatory and voluntary GM labeling regimes currently in place throughout the world. The mandatory regime reflects the labels consumers might find in Europe, where foods that are GM must be labeled as such. The voluntary labeling regime captures the labels consumers might see the United States, where food manufacturers can label their products as non-genetically-engineered if they choose. I do not examine several other potential but currently non-implemented labeling policies, including a mandatory labeling policy that require all non-GM foods to label themselves, or a policy that requires every food product in a market labeled as GM or non-GM.
4. Soybean oil was initially used in the April experiments – I then tried to find non-GM soybean oil in 32 oz. bottles and was 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.

5. Note that these 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.
6. 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
7. To check the robustness of the results, I 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.

3.7. Figures and Tables

Table 3.7.1. Information and labeling given to treatments 1 through 8

Treatment	Labeling regime type	Verifiable information	Round with GM labels
1.	Voluntary regime	Yes	1
2.	Voluntary regime	Yes	2
3.	Voluntary regime	No	1
4.	Voluntary regime	No	2
5.	Mandatory regime	Yes	1
6.	Mandatory regime	Yes	2
7.	Mandatory regime	No	1
8.	Mandatory regime	No	2
7A.*	Mandatory regime	No	1
8A.*	Mandatory regime	No	2

* Treatments 7 and 8 are replicated across time. Treatments 7 and 8 were conducted in April, while 7A and 8A were conducted in December.

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 3.7.2. The Three Types of Labels

Table 3.7.3. Mean Bids

A. Mean bids when participants bid on food in a mandatory GM-labeling market.

	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 in a voluntary GM-labeling market.

	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 3.7.4. Test on whether difference for "perceived" GM and "perceived" non-GM foods are different
N=142

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

Table 3.7.5. 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 – mandatory regime n=86	Mean bid – voluntary regime n=56	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 3.7.6. T-Test to determine whether difference in bids are statistically different

	Difference – mandatory regime	Difference – voluntary regime	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

CHAPTER 4: THE IMPACT AND VALUE OF VERIFIABLE INFORMATION IN A CONTROVERSIAL MARKET

4.1. Introduction

R&D frequently leads to the development of new inputs and consumer goods, and the introduction of new products, e.g., foods, can lead to information wars as interested parties try to influence market outcomes. Two groups dominate the debate over genetically modified (GM) foods. These groups have very different ideas or beliefs about the benefits and risks of agricultural biotechnology. Agribusiness companies like Monsanto and Syngenta support agricultural biotechnology and say that GM foods will help protect the environment, increase nutrition, and help end world hunger (Council for Biotechnology Information, 2001). Environmental groups like Greenpeace and Friends of the Earth oppose agricultural biotechnology and say that GM foods could cause allergic reactions, will hurt the environment, and could increase the power of multinational companies (Greenpeace, 2001). One could characterize the on-going GM-food controversy as an information war between the pro- and anti-biotech interest groups. The average U.S. consumer and farmer has available to him (her) diverse information from these interested parties as they make decisions on the use of GM products. Socially good or bad decisions may result

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 (b) they can verify all the information provided (Milgrom and Roberts, 1986). Unfortunately, this full and verifiable information environment does not define the market for genetically modified products. Genetic modification is a complex process, which involves taking genes from one organism and placing them into another. Most consumers do not know the intricate details of this process. In addition, not all information on GM is currently verifiable. Also, the search costs for most consumers to find neutral information is very high, as there are contradictory messages about GM as "food to feed the planet" versus GM as "frankenfood" (see for example Gates, 2001). Because of these high search costs, a verifiable information source – defined as a source that has no financial ties to genetic modification and produces information that is verifiable – could have tremendous consumer value (Huffman and Tegene, 2002).

Limited evidence from earlier surveys and the lab suggests that consumers only hear the bad news in a controversial market with diverse information and without verifiable information. Individuals amplify the risks of a neoteric product and discount its benefits. Viscusi (1997), for instance, showed using a survey that when consumers received divergent information on environmental risks, they 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 also observed in Fox, Hayes, and Shogren's (2001) lab auction experiment on the value of food irradiation. Their initial results follow intuition: a favorable description of irradiation increased demand and an unfavorable description decreased demand. But when presented with both a favorable and unfavorable description, demand fell to zero, suggesting the negative portrayal dominated the positive. Bidders bid as if they had only heard the anti-irradiation argument, 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 personal gain and for loss in welfare of others. The open question that neither the Viscusi (1998) nor Fox, Hayes, and Shogren (2001) studies address is the potential social value of introducing third party verifiable information about the risks and benefits of the controversial products for sale in the market. One attempt to estimate the value of such information was Foster and Just's (1989) study on how news of insecticide contamination (heptachlor) affected milk consumption in Hawaii. Foster and Just calculated the value of third party information as the difference in rational consumers' choices under incomplete and more complete information. They estimated the value of information as about $10.00 per person per month. Foster and Just did not, however, control for the type of information as a treatment variable. A distinguishing feature of this experiment is controlling for the type of information that is given to consumers.

This chapter examines the effects of information on consumers' demand for new food products, GM-foods, in an environment where information from one or more interested parties is provided. Four issues are examined. First, how does diverse information from interested parties affect consumers' willingness to pay for genetically modified foods? Second, does third party or verifiable information on genetic modification, in an environment where pro- or (and) anti-biotech information is provided, change consumers' purchasing behavior? Third, if behavior changes, what is the value of verifiable information to consumers? Fourth, if the results are generalized to the aggregate U.S. demand for processed foods, what is the approximate annual social value?

4.2. Theoretical Model

4.2.1 Model in a Household Production Framework

To foster better understanding of the reasons consumers choose whether or not to consume GM-labeled foods, I will first consider a household production model. Once intuition is gained into why consumers would choose whether or not to consume GM-labeled foods, a state dependent utility model is used to derive some predictions of consumer behavior. Consumers obtain utility in this static model from three different goods: food safety, environmental quality and energy. Consumers can not directly consume these three goods; instead they must be produced. Consumers produce these three goods by consuming two inputs: foods that are labeled as genetically modified and foods that are not labeled as genetically modified (plain-labeled foods).

This setup is represented in equations 1-3, where Z^j_{env} represents environmental

(1) $$Z^j_{env} = f^j_1\left(X^j_{labeled}, X^j_{non-labeled}; I\right)$$

(2) $$Z^j_{hlth} = f^j_2\left(X^j_{labeled}, X^j_{non-labeled}; I\right)$$

(3) $$Z^j_{engy} = f^j_3\left(X^j_{labeled}, X^j_{non-labeled}; I\right)$$

quality, Z^j_{hlth} represents health, and Z^j_{engy} represents energy. All three goods depend on the same two commodities: the consumption of foods that are labeled as genetically modified, $X^j_{labeled}$ and the consumption of plain-labeled foods, $X^j_{non-labeled}$. Information $I \sim (-\infty, \infty)$ affects the consumer's perceived production of food safety, environmental quality, and energy. When a consumer receives new positive information on genetic modification they will perceive greater production of at least one of the three goods. When a consumer receives negative information on GM foods they will perceive smaller production of at least one of the three goods. The information a consumer receives is exogenous, and can differ among individuals. Notice that this model mentions a consumer's perceived production of goods. This is because the information that a consumer obtains will not always be correct, yet unless they know better, a change in information will change the consumer's perceived production. This approach, viewing consumers as using the information available to them to the best of their ability, but possibly not using all the relevant information is similar to the approach used in Foster and Just (1989).

The consumer's objective is to maximize utility subject to their budget constraint. The utility function is shown in equation 4. Consumers get utility from environmental

(4) $$U^j = u^j\left(Z^j_{env}, Z^j_{hlth}, Z^j_{engy}\right)$$

quality, health, and energy. Consumer's utility is constrained by income, and the consumer objective is to maximize utility subject to their budget constraint. One can determine a consumer's optimal quantity of each good by maximizing the Lagrangian, as shown in equation 5:

(5) $$\max_{X^j_{labeled}, X^j_{non-labeled}, \lambda^j} \ell = u^j\left(Z^j_{env}, Z^j_{hlth}, Z^j_{engy}\right) +$$

$$\lambda^j[M^j - p_{labeled} X^j_{labeled} - p_{non-labeled} X^j_{non-labeled}].$$

In this maximization problem, λ^j is the Lagrangian Multiplier, M^j is the consumer j's (money) income, and p_l is the price for product l. Solving this problem gives the first order conditions shown in equations 6 through 8. Equation 8 is the budget constraint, and equations 6 and 7 represent the marginal conditions necessary for the consumer to maximize utility.

$$(6)\qquad \frac{\partial \ell}{\partial X^j_{labeled}} = \frac{\partial u(\bullet)}{\partial Z^j_{env}}\frac{\partial Z^j_{env}}{\partial X^j_{labeled}} + \frac{\partial u(\bullet)}{\partial Z^j_{hlth}}\frac{\partial Z^j_{hlth}}{\partial X^j_{labeled}} + \frac{\partial u(\bullet)}{\partial Z^j_{engy}}\frac{\partial Z^j_{engy}}{\partial X^j_{labeled}} - \lambda^j p_{labeled} \le 0$$

$$(7)\qquad \begin{aligned} \frac{\partial \ell}{\partial X^j_{non-labeled}} &= \frac{\partial u(\bullet)}{\partial Z^j_{env}}\frac{\partial Z^j_{env}}{\partial X^j_{non-labeled}} + \frac{\partial u(\bullet)}{\partial Z^j_{hlth}}\frac{\partial Z^j_{hlth}}{\partial X^j_{non-labeled}} \\ &+ \frac{\partial u(\bullet)}{\partial Z^j_{engy}}\frac{\partial Z^j_{engy}}{\partial X^j_{non-labeled}} - \lambda^j p_{non-labeled} \le 0 \end{aligned}$$

$$(8)\qquad \frac{\partial \ell}{\partial \lambda^j} = M^j - p_{labeled}X^j_{labeled} - p_{non-labeled}X^j_{non-labeled} \ge 0$$

Some useful insights into the consumer decision process can be gained by looking at how consumers choose their utility maximizing bundle. First rearrange equation 6 by putting the price for GM foods times the marginal utility of income λ on the right hand side. The right-hand side now has price times the marginal utility of income (the standard result from

$$(6)\qquad \frac{\partial u(\bullet)}{\partial Z^j_{env}}\frac{\partial Z^j_{env}}{\partial X^j_{labeled}} + \frac{\partial u(\bullet)}{\partial Z^j_{hlth}}\frac{\partial Z^j_{hlth}}{\partial X^j_{labeled}} + \frac{\partial u(\bullet)}{\partial Z^j_{engy}}\frac{\partial Z^j_{engy}}{\partial X^j_{labeled}} \le \lambda^j p_{labeled}$$

consumer theory), but the left-hand side is less typical. The first term on the left hand side is the marginal utility from increased environmental quality, and it is multiplied by the marginal effect on environmental quality from eating additional GM-labeled foods. The second term on the left-hand side is the marginal utility from health, multiplied by the marginal effect of health from consuming GM-labeled foods. The third term is similar, containing the marginal utility from energy, multiplied by the marginal effect on energy from consuming GM-labeled foods. So consumers maximize utility by considering the marginal effects of the three different goods; environmental quality, health and energy. Inequality (7) is similar, in that the consumer must consider the impact of plain-labeled foods on food safety, environmental quality, and energy.

This is important because each consumer considers three different aspects of GM-labeled foods when considering how to maximize utility. Some consumers may consume less GM-labeled foods because they perceive health risks, while other consumers may consume less (or more) GM-labeled foods because they are concerned about the environmental impact. The first order conditions show that different consumers may avoid GM-labeled foods for different reasons. Now consider a more simplified theoretical specification.

4.2.2. Model in a State-Dependent Utility Framework

Following Viscusi and Evans (1990), I begin the empirical specification by first developing a state-dependent utility model of GM food consumption given diverse information. A person compares his perceived expected utility (henceforth, utility) from consuming GM-labeled foods and plain-labeled foods. These two goods are nearly perfect substitutes, in which consumption can result in either a good or bad outcome, with distinct probabilities.[1] Equation (1) shows the state-dependent utility function for a consumer who purchases GM-labeled food, called *labeled*; equation (2) is his utility for a purchase of plain-labeled foods, called *non-labeled*:

(1) $$EU^j_{labeled}(w) = p^j_{labeled}(I)U^j(w) + (1 - p^j_{labeled}(I))V^j(w)$$

(2) $$EU^j_{non-labeled}(w-M) = p^j_{non-labeled}U^j(w-M) + (1 - p^j_{non-labeled})V^j(w-M).$$

where consumer *j*'s income is *w*, and M is the monetary premium he pays for the non-labeled food (the premium can be positive, negative, or zero). Consumer *j* obtains utility U^j if the good state occurs, and V^j if the bad state occurs, where $U^j > V^j > 0$.

Assume the bad state occurs when either consumer *j* becomes ill or a bad environmental outcome occurs (e.g., genetic cross-breeding). Let $p^j_{labeled}(I)$ and $p^j_{non-labeled}(I)$ be consumer *j*'s perceived probability that the GM-labeled food and plain-labeled food will yield the good state. Assume the information the consumer has on genetic modification, $I \sim (-\infty, \infty)$ affects the perceived probability that GM-labeled foods will result in a good state. Large positive I represents positive or favorable information on GM foods; large negative I represents negative or less favorable information on GM foods. When a consumer gets positive information on GM foods, I increases and the consumer perceives greater utility from GM-labeled foods and greater marginal utility from GM-labeled foods. The information a consumer receives in the experiments is randomly assigned, and can differ among participants. The consumer's perceived probability of a good outcome from plain-labeled food *does not depend on information about GM foods.*

When equation (3) holds, the consumer is indifferent between purchasing GM-labeled and plain-labeled foods:

(3) $$EU^j_{labeled}(w) = EU^j_{non-labeled}(w - M).$$

or:

(3a) $$p^j_{labeled}(I)U^j(w) + \left(1 - p^j_{labeled}(I)\right)V^j(w) =$$
$$p^j_{non-labeled}U^j(w - M) + \left(1 - p^j_{non-labeled}\right)V^j(w - M).$$

The consumer prefers GM-labeled foods when the left-hand side of (3a) exceeds the right-hand side; otherwise he prefers the plain-labeled foods. In addition, standard comparative statics show that an increase in positive GM information increases the consumer's likelihood of consuming GM-labeled foods by increasing the expected utility of GM-labeled foods:

$$\frac{\partial EU^j_{labeled}(w)}{\partial I} = \frac{\partial p^j_{labeled}(I)U^j(w) + (1 - \partial p^j_{labeled}(I))V^j(w)}{\partial I}$$

$$= \frac{\overbrace{\partial p^j_{labeled}(I)}^{+}U^j(w) + \left(\overbrace{1 - \partial p^j_{labeled}(I)}^{+}\right)V^j(w)}{\partial I} > 0.$$

I now define the aggregate demand for GM foods. Let $X^j_{labeled}$ represent the quantity of GM-labeled foods demanded by consumer *j*. Assume $X^j_{labeled}$ is positive for consumers who prefer GM-labeled foods, and zero otherwise. I sum the quantity demanded over all consumers to obtain the aggregate demand for GM-labeled foods:[2]

(4) $$AGDEMAND_{labeled} = \sum_j X^j_{labeled}(I).$$

Assume the population of consumers is heterogeneous in tastes and income such that they can be grouped as: (i) consumers of GM-labeled products, (ii) consumers who initially consume plain-labeled foods but switch to GM-labeled product with more positive GM information; and (iii) consumers of plain-label foods who never switch with positive information. Now split aggregate demand for GM-labeled foods into those consumers who initially buy GM-labeled foods and those who do not:

(4a) $$AGDEMAND_{labeled} = \sum X^{buyGM}_{labeled}(I) + \sum X^{zeroGM}_{labeled}(I).$$

Taking the derivative of (4a) with respect to information *I* yields:

(5) $$\frac{\partial AGDEMAND_{labeled}}{\partial I} = \overbrace{\sum \frac{\partial X^{buyGM}_{labeled}(I)}{\partial I}}^{\geq 0} + \overbrace{\sum \frac{\partial X^{zeroGM}_{labeled}(I)}{\partial I}}^{>0} > 0,$$

which says that an increase in positive information *I* increases the aggregate demand for GM-labeled foods. The first term on the right-hand side of (5) is the derivative for those who initially consumed the GM-labeled product, and it can be greater than or equal to zero. The second term is the derivative for consumers who do not initially consume GM-labeled foods. For some individuals this derivative is zero, and for others, this derivative is positive because they switch to GM-labeled foods. The second summation term is positive, and the aggregate demand for GM-labeled foods is increasing in information *I*. The opposite result holds for negative information.

4.3. Econometric Model

4.3.1. General Setup

I now consider the specific regression analysis used to examine consumer behavior under diverse information. The regressions hold consumers' tastes constant for each of the three products by making the dependent variable the difference in bid prices for plain-labeled and GM-labeled products for each participant. Taking the difference of the demand equations for each product in the two trials derives this price difference. Let the inverse demand equation for the GM-labeled and plain-labeled food be:

$$(6) \qquad P_j^{non-labeled} = \beta_1^{non-labeled} + \beta_2^{non-labeled} X_{j2} + \mu_j^{non-labeled}$$

and

$$(7) \qquad P_j^{labeled} = \beta_1^{labeled} + \beta_2^{labeled} X_{j2} + \mu_j^{labeled}.$$

where P_j represents the price bid for a good by participant j; β_1 is an intercept term; X_{j2} is a vector of exogenous variables, and β_2 is the associated vector of coefficients. μ_j is a zero mean disturbance term.

Subtracting equation (7) from equation (6), I obtain an equation in which the dependent variable is the difference in bid prices for the two trials:

$$(8)\quad \begin{aligned}&P_j^{non-labeled} - P_j^{labeled} = \\ &\beta_1^{non-labeled} - \beta_1^{labeled} + \left(\beta_2^{non-labeled} - \beta_2^{labeled}\right)X_{j2} + \mu_j^{non-labeled} - \mu_j^{labeled}.\end{aligned}$$

The coefficients and error terms can be condensed and rewritten as:

$$(8a)\quad P_j^{non-labeled} - P_j^{labeled} = \beta_1^* + \beta_2^* X_{j2} + \mu_j^*.$$

The difference in bid prices is explained by an intercept term β_1^*, a slope term β_2^* that is multiplied by a vector of exogenous characteristics X_{j2}, and a random error term μ_j^*.[3]

Equation (8a) is likely to be censored because a zero bid for the GM-labeled product or the plain-labeled product or both may occur. This censoring has four cases (see Table 4.8.2.). Case (1): consumer *j* bids a positive amount for both the GM-labeled and the plain-labeled product; the measured difference in bid prices is the difference between the two bid prices. Case (2): consumer *j* bids zero for the GM-labeled product and a positive amount for the plain-labeled product. The "true difference" in bid prices with the censored regression will be greater than the difference between the two observed bid prices. This arises because the bids on the GM-labeled product are censored at zero. Case (3): consumer *j* bids a positive amount for the GM-labeled product and zero for the plain-labeled product. This is the same as Case (2); the true difference in bid prices for the censored regression is absolutely larger than the measured difference between the two bid prices. Case (4): consumer *j* bids zero for both products. This does not give any information about their true demand for GM products.

A positive aspect of using the censored regression model is that zero bid prices are correctly accounted for, and effects of bias from the zero bids are minimized. The disadvantage is that I must assume a bid price distribution. Assume the zero bid prices would have followed a normal distribution, had they not been censored. Statistical tests are conducted using the likelihood ratio test statistic (Greene, 2000) to test the explanatory power of the variables.[4] The large sample distribution of $-2\ln\lambda$ is chi-squared, with degrees of freedom equal to the number of restrictions imposed.

4.3.2. Seemingly Unrelated Regressions

Regressions are run for each of the three food products individually. It is useful to examine whether the coefficients are the same across the three products. If the coefficients are different, it provides evidence that consumers view genetic modification differently in different products. A seemingly unrelated regression allows a test of whether the coefficients differ across products.

Recall equation 8A, which contains the equation that will be estimated by regression.

8A) $$P_j^{non-labeled} - P_j^{labeled} = \beta_1^* + \beta_2^* X_{j2} + \mu_j^*.$$

Consider 8A for all three products, which yields regression equations for potatoes, tortilla chips and vegetable oil. These three equations can be put into matrix form, which is shown in equation 9:

9) $$\begin{bmatrix} P^{non-labeled,pot} - P^{labeled,pot} \\ P^{non-labeled,chip} - P^{labeled,chip} \\ P^{non-labeled,oil} - P^{labeled,oil} \end{bmatrix} = \begin{bmatrix} X & 0 & 0 \\ 0 & X & 0 \\ 0 & 0 & X \end{bmatrix} \begin{bmatrix} \beta^{pot} \\ \beta^{chip} \\ \beta^{oil} \end{bmatrix} + \begin{bmatrix} \mu^{*pot} \\ \mu^{*chip} \\ \mu^{*oil} \end{bmatrix}.$$

In equation 9, X is the $(n \times k)$ matrix that contains all the individual exogenous characteristic vectors X_{j2}, P is a $(n \times 1)$ vector that contains prices for all participants, β is the vector of coefficients, and μ is an $(n \times 1)$ vector that contains every participants error term. One may want to test if certain variables have the same impact for different products. For example, one may want to test if gender has the same impact on the dependent variable for potatoes as it does for tortilla chips and vegetable oil. Equation 8 can be rewritten, separating the X matrix and the β vectors into two parts, one part that will be restricted and one part that will not be restricted. This is shown in equation 9A.

$$\text{9A)}\quad \begin{bmatrix} p^{non-labeled,pot} - p^{labeled,pot} \\ p^{non-labeled,chip} - p^{labeled,chip} \\ p^{non-labeled,oil} - p^{labeled,oil} \end{bmatrix} = \begin{bmatrix} [X_R, X_U] & 0 & 0 \\ 0 & [X_R, X_U] & 0 \\ 0 & 0 & [X_R, X_U] \end{bmatrix} \begin{bmatrix} \begin{bmatrix} \beta_R^{pot} \\ \beta_U^{pot} \end{bmatrix} \\ \begin{bmatrix} \beta_R^{chip} \\ \beta_U^{chip} \end{bmatrix} \\ \begin{bmatrix} \beta_R^{oil} \\ \beta_U^{oil} \end{bmatrix} \end{bmatrix} + \begin{bmatrix} \mu^{*pot} \\ \mu^{*chip} \\ \mu^{*oil} \end{bmatrix}$$

In equation 9A, $[X_R, X_U]$ is the matrix X partitioned into a restricted part and an unrestricted part. The vector of coefficients $\begin{bmatrix} \beta_R \\ \beta_U \end{bmatrix}$ is the vector β partitioned into a restricted part and an unrestricted part. One can test the unrestricted model in equation (9A) against a model that restricts certain coefficients to be the same across the equations. The restricted version of equation 9A is shown in equation 10. The coefficients β_R^* are restricted (to be the same) across all three equations. One can now test if both models are equivalent, which would indicate that the coefficients are the same across equations.

$$\text{10)}\quad \begin{bmatrix} p^{non-labeled,pot} - p^{labeled,pot} \\ p^{non-labeled,chip} - p^{labeled,chip} \\ p^{non-labeled,oil} - p^{labeled,oil} \end{bmatrix} = \begin{bmatrix} [X_R, X_U] & 0 & 0 \\ 0 & [X_R, X_U] & 0 \\ 0 & 0 & [X_R, X_U] \end{bmatrix} \begin{bmatrix} \begin{bmatrix} \beta_R^{*} \\ \beta_U^{pot} \end{bmatrix} \\ \begin{bmatrix} \beta_R^{*} \\ \beta_U^{chip} \end{bmatrix} \\ \begin{bmatrix} \beta_R^{*} \\ \beta_U^{oil} \end{bmatrix} \end{bmatrix} + \begin{bmatrix} \mu^{*pot} \\ \mu^{*chip} \\ \mu^{*oil} \end{bmatrix}$$

A version of the F-test can be used to test the validity of the null hypothesis that the coefficients are the same across equations, versus an alternative hypothesis of negation as shown in equation 11:

$$11)\quad \begin{array}{l} H_0 : R\beta = r \\ H_A : R\beta \neq r \end{array}.$$

The F-test needed for this equation is shown in equation 12:

$$12)\quad \left(R\hat{\beta} - r\right)'\left(R\hat{C}R'\right)^{-1}\left(R\hat{\beta} - r\right)\xrightarrow{d}\chi^2_{(J)}.$$

The chi-squared statistic is what the F-test in equation 11 converges to asymptotically if the null hypothesis is correct. The terms $R\hat{\beta}$ choose which variables will be restricted, where R is a matrix of 0's and 1's, and $\hat{\beta}$ is the vector of estimated coefficients. The vector r is what the variables $R\hat{\beta}$ are being restricted to in the test. The middle term in equation (10) is $\hat{C} = \left[X'\left(\hat{\Sigma}^{-1} \otimes I\right)X\right]^{-1}$, where $\left(\hat{\Sigma}^{-1} \otimes I\right)$ is the Kronecker product of the estimated covariance matrix by the Identity matrix. This is a more generalized version of the covariance matrix than the one used with the standard F-test.

4.4. The Value of Verifiable Information

I now define the empirical specification to obtain the value of verifiable information. I compare the utility gained using the *ex post* probabilities of harm from GM labeled foods for those bidders who switched their purchasing behavior with new information. This approach is similar to the approach used by Foster and Just (1989) and Teisl *et al.* (2001). Because the goods are nearly perfect substitutes, consumers who receive third-party information on GM foods could change their relative preferences, but their preferences might not change enough to cause them to switch to the other good. As an example, assume a consumer is initially willing to pay $1.00 for a GM-labeled food product and $2.00 for a plain-labeled food product, and the plain-labeled food costs $2.00. Suppose the market-clearing price for the GM-labeled food is $1.60. The consumer would initially buy the plain-labeled food. If third-party information increases the consumer's willingness to pay for the GM-labeled product from $1.00 to $1.50, the information changes the consumer's relative preference toward GM-labeled food but not enough to make him switch. Since the GM-labeled food costs $1.60, he is still better off purchasing the plain-labeled version of the product.

I evaluate two types of individuals who gain from third-party information. The first type is one who purchases GM-labeled foods before he received third party, verifiable information, but switches to plain-labeled foods after he receives the third-party information. The second type purchased plain-labeled foods before the third-party information is introduced, and then switches to GM-labeled foods after he receives the third-party information.

What is the welfare gain for consumers who switch after verifiable information is released/provided? First, let's look at the welfare gains for a consumer who switches from the plain-labeled food to the GM-labeled food. The consumer originally purchases the plain-labeled food, and the surplus the consumer receives from that purchase is the difference between his/her willingness to pay and the price for the plain-labeled food. Consumer j's surplus from purchasing plain-labeled food or GM-labeled food is shown in (9) and (10):

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

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

Because I am looking at the case in which a consumer originally purchases plain-labeled foods, the consumer initially perceives a greater surplus from consuming the plain-labeled food than from consuming the GM-labeled food. For consumers who switch after receiving third-party 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 consumers who switch is the surplus they receive from purchasing the GM-labeled food minus the surplus they would receive if they purchased the plain-labeled food. Consumer *j's* increase in welfare from third-party information due to switching from the plain-labeled product to the GM-labeled product is:

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

Those consumers who initially purchased the GM-labeled food and then switched to the plain-labeled food after they received third-party information will also gain. Their gain will be the welfare gain from purchasing the plain-labeled foods minus the gain they would have received if they had purchased GM-labeled foods. The welfare gain of an individual *j* who switches from the GM-labeled product to the plain-labeled product is:

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

Note all consumers enjoy the premium gained by consuming one product instead of another, as shown in expressions (11) and (12), but the premium gained represents increased welfare (i.e., the value of information) for those *who switch products*. The total welfare gained for each product from a third-party source can be computed by summing the welfare gains over all individuals. The total value of information is obtained by summing the value of information for all individuals who switched to GM-labeled foods and all individuals who switched to plain-labeled foods:

$$(13) \quad SUMVAL = \sum_{j \in switched} PREMGAIN^{j}_{non-labeled} + \sum_{j \in switched} PREMGAIN^{j}_{labeled} .$$

There are three combinations of information a person could have received when no third-party information is available. A consumer could have access to only positive information on GM foods, have access to only negative information on GM foods, or could have access to both positive and negative information on GM foods. The gains from third-party information are computed for each of the three situations.

Three magnitudes are needed to value verifiable information: (1) the difference in the marginal percentage who purchase GM-labeled foods after third-party information is introduced; (2) the value of third-party information to each person who switches; and (3) the average value of third-party information per person. These three values will be obtained for individuals in each of the three information settings (receiving positive information, receiving negative information, or receiving both positive and negative information).

First, I determine the net change in the percentage of consumers who purchase GM-labeled foods. The experimental auction provides data on how much a consumer values the plain-labeled product and the GM-labeled product, but no information on these prices. To compute the value of information, I need an estimate of the prices a consumer would face in the market. To do this, I assume that the price for a GM-labeled food *is the mean bid price for that food product across all auction participants*, and the price for the plain-labeled food is the mean bid price for that food product. Because I am trying to assess the average value of information for each product, I will assume that all participants purchase either the GM-labeled version or the plain-labeled version of a product. Individuals purchase the product that gives him/her the greater surplus, as shown in equations (9) and (10). 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 information" and the "percentage who purchase GM-labeled foods but do not receive third-party information;" given the other information they have received:

$$(14) \qquad Percentswitch = \left| percentbuyGM^{thirdparty} - percentbuyGM^{no-thirdparty} \right|.$$

For participants who receive only negative information, third-party information should cause some to switch to GM-labeled foods. For participants who only receive positive information, one would expect some to switch to plain-labeled foods. For consumers who receive both positive and negative information, it is difficult to predict whether consumers would buy more or less GM-labeled food when third-party information is given. The net percentage change is the absolute value of the difference in the percentage who consume the GM-labeled food with and without third-party information.

Who switches once third-party information is introduced? One cannot determine the particular individuals who switch, but I do know the percentage of the sample that switched after the introduction of third-party information. I assume that the individuals who switched had relative preferences for plain-labeled foods that were evenly distributed throughout the population who consumed the good that has been switched to. For example, if third-party information causes a number of consumers to switch their purchasing habits to consume GM-labeled foods, I will assume that these consumers who switched had relative valuations of plain-labeled foods that were evenly distributed throughout the population of consumers who purchase the GM-labeled foods.

Second, I estimate the value of third-party information to a person who switches either to or from the GM-labeled food. To determine the value of third-party information to a consumer who switches, divide the total value of verifiable information, as computed in equation (13), by the number of consumers who switched products:

(15) $$switchervalue_l = \frac{SUMVAL}{N^{buy-switchedproduct}}.$$

In equation (15), $switchervalue_l$ is the average value of third-party information to a consumer that switches his/her purchase of product l either to or from the GM-labeled food after they receive the third-party information. This works because I am assuming the consumers who switched are evenly distributed throughout the population of consumers. The total value of third-party information for product l can be obtained by multiplying the average value of third-party information per switcher by the number of switchers:

(16) $$totalvalue_l = switchervalue_l \times N^{switched}.$$

Then the average value of third-party information for product l can be computed by dividing the total value of third-party information by the total number of consumers in the population:

(17) $$avevalueperson_l = \frac{totalvalue_l}{N^{pop}}.$$

Recall that to compute the value of information, prices had to be estimated. The prices for plain-labeled and GM-labeled foods were estimated as the mean bid prices for each of the three products, meaning that the discount for the GM-labeled foods was just the mean difference in bids. The sensitivity of the value of information to the relative price of GM-labeled foods is now explored. To explore the sensitivity of the value of information, I will consider a smaller and a larger price for the GM-labeled food. These are shown in equations 18 and 19:

(18) $$PGM^{higher} = MEAN^{GM} + 0.5 * (MEAN^{non\text{-}labeled} - MEAN^{labeled})$$

(19) $$PGM^{lower} = MEAN^{GM} - 0.5 * (MEAN^{non\text{-}labeled} - MEAN^{labeled}).$$

By changing the discount for the GM-labeled foods, I am examining how sensitive the value of information is the prices, which had to be estimated.

In sum, the experimental auction data and econometric design allows a calculation of the percentage of consumers who switch in each of the information settings: receiving positive information, receiving negative information, or receiving both positive and negative information. The average value of third-party information per person who switches is then computed for each product. I then estimate an average value of third-party information per consumer in the population for each product, and then translate this into a total value to the United States.

4.5. Results and Discussion

The experimental design in this chapter exactly follows the experimental design described in chapter 2. A summary sheet of the 12 treatments given in this experiment are shown in table 4.8.1. Some participants chose to bid zero in both trials, i. e., for both the GM-labeled and the plain-labeled variety of a particular food product. These participants provide no information about their taste for genetic modification; they were willing to pay zero for one unit, indicating they had no demand for the particular food product. Tables 4.8.3. and 4.8.4. present the mean bids for participants, segregated by information treatment. Table 4.8.3. includes all bids, while table 4.8.4 does not include bids for consumers who bid zero for both the GM-labeled and plain-labeled varieties of a product.[5] In Table 4.8.4., 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 consumers who bid zero for both varieties of one product, bid a positive amount for the other products.[6]

4.5.1 The Effect of Diverse Information

I will discuss the results presented in table 4.8.4. Part A of table 4.8.4. shows the mean bid prices for all participants. Consumers, on average, discounted GM-labeled foods by fourteen percent. Part B shows that participants who received only positive information actually put a premium on the GM-labeled food for two of the three products. This was despite the fact that the genetic modification was only used to enhance the production process, and did not give the foods any enhanced attributes. Part C shows that when consumers received only negative information, they discount the GM-labeled foods by an average of approximately thirty-five percent. Part D shows that consumers who received both positive and negative information discount the GM-labeled foods by an average of seventeen to twenty-nine percent, depending on the food product.

Third-party information has an impact on the willingness to pay for GM-labeled foods. Part E shows that consumers who received positive and third party information discounted GM-labeled foods slightly. This is in contrast to the consumers who received only positive information who valued the GM-labeled foods more than their plain-labeled counterpart on average. Part F shows that participants who received negative and third party information still discounted the GM-labeled foods, but by a smaller amount than the participants who received only negative information. Part G shows that participants who received negative and third-party information discounted the GM-labeled foods by an average of seventeen to twenty-two percent, depending on the product. Participants who received positive, negative and third party information were more accepting of the GM-labeled foods than those who received only positive and negative information. The participants who received positive, negative and third party information discounted the GM-labeled food by an average of zero to eleven percent, depending on the product.[7]

The results are consistent with Viscusi (1997) who found that individuals placed a slightly greater weight on negative information than positive information. In the auction, participants who received only positive information did not discount the GM-labeled food, while those who received only negative information discounted the GM-labeled food by an average of 35 percent. Those who received both positive and negative information put slightly more weight on the negative information, discounting the GM-labeled foods by 20 percent. The results here are in contrast to the results in Fox *et al.* (2002) who found that negative information dominated positive information. They argued that one reason could be due to a "status quo bias," (or endowment effect) where participants 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. This auction had participants bid on items in separate rounds (trials); thus these results are not influenced by a "status quo bias."

Note that this chapter (and this dissertation) examines the impact of information on consumer behavior. Many have shown that consumers update their beliefs when they receive new information through Bayes rule (for example, see Viscusi 1997). Others would argue that consumers do not use Bayes Rule to update their beliefs. How individuals process information, and then use information in their daily lives is an important topic but one that is not covered in this dissertation.

Tables 4.8.5-4.8.7. display the censored regression results. For all three goods, models were fitted using five dummy variables to test for impacts of different information types. Dummy variables are defined for negative information; negative and positive information; positive and third party information; negative and third party information; and positive, negative, and third-party information. *Positive information is the omitted information type from the reported regression results.* Other regressors include gender, income, a dummy variable indicating if a person saw the food with GM labels in trial one, and a dummy variable indicating if the participant perceived themselves to be informed about GM foods.[8] These variables allow us to control for selective demographic characteristics and examine how prior knowledge about genetically modified foods affects willingness to pay or demand. I will only be discussing the results from the censored regressions, but the results from OLS regressions both with and without the double-zero bids are presented in tables 4.8.8-4.8.13.[9]

The intercept term is statistically insignificant for all three products. The coefficients for the dummy variables indicating that participants received only negative information are large, positive, and statistically significant. The coefficients for the dummy variable indicating that an individual who received positive and negative information is positive and these coefficients are statistically significant for some of the food products. These results show individuals who received only negative or both positive and negative information behaved differently than individuals who received only positive information when making purchasing decisions.

The coefficients for the dummy variables where an individual received positive and third party information are small, positive, and not statistically significant. Hence, third-party information does not have a large impact on the difference in bids between the plain-labeled and GM-labeled foods for participants who received only positive information.

The coefficients for the dummy variables indicating that a participant received negative and third party information are generally statistically significant. The coefficients for the dummy variables indicating that a participant received all three types of information are not statistically different from zero for any of the food products. The impact is not significantly different from the outcome when consumers received only positive information.

Few demographic variables were found to contribute significantly in explaining bid price difference for the two trials. Females discounted GM-labeled foods by less than men for all of three products in the auctions. The fact that female consumers discounted GM-labeled foods by less than men seems contrary to much of the risk perception literature that states that women are more risk averse. One explanation is that females on average have more experience shopping for food than do males. However, none of the coefficients was statistically significant from zero.

Those consumers who had higher incomes discounted all three GM-labeled food products more than those who have lower incomes. The coefficient is statistically significant for one of the three products – vegetable oil. It is not surprising that higher income consumers discounted GM-labeled foods more heavily. This is consistent with "food quality" being a luxury good.

Those consumers who considered themselves at least "somewhat informed about GM foods" (as recorded in the pre-auction survey) discounted GM-labeled foods by more than other participants did. This coefficient is statistically significant (10% level) for one of the three food products – Russet potatoes. Those who perceived themselves to be informed bid far less for the GM-labeled foods than others. This result suggests they had heard negative information on GM foods prior to the experiment. In all of the censored regression equations, I rejected the null hypothesis that the explanatory variables included in the regression had no explanatory power (or all non-intercept coefficients were jointly zero).

Table 4.8.14 shows the results of five different tests that examined restrictions across equations. An F-test is conducted to see if the coefficients for the three intercept terms were the same. Also, three separate tests are conducted to see if the three income coefficients were the same, the three coefficients on the dummy variable for gender were the same, and the three coefficients for the dummy variable indicating how informed an individual is on GM foods before the experiments. A test is also conducted that includes all of the restrictions at once. None of the restrictions can be rejected at a ten-percent level of significance. This implies that the coefficients for each of the three products are similar and consumers view genetic modification similarly across products.

4.5.2. The Value of Verifiable Information

I present the value of third-party information for each of the three cases a consumer could find themselves in: only receiving positive information, only receiving negative information, and receiving both positive and negative information. Table 4.8.15 presents the value of information results for the three food products: the marginal percentage of people who switch, the value to a person who switches, and the average value to a person in society.

When an individual received only positive information, one would expect third-party information to cause some individuals to switch to plain-labeled foods. These results show that this is not necessarily the case. Those consumers who received both positive and third party information 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 positive information. The share of consumers who switched to either of these goods is very small. The average value per person from the introduction of third-party information was approximately one-half cent per product.

While third-party information brought about virtually no change in consumption behavior for tortilla chips and potatoes, consumers who received positive and third-party information were much more likely to purchase GM-labeled vegetable oil than consumers who receive only positive information. Approximately fifteen percent of the population that received positive information switched from plain-labeled vegetable oil to GM-labeled vegetable oil after the introduction of third-party information. This is consistent with third-party information revealing that when vegetable oils are refined, there is virtually no genetically modified material left in vegetable oil even when they are made from genetically engineered soybeans. For consumers 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 twenty-one cents per switcher, and the average value per person is just over three cents per bottle. This is interesting because consumers who receive third-party information would get virtually no gain from this information except when purchasing the vegetable oil. While these are interesting results, very few participants have heard only positive information about GM foods prior to the experiment. Therefore, the other two groups - those who received only negative information and those who received both positive and negative information were probably more representative of the general population.

One expects that consumers who initially received only negative information on GM foods but later were given third-party information to be more likely to consume GM-labeled foods. The results from the experiments validate this expectation. For all three products, a significant portion of the population switched from plain-labeled to the GM-labeled food: 18.6 percent to 28.2 percent of people switch to the GM-labeled food, depending on the product. The value of the third-party information for each person who switches ranges from seventeen to twenty-five cents per item, depending on the product.

Combining information together, the average consumer gains 4.7 cents per bag of tortilla chips, 6.7 cents per bottle of vegetable oil, and 4.3 cents per bag of potatoes when they initially received only negative information and then third-party information is introduced. Participants who received positive, negative and third party information are more likely to purchase GM-labeled foods than individuals who received only positive and negative information. 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 negative information, but greater for each food than for individuals who receive only positive information.

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. The value per person who switched from the plain-labeled to GM-labeled food ranged from twenty-three to twenty-nine cents per product. This leads to an average value per person 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.

The value of verifiable information was not too sensitive to the estimated prices, as shown in tables 4.8.16. - 4.8.18. Overall, the value of verifiable information is approximately 5 cents per product when using the larger discount for GM-labeled foods. When using the smaller discount for GM-labeled foods, the value of verifiable information was approximately 3 cents per product.

Generalizing the per person value of information in an experiment to the aggregate value of the U.S. population is risky but instructive, even if only to understand the upper limit on the value that verifiable information on GM might provide. On average, the value of verifiable information is about 4 cents per product for those individuals who have heard either negative information or both positive and negative information on GM foods. Because the prices for these three food products typically range 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 vary for the amount of foods on grocers' shelves that are GM. On the lower end, some observers predict that two thirds of *all processed foods* in the U.S. contain some GM material (Davis, 2001); on the upper end, some people argue that two thirds of *all products* in a grocery store contain GM material (Friends of the Earth, 2001). I approximate the aggregate value of verifiable information using a lower estimate, assuming one third of all products on a grocer's shelf might be GM. In 1997, U.S. citizens spent $390 billion for food at home (Putnam and Allshouse, 1999). Thus, if one third of all products are GM, Americans spent roughly $130 billion on foods that could be GM. If verifiable information has a value of approximately 2 percent of the product's price, and if one could generalize these results the best estimate is that verifiable information would be worth about 2.6 billion dollars annually to U.S. consumers.

While large, the aggregate value does not seem unrealistic.[10] The value of $2.6 billion divided by the number of people in the US gives an average value of approximately $9.00 per year for every man, woman, and child. Foster and Just found a value of information of approximately $10.00 per person, per month ($120.00 per year), using the same techniques. Their study only focused on milk, while this study is examining all consumer foods that might be genetically modified.

4.6. Conclusion

While new food products developed using genetic modification remain controversial, the results showed that pro-, anti-, and verifiable biotech information have significant impacts on consumers' demand for GM-labeled foods. This experimental design revealed three key results. First, information about GM foods from interested parties impacts consumer demand. This helps explain why groups such as Greenpeace and Friends of the Earth have been disseminating massive amounts of negative information on GM foods. Although these groups are interested parties and provide biased information, their information has an impact. Likewise, it explains why biotechnology companies have invested heavily to advertise the positive aspects of biotechnology (Thrane, 2001). Although these companies are interested parties and provide biased information, their information has increased the demand for GM-foods-- even in the presence of negative information. This is important because previous literature dealing with other new food products, e.g., irradiated pork, showed that negative information tends to dominate positive information when both are presented to consumers.

Second, an independent, third party source that provides verifiable information on GM foods has a significant impact on consumers' demand for GM foods. Third-party information had its greatest impact on consumers who received negative information, prompting them to view GM foods more favorably and to increase their demand.

Finally, through a new method developed to determine the value of information, it was shown that third-party information on GM foods could have a value of $2.6 billion per year to U.S consumers. Although this number may seem large to some readers, I believe that it is a lower bound estimate because the anti-biotechnology lobby has in some cases been successful in getting such large reductions in the demand for GM products that they have been removed from the shelves of grocery stores. This type of holdup outcome would have much greater welfare costs than the marginal effects of information that I have estimated. A second reason why $2.6 billion is an underestimate of social value of verifiable information is that this information has international public good attributes (Huffman and Tegene 2002). Therefore, the total social value of verifiable information is potentially much larger than this estimate. Because of the large social value of verifiable information on GM food and the unlikelyhood that another country will provide it, i.e., free-rider problem among affected countries (Huffman and Tegene 2002), the United States should develop a new third-party institution, separate from the federal government, to oversee the provision of this information. Resources to support this activity, however, seem most likely to come from federal tax collections because of the free-rider problem within the United States.

4.7. Notes

1. Each individual consumer chooses between GM-labeled and plain-labeled foods, which are technically described as having a linear indifference curve. Assuming away the possibility that the budget constraint line lies exactly on the consumer's linear indifference curve, if the consumer purchases multiple quantities of the same product, all of the purchases will be the GM-food or all of the product will be the non-GM food.
2. Assume no non-pecuniary external effect across consumers occurs.
3. Because no bid prices are revealed until all bids are placed and participants in a trial were restricted from talking with each other, there is no contemporaneous correlation of random disturbance terms across participants in a trial.
4. The likelihood ratio takes the maximum of the likelihood function of a regression that only has an intercept term (the restricted equation) divided by the maximum of the likelihood function of the regression that includes some explanatory variables (the unrestricted equation). This is shown in the following equation:

   $$\lambda = \frac{\hat{L}_R}{\hat{L}_U}.$$

   In this equation, $\hat{L}_R$ represents the maximum of the likelihood function for the regression with only the intercept term, and $\hat{L}_U$ represents the maximum of the likelihood function for the unrestricted equation.
5. The percentage discount of foods is similar to the percentage when all bids are included.
6. Only 7 out of the 172 participants bid zero for all six products.
7. The possibility of variability due to factors that are not controlled, e.g., time of day, particular date the auction was held, was considered. By testing the difference between

sequences, I found that the interaction term for information and labeling treatments was zero for all three products. This supports the analysis of treating each individual as a separate observation.

8. Several other models were fitted which included as regressors, the participant's age, marital status, religious upbringing, and educational attainment. None of these variables, however, impacted the difference in bid prices in a statistically significant way (at the ten-percent level).

9. The results for the OLS regressions are similar, which is reassuring since the number of double zero bids per product was never more than 20%.

10. One could argue that this might underestimate value for two reasons. First, this model presumes people who did not change their consumption habits of genetic modification get no value from new information. This is a restrictive assumption, as some people may feel better about their consumption if verifiable information confirms that they were making the correct choices, relative to their preferences. Second, I am considering the aggregate value to U.S. consumers only. But this information would also be freely available to people in foreign countries who make up 19/20th of the world population, which implies more aggregate value for the GM information.

4.8. Tables

Table 4.8.1. Information and labeling given to treatments one through twelve

treatment	Positive/negative	Verifiable Information	Round with GM labels
1.	Pro-biotech	Yes	1
2.	Anti-biotech	Yes	1
3.	Pro-biotech, anti-biotech	Yes	1
4.	Pro-biotech	Yes	2
5.	Anti-biotech	Yes	2
6	Pro-biotech, anti-biotech	Yes	2
7	Pro-biotech	No	1
8	Anti-biotech	No	1
9.	Pro-biotech, anti-biotech	No	1
10.	Pro-biotech	No	2
11.	Anti-biotech	No	2
12.	Pro-biotech, anti-biotech	No	2

Table 4.8.2. The four cases of the censored regression

Case	Plain-labeled bid	GM-labeled bid	Censored Regression Difference
1.	$P^{non-labeled}$	$P^{labeled}$	$P^{non-labeled} - P^{labeled}$
2.	$P^{non-labeled}$	0	$> P^{non-labeled}$
3.	0	$P^{labeled}$	$< -P^{labeled}$ or $> \lvert -P^{labeled} \rvert$
4.	0	0	.

. represents a missing value, due to the zero bids.

Table 4.8.3. Mean bids for all participants

A. Mean bids – all participants

	n	mean bid	std. dev.	Median	Minimum	Maximum
GM OIL	172	0.91	0.84	0.75	0	3.99
OIL	172	1.05	0.85	1.00	0	3.79
GM CHIPS	172	0.93	0.86	0.70	0	3.99
CHIPS	172	1.08	0.85	0.99	0	4.99
GM POTATOES	172	0.78	0.67	0.69	0	3.00
POTATOES	172	0.91	0.67	0.80	0	3.89

B. Mean bids when participants only received positive information.

	n	mean bid	std dev	Median	Minimum	Maximum
GM OIL	30	1.35	0.87	1.50	0	2.99
OIL	30	1.33	0.90	1.50	0	3.50
GM CHIPS	30	1.31	0.72	1.13	0	2.99
CHIPS	30	1.36	0.72	1.18	0	2.99
GM POTATOES	30	1.17	0.78	1.03	0	2.50
POTATOES	30	1.13	0.75	1.10	0	2.00

C. Mean bids when participants only received negative information.

	n	mean bid	std dev	Median	Minimum	Maximum
GM OIL	29	0.71	0.81	0.46	0	3.25
OIL	29	1.09	0.73	1.00	0	2.49
GM CHIPS	29	0.81	0.94	0.50	0	3.99
CHIPS	29	1.25	1.02	1.00	0	4.99
GM POTATOES	29	0.61	0.68	0.50	0.05	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	std dev	Median	Minimum	Maximum
GM OIL	28	0.59	0.56	0.50	0	1.79
OIL	28	0.77	0.74	0.50	0	3.00
GM CHIPS	28	0.55	0.72	0.25	0	2.25
CHIPS	28	0.67	0.78	0.30	0	2.75
GM POTATOES	28	0.46	0.40	0.50	0	1.50
POTATOES	28	0.64	0.45	0.50	0	1.60

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

	n	mean bid	std dev	Median	Minimum	Maximum
GM OIL	28	1.04	0.67	1.00	0	2.39
OIL	28	1.06	0.62	1.00	0	2.39
GM CHIPS	28	1.11	0.82	1.03	0	2.79
CHIPS	28	1.19	0.81	1.00	0	2.89
GM POTATOES	28	0.86	0.49	0.99	0	1.85
POTATOES	28	0.87	0.45	0.99	0	1.90

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

	n	mean bid	std dev	Median	Minimum	Maximum
GM OIL	29	0.97	1.08	0.50	0	3.99
OIL	29	1.16	1.09	0.99	0	3.79
GM CHIPS	29	0.96	0.97	0.69	0	3.50
CHIPS	29	1.19	0.86	0.99	0	3.00
GM POTATOES	29	0.83	0.78	0.75	0	3.00
POTATOES	29	1.06	0.71	0.89	0	3.00

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

	n	mean bid	std dev	Median	Minimum	Maximum
GM OIL	28	0.77	0.79	0.68	0	2.75
OIL	28	0.87	0.85	0.89	0	3.29
GM CHIPS	28	0.78	0.82	0.55	0	3.25
CHIPS	28	0.78	0.70	0.60	0	2.89
GM POTATOES	28	0.70	0.64	0.79	0	1.99
POTATOES	28	0.72	0.59	0.77	0	2.00

Table 4.8.4. Mean bids for people, excludes double-zero bids

A. Mean bids – all participants

	n	mean bid	std. dev.	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 only received positive information.

	n	mean bid	std dev	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 only received negative information.

	n	mean bid	std dev	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	std dev	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 both positive and third-party information.

	n	mean bid	std dev	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 both negative and third-party information.

	n	mean bid	std dev	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 third party information.

	n	mean bid	std dev	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 4.8.5. Censored Regression Estimates explaining difference in bid prices between GM-labeled and plain-labeled tortilla chips
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Pro	0.060	0.093	0.106	0.008	0.039	-0.034
	(0.099)	(0.110)	(0.119)	(0.137)	(0.119)	(0.151)
Anti	0.481 **	0.473 **	0.474 **	0.481 **	0.489 **	0.494 **
	(0.145)	(0.145)	(0.145)	(0.144)	(0.145)	(0.144)
Pro and Anti	0.132	0.124	0.128	0.138	0.136	0.147
	(0.152)	(0.153)	(0.153)	(0.152)	(0.152)	(0.153)
Pro and third-party	0.035	0.031	0.035	0.003	0.023	0.001
	(0.147)	(0.147)	(0.147)	(0.148)	(0.146)	(0.148)
Anti and third-party	0.245 *	0.241	0.246 **	0.244 *	0.241	0.256 *
	(0.148)	(0.148)	(0.149)	(0.147)	(0.147)	(0.148)
All information	-0.027	-0.023	-0.019	0.003	-0.028	-0.009
	(0.151)	(0.151)	(0.151)	(0.151)	(0.151)	(0.151)
Labels-Round 1		-0.063	-0.063	-0.064	-0.045	-0.050
		(0.089)	(0.089)	(0.089)	(0.090)	(0.090)
Gender			-0.025			-0.011
			(0.091)			(0.091)
Income				0.0017		0.0015
				(0.0014)		(0.0014)
Informed					0.104	0.087
					(0.092)	(0.093)
Likelihood ratio test	15.92 **	16.28 **	16.49 **	17.93 **	17.70 **	18.83 **

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.6. Censored Regression Estimates explaining difference in bid prices between GM-labeled and plain-labeled vegetable oil.
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.032	0.053	0.117	-0.128	-0.015	-0.104
	(0.126)	(0.142)	(0.150)	(0.169)	(0.152)	(0.180)
Anti	0.530 **	0.496 **	0.504 **	0.505 **	0.516 **	0.529 **
	(0.180)	(0.181)	(0.180)	(0.179)	(0.181)	(0.178)
Pro and Anti	0.259	0.231	0.262	0.255	0.250	0.295
	(0.183)	(0.183)	(0.183)	(0.181)	(0.182)	(0.181)
Pro and third-party	0.061	0.046	0.079	-0.012	0.032	0.014
	(0.179)	(0.178)	(0.179)	(0.178)	(0.177)	(0.179)
Anti and third-party	0.335 *	0.301	0.338 *	0.288	0.312 *	0.333 *
	(0.190)	(0.191)	(0.192)	(0.188)	(0.190)	(0.189)
All information	0.186	0.181	0.204	0.208	0.170	0.218
	(0.185)	(0.184)	(0.184)	(0.182)	(0.184)	(0.182)
Labels-Round 1		-0.139	-0.136	-0.149	-0.115	-0.127
		(0.109)	(0.108)	(0.107)	(0.110)	(0.108)
Gender			-0.140			-0.131
			(0.111)			(0.109)
Income				0.0032 *		0.0029 *
				(0.0017)		(0.0017)
Informed					0.142	0.112
					(0.113)	(0.112)
Likelihood ratio test	10.90 *	12.52 *	14.11 **	16.21 **	14.09 **	18.63 **

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.7. Censored Regression Estimates explaining difference in bid prices between GM-labeled and plain-labeled potatoes.
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.039	0.064	0.076	-0.019	-0.029	-0.069
	(0.088)	(0.096)	(0.103)	(0.117)	(0.101)	(0.124)
Anti	0.504 **	0.470 **	0.472 **	0.478 **	0.501 **	0.507 **
	(0.125)	(0.122)	(0.122)	(0.122)	(0.120)	(0.120)
Pro and Anti	0.262 **	0.233 *	0.239 *	0.248 **	0.258 **	0.271 **
	(0.126)	(0.124)	(0.125)	(0.124)	(0.122)	(0.123)
Pro and third-party	0.057	0.041	0.046	0.018	0.026	0.015
	(0.125)	(0.123)	(0.123)	(0.124)	(0.120)	(0.122)
Anti and third-party	0.339 **	0.323 **	0.329 **	0.322 **	0.332 **	0.337 **
	(0.125)	(0.123)	(0.124)	(0.122)	(0.120)	(0.122)
All information	0.088	0.095	0.099	0.110	0.078	0.092
	(0.128)	(0.126)	(0.126)	(0.126)	(0.124)	(0.124)
Labels-Round 1		-0.174 **	-0.174 **	-0.177 **	-0.146 **	-0.150**
		(0.073)	(0.073)	(0.072)	(0.072)	(0.072)
Gender			-0.026			-0.022
			(0.075)			(0.074)
Income				0.0014		0.0009
				(0.0014)		(0.0011)
Informed					0.190 **	0.179 **
					(0.074)	(0.075)
Likelihood ratio test	22.54 **	28.17 **	28.29 **	29.69 **	34.56 **	35.36 **

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.8. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled tortilla chips
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.052	0.101	0.116	0.021	0.049	0.002
	(0.087)	(0.095)	(0.102)	(0.116)	(0.103)	(0.127)
Anti	0.382 **	0.374 **	0.376 **	0.381 **	0.395 **	0.400 **
	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)	(0.125)
Pro and Anti	0.056	0.047	0.054	0.062	0.063	0.080
	(0.125)	(0.125)	(0.126)	(0.125)	(0.125)	(0.127)
Pro and third-party	0.027	0.027	0.032	0.006	0.020	0.009
	(0.125)	(0.125)	(0.126)	(0.126)	(0.125)	(0.125)
Anti and third-party	0.176	0.178	0.185	0.180	0.183	0.190
	(0.124)	(0.124)	(0.125)	(0.123)	(0.123)	(0.125)
All information	-0.048	-0.045	-0.042	-0.030	-0.048	-0.034
	(0.125)	(0.125)	(0.125)	(0.125)	(0.124)	(0.126)
Labels-Round 1		-0.091	-0.090	-0.093	-0.075	-0.078
		(0.073)	(0.073)	(0.073)	(0.074)	(0.074)
Gender			-0.032			-0.026
			(0.076)			(0.076)
Income				0.0014		0.0011
				(0.0012)		(0.0011)
Informed					0.010	0.089
					(0.077)	(0.078)
R^2	.087	.096	.097	.104	.105	.111

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.9. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled vegetable oil
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.022	0.062	0.114	-0.101	0.007	-0.080
	(0.102)	(0.111)	(0.118)	(0.134)	(0.120)	(0.147)
Anti	0.441 **	0.397 **	0.403 **	0.411 **	0.419 **	0.432 **
	(0.145)	(0.144)	(0.144)	(0.143)	(0.145)	(0.144)
Pro and Anti	0.207	0.190	0.214	0.222	0.208	0.252 *
	(0.146)	(0.146)	(0.147)	(0.145)	(0.146)	(0.146)
Pro and Third-party	0.041	0.041	0.061	-0.000	0.034	0.016
	(0.146)	(0.145)	(0.146)	(0.145)	(0.145)	(0.146)
Anti and Third-party	0.214	0.217	0.241 *	0.222	0.222	0.247 *
	(0.145)	(0.144)	(0.145)	(0.143)	(0.144)	(0.144)
All information	0.118	0.124	0.132	0.155	0.121	0.155
	(0.146)	(0.145)	(0.145)	(0.145)	(0.145)	(0.145)
Labels-Round 1		-0.158 **	-0.154 *	-0.162 *	-0.141	-0.146 *
		(0.085)	(0.085)	(0.084)	(0.086)	(0.085)
Gender			-0.108			-0.095
			(0.088)			(0.088)
Income				0.0028 **		0.0025 *
				(0.0013)		(0.0014)
Informed					0.106	0.082
					(0.089)	(0.090)
R^2	.058	.077	.086	.101	.085	.112

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.10. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled potatoes
(n=172, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.037	0.054	0.063	-0.024	-0.025	-0.072
	(0.073)	(0.079)	(0.085)	(0.096)	(0.084)	(0.436)
Anti	0.416 **	0.401 **	0.402 **	0.408 **	0.433 **	0.436 **
	(0.105)	(0.102)	(0.103)	(0.102)	(0.102)	(0.102)
Pro and Anti	0.224 **	0.206 **	0.210 **	0.221 **	0.231 **	0.244 **
	(0.105)	(0.103)	(0.105)	(0.104)	(0.102)	(0.104)
Pro and third-party	0.047	0.047	0.051	0.027	0.037	0.025
	(0.105)	(0.103)	(0.104)	(0.104)	(0.102)	(0.104)
Anti and third-party	0.270 **	0.273 **	0.277 **	0.276 **	0.281 **	0.285 **
	(0.105)	(0.102)	(0.104)	(0.102)	(0.101)	(0.102)
All information	0.058	0.065	0.066	0.080	0.059	0.072
	(0.105)	(0.103)	(0.104)	(0.104)	(0.102)	(0.103)
Labels-Round 1		-0.17 **	-0.17 **	-0.17 **	-0.14 **	-0.15 **
		(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
Gender			-0.018			-0.014
			(0.063)			(0.062)
Income				0.0013		0.0010
				(0.0010)		(0.0010)
Informed					0.154 **	0.144 **
					(0.063)	(0.064)
R^2	.123	.164	.165	.175	.194	.200

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.11. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled tortilla chips – double zero bids deleted
(n=155, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.052	0.096	0.113	0.015	0.036	-0.007
	(0.091)	(0.101)	(0.110)	(0.126)	(0.110)	(0.138)
Anti	0.382 **	0.375 **	0.377 **	0.382 **	0.399 **	0.403 **
	(0.129)	(0.130)	(0.131)	(0.130)	(0.131)	(0.097)
Pro and Anti	0.080	0.068	0.073	0.080	0.086	0.097
	(0.138)	(0.139)	(0.139)	(0.139)	(0.139)	(0.140)
Pro and Third-party	0.036	0.032	0.036	0.009	0.023	0.010
	(0.135)	(0.135)	(0.136)	(0.137)	(0.135)	(0.138)
Anti and Third-party	0.212	0.208	0.215	0.210	0.217	0.224
	(0.135)	(0.135)	(0.137)	(0.135)	(0.135)	(0.137)
All information	-0.047	-0.041	-0.037	-0.027	-0.043	-0.028
	(0.138)	(0.139)	(0.139)	(0.139)	(0.138)	(0.140)
Labels-Round 1		-0.083	-0.083	-0.084	-0.063	-0.067
		(0.081)	(0.081)	(0.081)	(0.082)	(0.082)
Gender			-0.031			-0.027
			(0.083)			(0.083)
Income				0.0014		0.0011
				(0.0013)		(0.0013)
Informed					0.115	0.102
					(0.085)	(0.087)
R^2	.086	.092	.093	.010	.103	.108

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.12. OLS Estimates explaining difference in bid prices between GM-labeled and non- GM labeled vegetable oil – double zeroes deleted
(n=146, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.026	0.059	0.112	-0.114	-0.003	-0.098
	(0.118)	(0.133)	(0.140)	(0.157)	(0.142)	(0.170)
Anti	0.459 **	0.427 **	0.437 **	0.437 **	0.447 **	0.461 **
	(0.166)	(0.167)	(0.167)	(0.166)	(0.168)	(0.167)
Pro and Anti	0.241	0.214	0.239	0.236	0.230	0.269
	(0.170)	(0.170)	(0.172)	(0.169)	(0.171)	(0.171)
Pro and third-party	0.046	0.030	0.058	-0.025	0.018	-0.004
	(0.166)	(0.166)	(0.168)	(0.167)	(0.166)	(0.169)
Anti and third-party	0.290	0.258	0.288	0.245	0.269	0.283
	(0.176)	(0.177)	(0.179)	(0.175)	(0.177)	(0.178)
All information	0.142	0.136	0.153	0.164	0.125	0.169
	(0.172)	(0.171)	(0.172)	(0.170)	(0.171)	(0.171)
Labels-Round 1		-0.138	-0.135 **	-0.149	-0.116	-0.128
		(0.101)	(0.100)	(0.010)	(0.102)	(0.102)
Gender			-0.119			-0.109
			(0.103)			(0.102)
Income				0.0031 **		0.0028 *
				(0.0016)		(0.0016)
Informed					0.127	0.097
					(0.105)	(0.106)
R^2	.068	.081	.089	.107	.090	.120

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.13. OLS Estimates explaining difference in bid prices between GM-labeled and non-GM labeled potatoes – double zeroes excluded
(n=159, standard errors are in parentheses)

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

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.041	0.065	0.077	-0.013	-0.017	-0.058
	(0.080)	(0.087)	(0.094)	(0.106)	(0.093)	(0.114)
Anti	0.420 **	0.394 **	0.396 **	0.402 **	0.425 **	0.430 **
	(0.111)	(0.109)	(0.110)	(0.109)	(0.108)	(0.109)
Pro and Anti	0.243 **	0.212 *	0.218 *	0.227 **	0.233 **	0.247 **
	(0.114)	(0.113)	(0.114)	(0.113)	(0.111)	(0.113)
Pro and third-party	0.052	0.035	0.040	0.014	0.023	0.012
	(0.114)	(0.112)	(0.113)	(0.113)	(0.111)	(0.113)
Anti and third-party	0.291 **	0.278 **	0.285 **	0.277 **	0.286 **	0.291 **
	(0.113)	(0.111)	(0.113)	(0.111)	(0.109)	(0.111)
All information	0.066	0.072	0.076	0.087	0.056	0.071
	(0.117)	(0.114)	(0.115)	(0.115)	(0.113)	(0.114)
Labels-Round 1		-0.179 **	-0.179 **	-0.183 **	-0.153 **	-0.157 **
		(0.065)	(0.066)	(0.065)	(0.065)	(0.066)
Gender			-0.026			-0.022
			(0.068)			(0.067)
Income				0.0013		0.0010
				(0.0010)		(0.0010)
Informed					0.164 **	0.154 **
					(0.068)	(0.069)
R^2	.123	.164	.165	.173	.195	.201

** indicates that a variable is significant at 5%
* indicates that a variable is significant at 10%

Table 4.8.14. Seemingly Unrelated Regression F-test results testing whether coefficients are the same across equations.
(n = 172)

Coefficient	Numerator DF	Denominator DF	F Value
Intercept	2	486	0.35
Income	2	486	1.17
Gender	2	486	0.82
Informed	2	486	0.67
All Four	8	486	0.73

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

Table 4.8.15. Value of third-party, independent information on genetically modified foods.

A. Value to participants who receive positive information*

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

B. Value to participants who receive negative information**

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

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

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

Table 4.8.16. Value of independent information – test of higher and lower prices for Tortilla chips.

A. Value to people who receive positive information*

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	1.3%	$0.086/bag	$0.001/bag
Smaller discount for GM	4.6%	$0.137/bag	$0.006/bag

B. Value to people who receive negative information**

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	12.3%	$0.321/bag	$0.040/bag
Smaller discount for GM	18.6%	$0.165/bag	$0.031/bag

C. Value to people who receive both positive and negative information***

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	13.0%	$0.298/bag	$0.039/bag
Smaller discount for GM	4.3%	$0.172/bag	$0.007/bag

Table 4.8.17. Value of independent information – test of higher and lower prices for vegetable OiL

A. Value to people who receive positive information*

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	15.4%	$0.277/bag	$0.043/bag
Smaller discount for GM	15.4%	$0.162/bottle	$0.012/bottle

B. Value to people who receive negative information**

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	24.4%	$0.301/bag	$0.074/bag
Smaller discount for GM	17.8%	$0.197/bottle	$0.035/bottle

C. Value to people who receive both positive and negative information***

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	19.9%	$0.327/bag	$0.065/bag
Smaller discount for GM	6.9%	$0.216/bottle	$0.015/bottle

Table 4.8.18. Value of independent information – test of higher and lower prices for potatoes.

A. Value to people who receive positive information*

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	7.2%	$0.225/bag	$0.017/bag
Smaller discount for GM	10.7%	$0.112/bag	$0.012/bag

B. Value to people who receive negative information**

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	18.2%	$0.244/bag	$0.044/bag
Smaller discount for GM	31.9%	$0.101/bag	$0.032/bag

C. Value to people who receive both positive and negative information***

	Percent who switch to GM	Value per switcher	Value per person
Larger discount for GM	17.9%	$0.348/bag	$0.063/bag
Smaller discount for GM	24.6%	$0.298/bag	$0.061/bag

CHAPTER 5: ARE U.S. CONSUMERS TOLERANT OF GM FOODS?

5.1. Introduction

Consumers are reluctant to accept new food products they perceive as risky, which includes those products that involve some form of genetic modification (GM). GM foods remain controversial as some groups want GM foods banned (Greenpeace, 2001; Friends of the Earth, 2001); while others believe GM foods can help feed the world (Council for Biotechnology Education, 2001; Gates, 2001). But since a complete GM ban has thus far been politically infeasible, environmental and consumer groups have successfully lobbied for labeling of genetically modified foods in dozens of countries, including Australia, China, Japan, Korea, and member countries of the European Union.

A key issue in the labeling debate is *tolerance*, the acceptable percentage of GM-impurity. Counties have accepted *positive tolerance standards* because a zero tolerance standard is prohibitively costly, and a perfect segregation system can never be guaranteed (Shoemaker *et al.* 2001; Golan *et al.* 2002).[1]

The United States currently does not require labeling of GM foods and does not have a positive tolerance standard. The question I address herein is how US consumers react to a positive tolerance standard for GM ingredients. Using the tools of statistical experimental design, an experimental auction is designed using three GM-products to test two hypotheses: (a) the mean consumer bids for the GM-free product equals the mean bid for the GM-threshold products, set either at 1% or 5%; and (b) the mean bids for the 1%-GM-product equals the mean bids for the 5%-GM-product.[2] The results suggest that one can reject the first hypothesis (a) but not the second one (b). My results suggest that consumers reduce their demand by about 10% relative to the certain baseline, irrespective of whether the GM-threshold is set at 1 or 5 %. This then suggests a policy direction—if a tolerance level is to be used in the US, a 5%-GM threshold is likely to be more efficient than a 1%-GM threshold because the 5% level is less costly to meet and demand reduction is independent of the tolerance level.

5.2. Experimental Design

One previous study has examined the willingness to pay for GM foods with different tolerance thresholds. Noussair, Robin, and Ruffieux (2002) conducted experimental auctions using consumers in France and found that consumers valued biscuits with a 1% and a 0.1% tolerance threshold differently (they also were bidding on non-GM and GM biscuits – 4 biscuits total). Their results also found that consumers did not appear to think that 0.1% GM or 1% GM content was as good as a GM free product. One problem with their experimental design is that they were selling consumers four different biscuits that were, in their words, close substitutes. Selling four close substitutes leads to demand reduction by consumers perceiving the potential of obtaining multiple units (List and Lucking-Reiley, 2000) which could potentially cause a confounding problem where one does not know if bid reduction is due to genetic modification or demand reduction.

Consumers bid on three food products that differed by the tolerance labels on the foods. All consumers bid on foods with a non-GM label certified to be completely free of genetically engineered material in one trial, and in the other trial consumers bid on foods with a non-GM-label indicating that a certain percentage genetically modified material, either 1% or 5%, was tolerated. These specific tolerance threshold levels are of particular importance as they match up with the current European and Japanese standards and would be the likely tolerance choices of the United States should a standard be enacted.

The experimental design has two treatments. The treatments are randomly assigned to three experimental units. The GM-food products were introduced for the next two rounds of bidding. The two bidding rounds were differentiated by the food label—either a non-GM label certified to be GM-free or a non-GM label that indicated the tolerance of GM material (see Figure 5.6.1.). In one round (which could be round 1 or 2 depending on experimental unit), participants bid on the three food products each with the certified non-GM food label. In the other round, participants bid on the same three food products with the 1% or 5%-GM food tolerance levels.

5.3. Results

Two main results emerge from this experiment. First, consumers reduced their demand for the products having GM-tolerance levels relative to the GM-free benchmark. Table 5.6.2. shows the mean and median bids by food type. Twenty-eight participants bid in the 5% tolerance treatments; sixteen participants bid in the 1% tolerance treatment. Overall, the mean consumer bid less on the food product with the GM-tolerance labels relative to the GM-free products. Consumers bid 7 cents less on the GM-tolerant oil, 14 cents less on the tortilla chips, and 9 cents less on the potatoes.[3] Consumers discounted the foods with the GM-tolerance by an average of 7 to 13 percent. This is a significant demand reduction for 1%- and 5%-GM products. In comparison, the results in chapter 4 show that consumers discounted GM-labeled food by an average of 14 percent that had a GM-label without a tolerance level. Pooling all observations,[4] table 5.6.3. shows one can reject the null hypothesis that bidding behavior over GM-tolerance labels is identical to that for the GM-free benchmark for the tortilla chips and the potatoes, and not for the vegetable oil.[5] Consider the 1% and 5%-GM treatment separately, one cannot reject the null hypothesis that bids different for 5 of 6 products.[6] The significant discount for the GM-tolerant food is consistent with Viscusi *et al.* (1987) findings. In that study, consumers initially purchased a given product when told that it injured 15 out of 10,000 who used the product, but over two-thirds of the consumers were unwilling to purchase the same product when the chance of injury increased to 16 out of 10,000. This indicates a strong reference risk effect, which could help explain why consumers placed such a large discount on the GM-tolerant food.

Second, consumers discounted the 5%-GM products by the same amount as they discounted the 1%-GM food. Table 5.6.4. shows that at the 5 percent significance level one cannot reject the null hypothesis that demand reduction is independent of the GM tolerance level. This supports the view that if a GM-tolerance policy is enacted in the US, consumers might not place a greater value on a 1%-GM relative to a 5%-GM tolerance. Because of the higher segregation and handling cost of a 1% tolerance threshold compared to a threshold of 5%, society may be better off implementing a higher tolerance threshold. Consumers value GM-free products, but if GM contamination does exist, the marginal willingness to pay to avoid more contamination, from 1% to 5%, are small.

This result is consistent with the theory of surrogate bidding (for a good review see Shogren, forthcoming). This is where consumers reveal the same willingness to pay to avoid varying levels of contamination. Surrogate bidding has been shown to exist in other food markets. Hayes *et al.* (1995) used experimental auctions to show that consumer bids to reduce risk by eliminating a cluster of foodborne pathogens were indistinguishable from bids to reduce specific pathogens. Using a survey, Hammitt and Graham (1999) found the same result, that consumers were insensitive to probabilities.

5.4. Conclusion

In the experimental treatments, consumers reduce their demand by an average of 7%-13% for each food product with a 1% and 5% tolerance for GM-material relative to GM-free food. I found no evidence, however, that consumers value a food with a 1%-GM tolerance greater than a food with a 5%-GM tolerance. These results support the notion that if the United States decides to allow a tolerance of GM material in food products, the 5% tolerance would be best socially. This occurs because consumers do not value a 1% tolerance more, and it is less expensive for food producers to comply with a higher tolerance level.

Consumers were willing to pay a large premium to avoid contamination in an uncontaminated product but were not willing to pay to reduce contamination in a product that already had a small amount of contamination. An interesting extension of this work would be to see if this result generalizes to other products by examining the marginal willingness to avoid small amounts of contamination in other products. If this result generalizes to a broad range of products this would have a significant influence on many aspects of environmental policy. For instance, it would help explain the fierce opposition to drilling in the Alaska Wildlife area. It would also indicate that if proponents of drilling were initially successful in getting a small amount of oil drilling, it would be easier to convince the public to further increase drilling over time.

Future research remains to be done. More information is needed on the cost of producing non-GM crops at different tolerance levels. Also, this project could be replicated internationally to provide evidence on the efficiency of GM-tolerance policies in foreign countries, e.g. Europe and Japan. Trading across countries would be easier if all countries maintained the same tolerance. If research could show that consumers have similar values for tolerance levels across countries, this research could be useful for better understanding whether uniform GM-tolerance standards across countries makes sense.

5.5. Notes

1. While no literature currently exists on the costs of a low tolerance for GM foods, Klein and Brester (1997) estimated the cost for a zero-tolerance directive for beef packing companies. They found that zero-tolerance beef directive might cost society over $3 billion dollars annually.
2. Note some argue it is impossible to claim that a product is 100% GM-free, saying that more accurate testing equipment would detect GM material on almost any food that was made, even non-GM foods. This auction sold foods that were tested and found to not contain GM material – thus the food product in the auctions were certified to have no GM content.
3. Table 2 also shows that consumers bidding on 5%-GM tolerance discounted the oil by 6 cents, the tortilla chips by 9 cents, and the potatoes by 7 cents. Consumers bidding on 1%-GM tolerance discounted the vegetable oil by 9 cent, the tortilla chips by 25 cents, and the potatoes by 12 cents. T-tests could not reject the null hypothesis that the bids for the non-GM foods differed across treatments – this is a good consistency check and does not reject the hypothesis that the bidding behavior was reasonable. Between 32%-41% of consumers bid less for the GM-tolerance food - the percentage varies by food product.
4. Because the participants in the three separate treatments were independent of each other, one can pool the data to test whether consumers discounted the GM-tolerant food.
5. I also ran Wilcoxon Signed-Rank tests and the results were similar – the bids on the vegetable oil were not statistically different at any conventional significance level, the bids for the tortilla chips were significantly different at the five percent level, and the bids for the potatoes were significantly different at the fifteen percent level.

6. I also ran several regressions to test if demographic characteristics, like consumer's gender, household income, race, or age could explain the difference in bids for the certified non-GM labeled food and the GM-tolerant food. No demographic characteristic has a statistically significant impact on the difference in bids.

5.6. Figures and Tables

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* This product is certified to BE FREE OF ANY
GM-material.

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* Subject to a 1% tolerance, that is up to
1% of any ingredient could be genetically
engineered.

Vegetable Oil

Net weight 32 fl. oz.

This product is made without
genetic engineering *

* Subject to a 5% tolerance, that is up to
5% of any ingredient could be genetically
engineered.

Figure 5.6.1. The three types of labels used for the tortilla chips

Table 5.6.2. Mean Bids

A. Mean bids – all participants

	n	mean bid	std. dev.	Median	Minimum	Maximum
OIL	44	0.99	0.92	0.75	0	3.50
OIL – TOL	44	0.92	0.76	0.75	0	2.50
CHIPS	44	1.13	0.99	0.82	0	5.00
CHIPS - TOL	44	0.99	0.80	0.75	0	3.49
POTATOES	44	0.95	0.71	0.89	0	3.00
POTATOES - TOL	44	0.86	0.67	0.84	0	3.00

B. Mean bids when participants bid on food with a 5% tolerance level.

	n	mean bid	std. dev.	Median	Minimum	Maximum
OIL	28	0.94	0.81	0.75	0	3.00
OIL – TOL	28	0.88	0.71	0.68	0	2.50
CHIPS	28	0.99	0.77	0.75	0	3.00
CHIPS - TOL	28	0.90	0.69	0.73	0	2.00
POTATOES	28	0.83	0.64	0.75	0	3.00
POTATOES - TOL	28	0.76	0.65	0.75	0	3.00

C. Mean bids when participants bid on food with a 1% tolerance level.

	n	mean bid	std. dev.	Median	Minimum	Maximum
OIL	16	1.06	1.12	0.75	0	3.50
OIL – TOL	16	0.97	0.85	0.88	0	2.39
CHIPS	16	1.38	1.28	1.13	0	5.00
CHIPS - TOL	16	1.13	0.98	0.77	0	3.49
POTATOES	16	1.15	0.81	1.00	0	3.00
POTATOES - TOL	16	1.03	0.69	0.99	0	2.00

Table 5.6.3. T TEST – Non-GM foods with and without GM tolerance levels

A. T-Test on whether difference in bids are different – all observations (N=44).

	Bid Non-GM	Bid w/ tolerance	Difference	T-Test Statistic
Oil	0.99	0.92	0.07	1.24
Chips	1.13	0.99	0.14	2.44 **
Potatoes	0.95	0.86	0.09	1.70 *

B. T-Test on whether difference in bids are different – 5% tolerance (N=28).

	Bid Non-GM	Bid w/ tolerance	Difference	T-Test Statistic
Oil	0.94	0.88	0.06	1.05
Chips	0.99	0.90	0.09	1.51
Potatoes	0.83	0.76	0.07	1.33

C. T-Test on whether difference in bids are different – 1% tolerance (N=16).

	Bid Non-GM	Bid w/ tolerance	Difference	T-Test Statistic
Oil	1.06	0.97	0.09	0.71
Chips	1.38	1.13	0.25	1.93 *
Potatoes	1.15	1.03	0.12	1.08

Table 5.6.4. T-Test on whether consumers value foods with a 1% tolerance differently than foods with a 5% tolerance.
N=44

	Non-GM Premium – 5%	Non-GM Premium – 1%	Difference	T-Test Statistic
Oil	0.06	0.09	-0.03	-0.20
Chips	0.09	0.25	-0.16	-1.33
Potatoes	0.07	0.12	-0.05	-0.47

CHAPTER 6: NEGATIVE INFORMATION AND RESISTANCE TO ADOPTION OF NEW TECHNOLOGIES

6.1. Introduction

The standard of living in developed countries grew considerably in the twentieth century. One reason has been the steady introduction of new goods that result from research and development. The standard of living for the U.S. population has increased during the past century due to the invention and adoption of many new goods (and services). Because of new technology, goods have improved in quality and new goods have been introduced, both have increased welfare. New goods and quality improvements have caused a major revision of the Consumer Price Index (CPI). The CPI was biased upwards by approximately 0.6 percent per year (Boskin *et al.* 1998), and estimates of increases in the prices of individuals goods have also been shown to be biased upwards by ignoring the effect of new products (Hausman, 1996). This bias estimate could be thought of as a lower bound on how much better off consumers are due to the introduction of new goods – which means that new goods and services alone led to an almost doubling of welfare in the twentieth century.

Not all new goods, however, have resulted in consumers being better off with the consumption of the new good relative to the consumption of the pre-existing good, e.g. the Ford Edsile and Chevy Corvaire, were major flops as consumer goods. Also, there has been major resistance by consumers to the use of electricity generated by nuclear power and to eating irradiated meat (Fox et al). The two latter examples are somewhat surprising because it is generally cheaper to produce electricity by nuclear power than by coal or oil fired generating plants. Irradiated pork is free form hazardous to human health causing bacteria. The good attributes not withstanding, these latter goods have not been able to overcome the bad negative image of nuclear energy created by environmental groups like Greenpeace and Friends of the Earth. In the United States, these groups helped increase the public's risk perception of nuclear power, forcing stringent safety standards to be enacted that contributed to a quadrupling of plant costs in just more than a decade (Ruttan, 2001). No new nuclear power plants have been ordered in the United States since 1978.

Because the consequences for not adopting newer, better technologies can be great, future generations of Europeans may be worse off by the actions of the current generation. This chapter examines the demographic and market characteristics that would push a consumer to resist genetically modified foods, with special attention given to the role of negative information and verifiable information. This chapter has two key results. First, negative information on genetically modified foods pushes some consumers out of the market for GM-labeled foods, where they do not have demand at a price of zero. Second, a third party source providing verifiable information dampens the effectiveness of negative information and causes consumers to be more likely to be in the market for GM-labeled foods. This question has tremendous importance, because if negative information can stymie socially useful technology adoption, groups that do not want new products introduced would have an incentive to disseminate negative information on a broad range of new goods, not just genetic modified foods. Fox *et al.* (2001) showed that negative information from environmental groups can significantly decrease the demand for a new product – if the environmental groups can get consumers to perceive the new product as risky. They discussed that allowing environmental groups to speak freely about these products may lower overall welfare, if newer, more efficient products and technologies are not developed due to negative information.

6.2. Background on Technology Adoption

New planting technologies are adopted first in areas where they are most profitable (Griliches, 1957 and 1960). For hybrid corn, the technology was first adopted in the high quality planting areas that allowed the greatest increase in yield. When one thinks about a new technology that is controversial like genetic modification, it seems logical that most of the early adoption takes place in areas where the good is least controversial (expected demand is largest). United States consumers worry about genetic modification far less than consumers in many other countries do, which explains why much of the initial planting of GM crops took place in the United States.

Adoption of new technology does not always occur because of price reasons. Green *et al.* (1996) showed that for irrigation technology, physical and agronomic characteristics are more important factors for adoption than price. One of the main benefits of genetic modification is that it makes farming easier – as pest resistant crops require fewer hassles. However, if demand were lower for the product that uses the newer technology, adoption of the new technology would not necessarily make farming easier and this could lead to lower adoption rates.

Uncertainty is likely to decrease the probability of adopting new investments, if the decision is irreversible (Dixit and Pinkyck, 1994; Purvis *et al.* 1995). The decision to plant GM crops is at least partially irreversible, as once a field is planted with genetically modified crops, traces of genetic modification are likely to persist for several years into the future, even if the farmer returns to planting conventional (non-GM) seeds. If a group can increase the uncertainty about the success or the risks of a new technology, adoption of that technology may be slowed, or possibly reversed as with nuclear power in the U.S. This reasoning would provide incentives for environmental groups to oppose genetic modification by disseminating negative - possibly erroneous - information, even if their information is highly biased.

Klotz *et al.* (1995) examined the role of information in technology adoption regarding rbST. First, they showed that immediate adoption of the new technology might not be optimal, due to the option value of waiting. In general, adoption will occur when the expected returns from adoption equals the expected value of waiting and having the option to adopt in the next period. In addition, they found as farmers become more informed about rbST, they became more negative about it. They concluded that farmers might have been worried about an adverse consumer reaction.

A certain level of information is thought to be required before a farmer is ready to adopt a new technology (Feder and Slade, 1984). Thus, in general, larger farms, those with access to better information, or those with higher human capital are more likely to adopt a new technology first. When negative information is available on a new technology, however, like the information made available by environmental groups, it is not known how human capital will affect the adoption decision.

Negative information provided by environmental groups is likely to contribute to farmers and consumers resisting GM technology. This could happen for many reasons and one reason is that when consumers are given negative information, many will not buy GM-labeled foods at any price. This could help explain why in Europe, where environmental groups are more vocal, adoption of GM technology is much slower than in the United States.

6.3. Empirical Model

This chapter follows the state-dependent utility specification in chapter 4, where a consumer compares his/her *perceived* expected utility (henceforth, utility) from consuming GM-labeled foods and plain-labeled foods. Equation (1) shows the state-dependent utility function for a consumer who purchases GM-labeled food, called *labeled*. Equation (2) is his/her utility for a purchase of plain-labeled foods, called *non-labeled*.

(1) $$EU^j_{labeled}(w) = p^j_{labeled}(I)U^j(w) + \left(1 - p^j_{labeled}(I)\right)V^j(w)$$

(2) $$EU^j_{non-labeled}(w-m) = p^j_{non-labeled}U^j(w-m) + \left(1 - p^j_{non-labeled}\right)V^j(w-m).$$

As in chapter 4, consumer j's income is w, and m is the monetary premium he/she pays for the non-labeled food (the premium can be positive, negative, or zero). Consumer j obtains utility U^j if the good state occurs, and V^j if the bad state occurs, where $U^j > V^j > 0$.

Assume the bad state occurs when either consumer j becomes ill or a bad environmental outcome occurs (e.g., genetic crossbreeding). Let $p^j_{labeled}(I)$ and $p^j_{non-labeled}$ be consumer j's perceived probability that the GM-labeled food and plain-labeled food will yield the good state. Assume information the consumer has on genetic modification, $I \sim (-\infty, \infty)$ affects the perceived probability that GM-labeled food will result in a good state. A positive I indicates the consumer has received positive or favorable information on GM foods; a negative I indicates the consumer has received negative or less favorable information on GM foods. When a consumer gets positive information on GM foods, I increases and the consumer perceives greater utility and greater marginal utility from GM-labeled foods. The information a consumer receives in the experiments is randomly assigned, and can differ among participants. The consumer's perceived probability of a good outcome from plain-labeled food *does not depend on information about GM foods.*

The probability that a consumer will never purchase GM-labeled foods is the probability that the utility from GM-labeled foods is smaller than the utility from plain-labeled food at all feasible prices (for any possible monetary premium m for non-GM foods), as shown in equation 3:

(3) $$P(MK^j = 1) = P[EU^j_{labeled}(w) - EU^j_{non-labeled}(w-m) < 0] \quad \forall m \in M .$$

or:

(3a) $$P(MK^j = 1) = P[p^j_{labeled}(I)U^j(w) + \left(1 - p^j_{labeled}(I)\right)V^j(w) - p^j_{non-labeled}U^j(w-m) + \left(1 - p^j_{non-labeled}\right)V^j(w-m) < 0] \quad \forall m \in M .$$

Where $MK^j = 1$ if consumer j is out of the market for GM-labeled foods, and equals 0 otherwise. M is the set of all feasible monetary premiums m on non-labeled foods. Standard comparative statics show that an increase in positive information increases the consumer's likelihood of consuming GM-labeled foods by increasing the expected utility of GM-labeled foods. First, examine how information affects the inner part of equation 3a:

(4) $$= \frac{\partial p^j_{labeled}(I)U^j(w) + \left(1 - \partial p^j_{labeled}(I)\right)V^j(w)}{\partial I}$$

$$= \frac{\overbrace{\partial p^j_{labeled}(I)}^{+}U^j(w) + \left(1 - \overbrace{\partial p^j_{labeled}(I)}^{+}\right)V^j(w)}{\partial I} > 0 .$$

An increase in the likelihood of consuming GM-labeled foods decreases the probability that the consumer is out of the market for GM-labeled foods, as shown in equation (5):

(5) $$\frac{\partial P(M^{j}=0)}{\partial I}=\frac{\partial\left[\overbrace{EU^{j}_{labeled}(w)-EU^{j}_{non\text{-}labeled}(w-m)}^{+}<0\right]}{\partial I}<0$$

Conversely, and perhaps more importantly, negative information will increase the probability that a consumer is out of the market for GM-labeled foods.

6.4. Econometric Model

A consumer is considered out of the market for genetically modified food if they do not demand one unit of a GM-labeled food product at any price. Let a consumer be out of the market if $M_j = 1$. To examine the impact information and demographic characteristics have on the probability of being out of the market for genetically modified foods; a probit model is used, and is shown in the following equation:

6) $$\text{Prob}(M_j = 1) = \Phi(\beta' X).$$

Where X is the matrix of exogenous characteristics for consumers and β is the associated vector of coefficients, and Φ is the cdf for the normal distribution.

The probability of being "out of the market," i.e. the probability that $M_j = 1$, is assumed to be the probability that the consumer bids zero for one unit of the genetically modified food. If a consumer does not have a positive willingness to pay for one unit of a genetically modified food when they have a positive demand for their non-GM counterpart, this provides strong evidence that they will not consume the genetically modified variety of the product at any price. Determining what impacts the probability of being out of the market is important, because if a large share of consumers bid a non-positive amount for one unit of consumption, the grocery store will discontinue displaying/stocking/supplying the food.

An alternative definition of being "out of the market" will also be used. All individuals who participated in the auctions bid on both GM-labeled and plain-labeled food products. If the price an individual bids for the GM-labeled food is less than or equal to 2/3 of the price they bid for the plain-labeled food, then they will also be considered out of the market. This seems realistic because most premiums for non-GM foods do not exceed twenty percent.

The probit model in equation 6 will be estimated for the three products used in the experiments – Russet potatoes, vegetable oil, and tortilla chips. In this model I examine the contribution of a set of factors, including anti-GM information from environmental groups and verifiable information from a third party on the probability that a consumer bids zero for GM food (when they otherwise bid positive amounts). In addition, equation 6 will estimate the probability that a consumer is out of the market for all 3 food products. This is the probability that a consumer bid zero for every GM-labeled food product for the initial specification, or bid 2/3's or less of their bid for each plain-labeled product in the alternative specification.

6.5. Results

Table 6.7.1. shows the percentage of participants who bid zero for the GM-labeled commodities. The number of observations differs, because if an individual bids zero for both the GM-labeled and plain-labeled versions of a commodity, they are not included in the analysis (they just did not demand the product, and one cannot determine their taste for genetic modification). Similarly, when reporting on who is out of the market for all GM-

labeled foods, those who bid zero for all the food products are not included. In the sample of consumers, ten percent did not place a positive bid for any of the GM-labeled products. For the individual goods, almost nine percent of consumers bid zero for the vegetable oil, while over twelve percent of consumers bid zero for the potatoes and tortilla chips. The likely reason why more consumers were willing to purchase GM-labeled vegetable oil is because vegetable oil is a refined product such that all the GM protein is removed. Thus, consumers who consume GM oil would not be harmed even if genetic modification was found to be harmful.

Table 6.7.2. reports a summary of outcomes for the alternative measure of being out of the market; consumers whose bid for the GM-labeled food is less than or equal to 2/3 of their bid for the plain-labeled food. Using this definition, over 16% of consumers would not purchase any of the GM-labeled foods. For the individual commodities, the percentage who are out of the market ranges from 19% to almost 24%, with fewer consumers being out of the market for vegetable oil.

Results from probit regressions are shown in tables 6.7.3. - 6.7.10. In tables 6.7.3. - 6.7.6., the dependent variable takes the value of 1 if the consumer bids zero for the GM-labeled food. In tables 6.7.7-6.7.10. the dependent variable takes a value of 1 if the consumer's bid for the GM-labeled food is less than or equal to 2/3 of their bid for the plain-labeled variety. Exogenous attributes of consumers are hypothesized to affect the probability that consumers will be out of the market for GM-labeled foods.

Negative information from environmental groups increases the probability that a consumer will be out of the market for GM-labeled foods. The coefficient is always positive and is statistically significant for many of the model specifications. This indicates that negative information from environmental groups will increase the probability a prospective consumer out of the market for GM-labeled foods.

This result has important implications. If an anti-technology group wishes to slow progress, they could disseminate large amounts of negative information – even if the information is highly biased. They could even disguise true intentions of wishing to keep a new product from coming to the market by telling consumers they want to keep everybody "fully informed" of the consequences of a product or technology. Yet, their negative information could help push demand down to zero for enough people that suppliers would not find it profitable to invest in the new technology. Also, even if firms do not fully believe the information, and they are not certain that consumers will believe the negative information, negative information will increase the uncertainty about genetic modification, which has been shown to decrease the likelihood of adoption. Given that technological change is one of the driving forces behind the rising standard of living enjoyed in many developed countries, stalled progress could decrease welfare significantly over time.

This result also presents an alternative explanation for why Europeans demand for GM foods is so small. Many have hypothesized that Europeans dislike GM foods because of food scares like BSE, dioxin, and foot and mouth disease. This presents an alternative explanation for why Europeans demand is so low – environmental groups are more prevalent and have pushed demand down to zero for many consumers.

Positive information from agribusiness companies decreases the probability that an individual will be out of the market for GM-labeled foods. The coefficients are consistently negative, and statistically significant for many model specifications. If a consumer receives positive information, they are more likely to purchase GM-labeled foods. This helps explain why the biotechnology industry has formed a coalition called the Council of Biotechnology Information, a group that provides positive information on biotechnology.

Third party, verifiable information decreases the probability that an individual is out of the market, as these coefficients are negative under all of the model specifications, and are statistically significant at the 5% level in many cases. This provides evidence that a third party source that provides neutral, verifiable information on genetically modified foods could help prevent the market from disappearing due to lack of demand. So in addition to value that verifiable information may have by providing consumers accurate information on the risks and benefits of genetic modification, it could have additional benefits by keeping new products available by increasing the probability that the consumer will bid be in the market for GM-labeled foods.

An increase in household income may increase the probability that a consumer is out of the market for GM-labeled foods. The coefficients on household income are consistently positive, however not statistically significant at a 10% level of significance. Thus, the effect of household income on increasing the probability of a consumer being out of the market cannot be determined with any conventional degree of certainty.

"Labels" is a dummy variable that equals one if the consumer said that he/she often or always reads food labels before they purchase a food product for the first time (as recorded on the pre-auction survey). The coefficient for labels is consistently positive, and is statistically significant (5% level) for many of the model specifications. This result indicates that consumers who usually read labels are more likely to be out of the market for a new (risky) food product than consumers who do not read food labels are.

"Informed" is a dummy variable that equals one if the consumer considers himself or herself at least somewhat informed about genetically modified foods (as recorded on the pre-auction survey). Those who considered themselves informed on GM foods are more likely to be out of the market, suggesting that they have heard negative information on GM foods. This result suggests the anti-biotechnology coalition has been doing a better job of disseminating negative messages than the pro-biotechnology coalition has been doing disseminating positive messages.

6.6. Conclusion

Technology adoption and use have dramatically increased the welfare of U.S. consumers over time. For future generations to enjoy a higher standard of living than the current generation, it is imperative that the adoption of new technologies continues. Hence, factors that cause the adoption or non-adoption of new products are particularly important. This paper examined the factors that increase the probability that consumers are out of the market for genetically modified foods, which could stymie the adoption of genetically modified crops by farmers.

Results from experimental auctions show two key results. First, when participants receive negative information on genetically modified foods, they are more likely to be "out of the market" for GM-labeled foods, i.e. these consumers will not buy GM foods at any positive price. In Europe, where negative information from environmental groups on GM foods is more prevalent, adoption of genetically modified crops has stalled. Many have said that this is because of food safety scandals like BSE (human form of mad cow disease) or the dioxin scandal in Belgium, but this paper presents an alternative explanation for Europeans reluctance to adopt genetically modified foods. The second result is that a third party source providing verifiable information can soften the effect of negative information and help keep consumers in the market for GM-labeled foods. This shows a value to verifiable information in addition to the value it has in providing consumers accurate information (Rousu *et al.* 2002).

The implications of this finding are great. If a group wants to stall technological progress, they could supply negative information to consumers and producers. This will contribute to the resistance of the adoption of new technologies. This could lower the overall welfare of society by preventing the adoption of social welfare improving new technologies. This presents an interesting dilemma that I will not try to answer: Should interested parties be allowed freedom of speech to disseminate welfare reducing negative information? This can happen when there are significant information asymmetries in society as there are with the introduction of new goods into the market. Future research to examine the specific value verifiable information has in keeping consumers in the market for GM foods and therefore allowing more efficient innovations to be adopted could be quite valuable.

6.7. Tables

Table 6.7.1. Percentage of consumers who bid zero for a GM-labeled food item. (When a consumer bids zero for both GM and non-GM version of a commodity their bids are not included)

	Observations	Out of market	Percent out of market
All goods	165	17	10.3%
Vegetable Oil, only	146	13	8.9%
Tortilla Chips, only	155	20	12.9%
Potatoes, only	159	20	12.6%

Table 6.7.2. Percentage of consumers who's bid for the GM-labeled food is 2/3's the amount they bid for the plain labeled food, or lower. (When a consumer bids zero for both GM and non-GM version of a commodity their bids are not included)

	Observations	Out of market	Percent out of market
All goods	165	27	16.4%
Vegetable Oil, only	146	28	19.2%
Tortilla Chips, only	155	37	23.9%
Potatoes, only	159	35	22.0%

Table 6.7.3. Probit model: Tortilla Chips
Dependent variable = 1 if a consumer is out of the market for tortilla chips (i.e. bid = 0)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.435 **	-1.931 **	-1.876 **	-1.542 **	-2.295 **	-2.196 **
	(0.437)	(0.557)	(0.513)	(0.460)	(0.613)	(0.615)
Anti_info	0.670 *	0.791 *	0.748 *	0.692 *	0.857 **	0.874 **
	(0.394)	(0.410)	(0.409)	(0.401)	(0.044)	(0.429)
Pro_info	-0.360	-0.334	-0.318	-0.400	-0.312	-0.321
	(0.302)	(0.306)	(0.307)	(0.307)	(0.316)	(0.321)
Ver_info						-0.475
						(0.294)
Income		0.0065			0.0057	0.0061
		(0.0041)			(0.0043)	(0.0043)
Labels			0.563 *		0.514 *	0.582 *
			(0.293)		(0.305)	(0.065)
Informed				0.251	0.047	0.107
				(0.277)	(0.297)	(0.303)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.4. Probit model: Potatoes
Dependent variable = 1 if a consumer is out of the market for potatoes (i.e. bid = 0)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.228 **	-1.479 **	-1.749 **	-1.438 **	-1.985 **	-1.916 **
	(0.441)	(0.554)	(0.526)	(0.473)	(0.628)	(0.632)
Anti_info	0.496	0.562	0.587	0.512	0.620	0.623
	(0.400)	(0.411)	(0.415)	(0.417)	(0.436)	(0.437)
Pro_info	-0.550 *	-0.525 *	-0.507	-0.659 **	-0.593 *	-0.604 *
	(0.304)	(0.307)	(0.310)	(0.320)	(0.326)	(0.328)
Ver_info						-0.234
						(0.285)
Income		0.0032			0.0020	0.0022
		(0.0041)			(0.0043)	(0.0043)
Labels			0.638 **		0.543 *	0.565 *
			(0.305)		(0.315)	(0.318)
Informed				0.523 *	0.401	0.439
				(0.282)	(0.293)	(0.298)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.5. Probit model: Vegetable Oil
Dependent variable = 1 if a consumer is out of the market for vegetable oil (i.e. bid = 0)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.652 **	-1.936 **	-2.313 **	-1.747 **	-2.516 **	-2.499 **
	(0.530)	(0.645)	(0.652)	(0.552)	(0.741)	(0.756)
Anti_info	0.698	0.761	0.797	0.704	0.840	0.836
	(0.483)	(0.493)	(0.510)	(0.493)	(0.523)	(0.523)
Pro_info	-0.418	-0.397	-0.367	-0.471	-0.384	-0.383
	(0.339)	(0.342)	(0.352)	(0.349)	(0.364)	(0.364)
Ver_info						-0.036
						(0.327)
Income		0.0038			0.0027	0.0027
		(0.0047)			(0.0049)	(0.0049)
Labels			0.810 **		0.771 **	0.772 **
			(0.377)		(0.382)	(0.382)
Informed				0.263	0.102	0.107
				(0.319)	(0.338)	(0.341)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.6. Probit model: All products
Dependent variable = 1 if a consumer is out of the market for all three products (i.e. bid = 0)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.262 **	-1.673 **	-1.818 **	-1.443 **	-2.190 **	-2.090 **
	(0.449)	(0.567)	(0.540)	(0.479)	(0.645)	(0.649)
Anti_info	0.395	0.493	0.461	0.410	0.537	0.543
	(0.406)	(0.420)	(0.525)	(0.421)	(0.445)	(0.446)
Pro_info	-0.549 *	-0.521	-0.525	-0.644 *	-0.580 *	-0.590 *
	(0.320)	(0.324)	(0.330)	(0.335)	(0.345)	(0.347)
Ver_info						-0.307
						(0.297)
Income		0.0053			0.0043	0.0044
		(0.0042)			(0.0044)	(0.0042)
Labels			0.728 **		0.644 *	0.661 *
			(0.326)		(0.336)	(0.338)
Informed				0.456	0.282	0.336
				(0.290)	(0.307)	(0.313)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.7. Probit model: Tortilla Chips – alternative specification
Dependent variable = 1 if a consumer is out of the market for Tortilla Chips (bid is 2/3's of bid for plain-labeled chips)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.689 **	-1.083 **	-0.704 *	-0.876 **	-1.111 **	-1.057 **
	(0.346)	(0.441)	(0.376)	(0.366)	(0.461)	(0.463)
Anti_info	0.358	0.451	0.360	0.389	0.458	0.460
	(0.299)	(0.308)	(0.299)	(0.305)	(0.313)	(0.312)
Pro_info	-0.450 *	-0.426	-0.448 *	-0.501 *	-0.492 *	-0.489 *
	(0.270)	(0.273)	(0.271)	(0.275)	(0.279)	(0.280)
Ver_info						-0.186
						(0.236)
Income		0.0053			0.0044	0.0046
		(0.0036)			(0.0036)	(0.0036)
Labels			0.024		-0.129	-0.117
			(0.229)		(0.244)	(0.245)
Informed				0.435 *	0.425 *	0.447 *
				(0.234)	(0.250)	(0.252)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.8. Probit model: Potatoes – alternative specification
Dependent variable = 1 if a consumer is out of the market for Potatoes
(bid is 2/3's of bid for plain-labeled chips)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.014 **	-0.972 **	-1.068 **	-1.238 **	-1.087 **	-0.962 *
	(0.384)	(0.482)	(0.425)	(0.413)	(0.518)	(0.529)
Anti_info	0.742 **	0.731 **	0.752 **	0.789 **	0.753 **	0.820 **
	(0.344)	(0.353)	(0.367)	(0.357)	(0.364)	(0.376)
Pro_info	-0.570 **	-0.575 **	-0.565 **	-0.638 **	-0.659 **	-0.694 **
	(0.264)	(0.266)	(0.264)	(0.270)	(0.274)	(0.282)
Ver_info						-0.714 **
						(0.262)
Income		-0.0005			-0.0015	-0.0006
		(0.0038)			(0.0038)	(0.0039)
Labels			0.073		-0.067	-0.014
			(0.242)		(0.256)	(0.265)
Informed				0.487 **	0.519 **	0.654 **
				(0.246)	(0.259)	(0.272)

** Significant at the 5% level
* Significant at the 10% level

**Table 6.7.9. Probit model: Vegetable Oil – alternative specification
Dependent variable = 1 if a consumer is out of the market for vegetable oil (bid is 2/3's of bid for plain-labeled chips)
(Standard errors in parentheses)**
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.248 **	-1.496 **	-1.200 **	-1.392 **	-1.484 **	-1.378 **
	(0.396)	(0.489)	(0.430)	(0.416)	(0.513)	(0.518)
Anti_info	0.778 **	0.829 **	0.772 **	0.791 **	0.822 **	0.864 **
	(0.347)	(0.353)	(0.348)	(0.352)	(0.357)	(0.366)
Pro_info	-0.327	-0.302	-0.334	-0.368	-0.369	-0.359
	(0.280)	(0.283)	(0.282)	(0.284)	(0.289)	(0.297)
Ver_info						-0.691 **
						(0.277)
Income		0.0034			0.0028	0.0040
		(0.0038)			(0.0039)	(0.0040)
Labels			-0.071		-0.186	-0.143
			(0.252)		(0.264)	(0.273)
Informed				0.357	0.378	0.493
				(0.256)	(0.268)	(0.280)

** Significant at the 5% level
* Significant at the 10% level

Table 6.7.10. Probit model: All Products – alternative specification
Dependent variable = 1 if a consumer is out of the market for All three products (bid is 2/3's of bid for plain-labeled chips)
(Standard errors in parentheses)
N=172

Regressors	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-1.198 **	-1.223 **	-1.174 **	-1.364 **	-1.258 **	-1.108 **
	(0.421)	(0.515)	(0.456)	(0.447)	(0.543)	(0.550)
Anti_info	0.718 *	0.724 *	0.714 *	0.751 *	0.735 *	0.786 *
	(0.384)	(0.391)	(0.384)	(0.394)	(0.400)	(0.408)
Pro_info	-0.613 **	-0.611 **	-0.619 **	-0.667 **	-0.687 **	-0.721 **
	(0.280)	(0.281)	(0.280)	(0.285)	(0.289)	(0.298)
Ver_info						-0.666 **
						(0.274)
Income		0.0034			-0.0034	0.0029
		(0.0039)			(0.0040)	(0.0040)
Labels			-0.033		-0.147	-0.108
			(0.253)		(0.267)	(0.275)
Informed				0.372	0.418	0.530 *
				(0.259)	(0.273)	(0.285)

** Significant at the 5% level
* Significant at the 10% level

CHAPTER 7: WHO DO CONSUMERS TRUST FOR INFORMATION ON GENETICALLY MODIFIED FOODS: ECONOMICS OF TASTE FORMATION

7.1. Introduction

The information on genetically modified (GM) foods is wide ranging. On the extreme ends of the spectrum, Agribusiness firms describe GM food as "food to feed the planet," while environmental companies describe GM food as "frankenfood" (Gates, 2001). Other organizations, such as the U.S. government, are more moderate in their description of GM foods. The information provided by these groups is designed to influence the consumer's perception of genetically modified foods. Environmental groups started their campaign relatively early attempting to expose the potential dangers of GM foods, with a campaign calling GM foods unnatural and stating that GM foods are made by large, multinational, companies. Environmental groups also claim that GM labels are needed because consumers have the right to know if their food is GM (Friends of the Earth 2001, Greenpeace 1997). The campaign by environmental groups was at least partially successful, as many countries have adopted mandatory GM labeling policies, and the European Union enacted a moratorium on approvals of GM foods in 1998.

To combat the negative publicity environmental groups were giving GM foods; several agribusiness firms formed the Council of Biotechnology Information. The Council for Biotechnology Education produced a website, made TV commercials, and even made a children's coloring book all to try to promote the positive aspects of GM foods. This group has been relatively successful in the United States, where there is little political support for mandatory labeling of GM foods (Hoban, 2002, 1997).

These groups need the public's trust for their information to be effective. Both the biotechnology industry and environmental groups have spent considerable amounts of time and money attempting to influence consumer behavior. A key question is which people would trust the agribusiness firms and who would trust the environmental groups. Further, what other groups would consumers trust? The Government? A third party group? No one?

People who are closer in social status are more likely to place trust in one another (Glaeser *et al.* 2000). For example, individuals who were raised with a particular religious upbringing would place more trust in those who were also raised by the same religion, ceteris paribus.

Becker (1998) discusses the importance of personal and social capital in accounting for a consumer's taste. Personal capital is defined as capital that the individual personally acquires, such as schooling, habits, or experience. Social capital is defined as the capital that the individual acquires by his/her surroundings, upbringings, and social network. Becker shows that when personal and social capital are considered in economic models, many previously mysterious outcomes, like addictions and advertising, can be explained by economic theory.

This paper explores the foundations of trust; specifically looking at the case of information on genetically modified foods. Special attention is paid to the formation of trust, and the factors that cause a consumer to trust one source of information more than others. A simple model is developed, examining the role of personal capital and social capital in the formation of trust. Then, results from a survey are analyzed using a multinomial logit model, to determine what characteristics would cause individuals to trust one source of information more than another source.

7.2. The Model

Consider the strictly quasi-concave utility function shown in equation 1:

1) $U = U(X_{labeled}, X_{non-labeled}; T_1, \ldots T_J)$.

Utility is based on the consumption of two choice variables, GM-labeled foods and foods that are not labeled as GM (henceforth plain-labeled foods). The utility of these two goods is affected by the consumer's trust of information from *J* sources. This information differs in quality for each type, i.e., level of trust. Information quality or trust in the *jth* source is assumed to be a function of the consumer's personal capital (PC) and social capital (SC):

2) $T_j = f_j(SC, PC)$.

The market price for GM-labeled foods is $p_{labeled}$ and the price of plain-labeled foods is $p_{non-labeled}$. At time *t*, the consumer maximizes his/her utility, subject to their budget constraint *M*, and stock of personal and social capital:

3) $MAX\ U(X_{labeled}, X_{non-labeled}; T_1, \ldots T_J),\ T_j = f_j(SC, PC)$

s.t. $p_{labeled} X_{labeled} + p_{non-labeled} X_{non-labeled} \leq M$.

The first order conditions are:

4) $MU_{labeled}(X_{labeled}, X_{non-labeled}; T_1, \ldots T_J) - \lambda p_{labeled} = 0$

5) $MU_{plain-labeled}(X_{labeled}, X_{plain-labeled}; T_1, \ldots T_J) - \lambda p_{plain-labeled} = 0$

6) $p_{labeled} X_{labeled} + p_{non-labeled} X_{non-labeled} - M = 0$.

This can be rearranged to show the marginal rate of substitution between GM-labeled and plain-labeled foods, as shown in equation 7:

7) $$\frac{MU_{labeled}(X_{labeled}, X_{non-labeled}; T_1, \ldots T_J)}{MU_{non-labeled}(X_{labeled}, X_{non-labeled}; T_1, \ldots T_J)} = \frac{p_{labeled}}{p_{non-labeled}}.$$

Hence, a consumer's marginal rate of substitution between GM-labeled and plain-labeled food is a function not only of the relative prices of the goods but also personal and social capital, which influences the trust for the j providers of information. By moving the ratio of prices to the left-hand side, one can differentiate with respect to personal capital or social capital. Consider the equation below, which examines the impact of a change in a consumer's personal capital on the marginal rate of substitution, for the two goods:

8) $$\frac{MU_{non-labeled}(\bullet)\left(\sum_{j=1}^{J}\frac{\partial MU_{labeled}(\bullet)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right)-MU_{labeled}(\bullet)\left(\sum_{j=1}^{J}\frac{\partial MU_{non-labeled}(\bullet)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right)}{[MU_{non-labeled}(\bullet)]^2}$$

A change in personal capital seems likely to have differential impacts across the j-information quality types, and hence not neutral on the marginal rate of substitution between GM-labeled and plain-labeled food. To simplify the analysis and without loss of generality, assume that a change in T_j, $j=1,..J$, does not have any impact on the marginal utility for plain-labeled (non-GM) foods. Then equation 8 becomes:

8a) $$\frac{MU_{non-labeled}(\bullet)\left(\sum_{j=1}^{J}\frac{\partial MU_{labeled}(\bullet)}{\partial f_j}\frac{\partial f_j}{\partial PC}\right)}{[MU_{non-labeled}(\bullet)]^2}.$$

To further understand how social capital can change consumption behavior, consider the following example. Suppose environmental groups provide negative information about GM food, and agribusiness companies provide positive information about GM food. For example, suppose an increase in a consumer's education increases his/her trust in environmental groups while decreasing his/her trust in agribusiness companies, other things equal. The response is summarized in equation 9:

$$9)\qquad \frac{MU_{non-labeled}(\bullet)\left(\frac{\partial MU_{labeled}(\bullet)}{\partial f_{ENV}}\frac{\partial f_{ENV}}{\partial PC}+\frac{\partial MU_{labeled}(\bullet)}{\partial f_{AGRI}}\frac{\partial f_{AGRI}}{\partial PC}\right)}{[MU_{non-labeled}(\bullet)]^2}.$$

Consider the sign if the derivative. First assume that the marginal utility of GM foods is positive. Second, the change in marginal utility of GM-labeled foods is negative with respect to trust of environmental groups, because environmental groups provide negative information on GM-labeled foods. Third, the change in the marginal utility of GM-labeled foods is positive with respect to trust of agribusiness firms because agribusiness firms provide positive information on GM-labeled foods. If, as mentioned before, an increase in personal capital causes a consumer to trust environmental information more and agribusiness information less then equation 10 has a negative sign:

$$10)\qquad \frac{\overbrace{MU_{non-labeled}(\bullet)}^{+}\left(\overbrace{\overbrace{\frac{\partial MU_{labeled}(\bullet)}{\partial f_{ENV}}}^{-}\overbrace{\frac{\partial f_{ENV}}{\partial PC}}^{+}+\overbrace{\frac{\partial MU_{labeled}(\bullet)}{\partial f_{AGRI}}}^{+}\overbrace{\frac{\partial f_{AGRI}}{\partial PC}}^{-}}^{-}\right)}{[MU_{non-labeled}(\bullet)]^2}<0.$$

In this case, an increase in personal capital causes the consumer's marginal rate of substitution between GM-labeled and plain-labeled foods to decrease, and the consumer will purchase more plain-labeled foods. See figure 7.8.1. The opposite result holds if a change in a consumer's personal capital causes him/her to trust environmental groups less and agribusiness firms more. A change in a consumer's social capital causes similar effects on the demand for GM-labeled foods. This example illustrates that, when personal or social capital changes the trust for an interested party (by changing the perceived quality of the information), it can change the consumer's demand for GM-labeled or plain-labeled food.

7.3. The Survey

Individuals participated in the experiment on genetically modified foods, and at the end of the experiment, they were asked: "If a source were to give you verifiable information on genetically modified foods, who would you trust most?" The participants then wrote their answer down (the question was open-ended). I was able to separate the responses from individuals into 6 categories.[1] The percentage of people who responded to each category is reported in table 7.8.2.

The category "other" contained the non-responders, responses by individuals that were unusable, and some other various responses that were too sparse for their own category (e.g. one person said they most trusted God to provide verifiable information on genetically modified foods). This groups also contained the respondents who said they most trusted the media (about 5%), which was not included in a separate category since the media reports information from various sources. Approximately 36% of the responses fell into the other category. The category government contains responses from individuals who named a government (national, state, or local) or a governmental entity (e.g. the U.S. Food and Drug Administration). Almost 20% of the participants indicated that they would most trust the government to disseminate verifiable information on genetically modified foods.

The next group will be called the independent, third party group. It contains responses from individuals who would most trust scientists, universities, or an independent 3rd party group that does not have financial ties to genetic modification. Almost 30% of participants indicated they would most trust a 3rd party group to disseminate verifiable information on genetically modified food. The next category is for participants who indicated they would most trust an "environmental or consumer group" to provide verifiable information on genetically modified foods. Almost 4% of the participants indicated they would most trust these groups.

Private organization is the category for any individual who listed a private entity or business as the group they would trust most. Most of these responses were for agribusiness firms or grocery stores. Five percent of the participants indicated they would most trust verifiable information from a private organization. The category "none" is for individuals who specifically said they would not trust anybody. Six percent of individuals would not trust any source to provide them verifiable information on genetically modified foods.

7.4. Econometric Model

First consider the random utility model based upon the choice the consumer makes as shown in equation 11:[2]

11) $U_{ij} = \beta' x_{ij} + \varepsilon_{ij}$.

The utility of consumer *i* is based on choice $j \in J$. If a consumer chooses the choice *j*, it must be the choice that yields the consumer the highest utility. With error terms that are independently and identically distributed with the Weibull distribution, the probability of consumer *i* choosing choice *j* is shown in equation 12:

12) $$\text{Prob}(Y_i = j) = \frac{e^{\beta_j' x_i}}{\sum_{k=1}^{J} e^{\beta_k' x_{il}}} \text{ for } j=0,1,\ldots,J.$$

Equation 12 is the multinomial logit model. However, to solve the model, one must first define $\beta^*_j = \beta_j + q$, for a vector q, and then normalize $\beta_0 = 0$. The probability of choosing choice *j* is:

13) $$\text{Prob}(Y=j)=\frac{e^{\beta_j' x_i}}{1+\sum_{k=1}^{J} e^{\beta_k' x_{il}}} \quad \text{for } j=1,2,\ldots,J$$

14) $$\text{Prob}(Y=0)=\frac{1}{1+\sum_{k=1}^{J} e^{\beta_k' x_{il}}}.$$

Now, one can determine the probability that a consumer would prefer one choice over another by computing the log-odds ratios, as shown in equation 15:

15) $$\ln\left(\frac{P_{ij}}{P_{i0}}\right)=\beta_j' x_i$$

Equation 15 shows the probability that a consumer would prefer (trust) choice *j* over choice 0, the reference choice. If β_j' is positive, then a marginal increase in x_i would increase the odds that the consumer would prefer choice *j* over the reference choice. For the multinomial logit model fitted to who consumers trust, the reference choice will be the "independent, third-party source" to provide verifiable information on genetically modified foods. A separate model is also run, with the reference choice being the government. I examine the probability that someone would rather have a different source providing him or her information on genetically modified foods.

7.5. Econometric Results

The results from the multinomial logit model are presented in tables 7.8.3. and 7.8.4. I will discuss the results of the multinomial logit model used to examine the odds that a consumer will trust a source of information more or less than they trust an independent, third party source to provide verifiable information on genetically modified foods. The odds of preferring an information source relative to third party information are hypothesized to depend on various forms of personal capital and social capital. Some personal capital stocks that are hypothesized to matter are a consumer's education, their age – which can be thought of as a proxy for experience, and a dummy variable that equals one if the consumer perceives themselves to be "at least somewhat informed regarding genetically modified foods". A form of social capital that is hypothesized to matter is a consumer's religious upbringing, represented by a dummy variable that equals one if the consumer was raised as a Baptist, a Catholic, or a Lutheran (the three strictest religious upbringings asked about in the survey).

Individuals who are well educated have larger odds for trusting an independent third party source relative to other options. They have lower odds of naming "other", reporting they trust "nobody", reporting they trust the government, and trusting information from private sources than they do of trusting third party information. These results cannot reject the hypothesis that education has no effect on the odds of a person's trusting environmental groups relative to an independent third party organization.

As a person gets older, the odds in favor of trusting nobody fall relative to trusting third party sources. One cannot reject the null hypothesis that an increase in the consumer's age does not alter the odds of trusting the government, environmental groups, and private organizations relative to third party sources.

Those who perceive themselves to be "informed about genetically modified foods" have higher odds of trusting the government than of trusting an independent third party organization to produce verifiable information on genetically modified foods. This model cannot reject the null hypothesis that being informed has no impact on the odds of most trusting any other source of information relative to trusting an independent third party source.

It is interesting to note that when a consumer is more educated it lowers the odds they trust government relative to a third party group, but when a consumer *thinks* they are well educated on genetically modified foods it raises the odds of trusting the government relative to a third party group.

If a consumer had a strict religious upbringing, he/she had higher odds of trusting nobody relative to an independent, third party source. They were also less likely to trust a private organization relative to an independent third party source. The individuals religious upbringing did not have a significant effect on the odds of any of the other choices relative to third party information.[3] This indicates that areas in the United States that have stricter religious upbringings would be less likely to trust a third party source of information should one be created, and people living in these areas would be less likely to place value in the third party information source as well.

Huffman and Tegene (2002) hypothesized that an independent, third party source of information on GM foods would be welfare improving and chapter 4 of this dissertation showed the value of verifiable information could be large. The source would have to be independent of the interested parties - the environmental groups and agribusiness firms. It also, may want to be at least partially independent of governments, as some are not in favor of current governmental policies on GM-labeled foods. Of the individuals in the survey, over 50% said they would most trust information on GM foods if it were given to them by an independent, third party group or if it were given to them by a governmental entity. Thus, a quasi-governmental entity, or a group funded by the government but not answering to the government, may be the best possible source to give information on GM-labeled foods. The key element of this group is that it should not allow people from interested parties into the decision making process. Less than 10% of consumers said they would most trust information from the interested parties (environmental groups and agribusiness firms) and that information is already freely available anyway.

7.6. Conclusion

Organizations that disseminate information need to be trusted for their information to be as effective as possible. Often, organizations with competing interests both will disseminate information. This is the case with GM foods. Environmental groups, biotechnology companies, and the U.S. government all have different interpretations of the benefits and risks of GM foods. These groups would like as many people to trust their information as possible.

The body of literature on the economics of trust is growing rapidly. However, little work has examined the foundations of trust, and how changes in capital stocks impact trust. That was the goal of this chapter, focusing on the case for genetically modified foods. I showed that both personal and social capital affect a consumers trust for information on genetically modified foods. Some personal capital stocks that were found to influence trust were education, how informed a person perceived themselves regarding genetically modified foods, and age which serves as a proxy for experience. The social capital stock that was shown to influence GM foods was a consumer's religious upbringing. With the ongoing, contentious debates over GM foods and other products – this chapter's contribution is developing a model to examine how personal and social capital change trust – and learning more about what personal and social capital characteristics factor into the trust of information on genetically modified foods.

7.7. Notes

1. If an individual listed more than one category, I chose the first item they listed.
2. This section follows Greene (2000) closely.
3. Multinomial logit models examining the impact of other characteristics, such as gender, income, and marital status were also run. These coefficients were not statistically different from zero at any conventional level of significance.

7.8. Figures and Tables

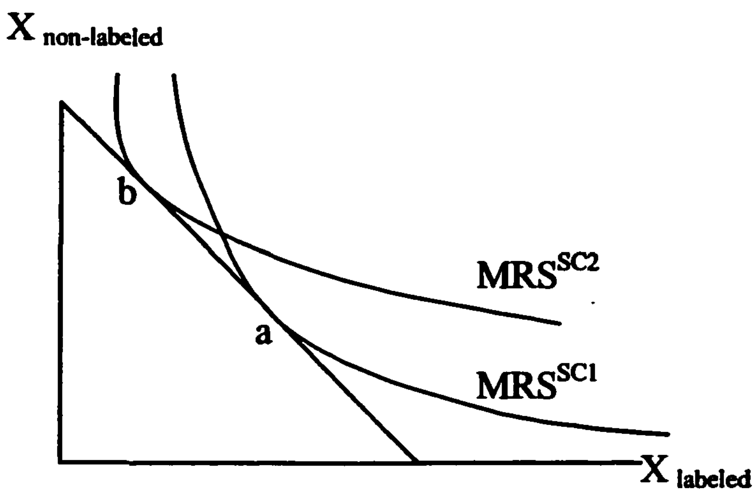


Figure 7.8.1. Graphical depiction of a change in MRS when a change in social capital causes the individual to place more trust in a source of information that views GM foods negatively

Table 7.8.2. Responses of who individuals trust for information on GM food

Information individuals trust	Number	Percentage
All	318	100%
Government	62	19.5%
University, Scientists/Researchers, or 3rd party group	94	29.6%
Environmental/Consumer group	12	3.8%
Private Organization	16	5%
None	19	6%
Other, Media or no answer	115	36.1%

Table 7.8.3. Multinomial Logit Results: Who do you trust for GM food information? Reference group is "independent, third party group"
N=318

Variable	(Other/ Third Party)	(None/ Third Party)	(Government/ Third Party)	(Env. Group/ Third Party)	(Private/ Third Party)
Intercept	5.494 **	3.614 **	1.146	-1.576	2.337
	(1.134)	(1.810)	(1.288)	(2.461)	(2.078)
Education	-0.375 **	-0.248 **	-0.140 **	0.042	-0.321 **
	(0.069)	(0.116)	(0.076)	(0.146)	(0.130)
Age	0.003	-0.035 **	0.010	-0.026	0.004
	(0.009)	(0.016)	(0.010)	(0.020)	(0.016)
Informed	0.153	0.034	0.345 **	0.455	-0.064
	(0.149)	(0.261)	(0.170)	(0.328)	(0.279)
Religious	-0.062	0.570 **	-0.041	0.053	-0.857 **
	(0.151)	(0.274)	(0.170)	(0.315)	(0.396)

* Represents a coefficient significant at the 10% level
** Represents a coefficient significant at the 5% level

Table 7.8.4. Multinomial Logit Results: who do you trust for GM food information? Reference group is the government
N=318

Variable	(Other/ Government)	(None/ Government)	(Third Party/ Government)	(Env. Group/ Government)	(Private/ Government)
Intercept	4.435 **	1.643	-1.144	-2.841	2.106
	(1.249)	(1.891)	(1.294)	(2.518)	(2.187)
Education	-0.240 **	-0.074	0.139 *	0.188	-0.212
	(0.077)	(0.120)	(0.076)	(0.151)	(0.137)
Age	-0.007	-0.044 **	-0.010	-0.036 *	-0.009
	(0.009)	(0.017)	(0.010)	(0.020)	(0.016)
Informed	-0.191	-0.348	-0.348 *	0.106	-0.378
	(0.164)	(0.272)	(0.169)	(0.338)	(0.288)
Religious	-0.077	0.695 **	-0.010	0.116	-0.592 *
	(0.164)	(0.346)	(0.169)	(0.326)	(0.305)

* Represents a coefficient significant at the 10% level
** Represents a coefficient significant at the 5% level

CHAPTER 8: GENERAL CONCLUSION

Information plays a key role in many aspects of life. A consumer's decision whether or not to purchase genetically modified (GM) foods is no different. Currently many different entities are willing to provide information outlining their views on the benefits or risks of genetic modification. This dissertation combines the tools of survey design, statistical experimental design, and laboratory auctions to take a detailed look at how this information affects consumer behavior.

Information on food labels is important, and chapter 3 looked at how consumers react to different types of labels on GM foods. Consumer behavior did not change when facing foods with labels that would be found in a mandatory labeling policy or foods with labels that would be found in a voluntary labeling policy. This provides evidence that the United States has been prudent in avoiding calls to implement a mandatory labeling policy on GM foods.

Chapter 5 looked at the impact of tolerance (or thresholds) and their impact on willingness to pay for non-GM-foods. Consumers paid less for foods that tolerated small amounts of GM-content (1% or 5%), but the price discount by consumers did not depend on the percentage of GM content that was present (at least over the range we examined). This indicates that if the United States initiates a tolerance standard for GM foods, a 5% tolerance level may be more efficient than a 1% threshold due to lower costs of complying with the 5% threshold.

Chapter 4 looked at how information from interested parties and verifiable information affected consumer willingness to pay for GM foods, and the value of verifiable information. A third-party source of verifiable information could have tremendous value for U.S. consumers – of over $2.6 billion dollars annually. In addition, chapter 6 showed that verifiable information could have additional value, by preventing the non-adoption of socially good inventions. A look at who consumers would trust to provide verifiable information is presented in chapter 7. A third-party source of verifiable information is trusted more than most other sources, by most individuals. Those who think they are informed about genetically modified foods are more likely to trust the government than a third party source. The results presented in chapter 7 indicate that a government funded agency that is not responsible for reporting to the government might be the best source for providing verifiable information on genetically modified foods.

This dissertation provides evidence on how information affects many aspects of consumer decision making and many implications for policy analysts. Concluding, this dissertation shows that the (1) establishment of an independent, third party source of information on GM foods is likely to be a good social investment, (2) that the U.S. continue with voluntary rather than mandatory labeling, (3) that the threshold level be set at a 5 percent GM impurity level (rather than zero or 1 percent), (4) negative GM-food information disseminated by environmental group raises consumer resistance to GM foods but verifiable information from and independent, third party source erodes this resistance. Furthermore, an individual's personal and social capital are important determinants of who he/she trusts to provide verifiable information. Schooling increases the probability of trusting independent, third party sources relative to other sources, e.g., private, government, none. One thing that has become apparent is that information plays a key role in almost every aspect of consumer behavior that involves genetically modified foods.

This dissertation used the tools of experimental economics, statistical experimental design, survey design, and laboratory auctions. These methods present an improvement over most of the experimental studies conducted in agricultural or food safety economics. A new method to value information given in experiments was also developed that could easily be applied to many different forms of information. This dissertation contains information that could be used by policy makers, experimental economists, agricultural economists, and those who do research in the economics of food safety.

CHAPTER 9: REFERENCES

AgBiotech Reporter Vol 18, No. 2 (February 2001).

AgBiotech Reporter Vol 18, No. 4 (April 2001).

AgBiotech Reporter Vol 18, No. 5 (May 2001).

AgBiotech Reporter Vol 18, No. 7 (July 2001).

Akerlof, George. "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism." *Quarterly Journal of Economics* 84 (August 1970): 488-500.

Antle, John M. and Prabhu L. Pingali. "Pesticides, Productivity and Farmer Health: A Philippine Case Study." *American Journal of Agricultural Economics* 76 (August 1994): 418-430.

Australia-New Zealand Food Authority. "Genetically Modified Foods" http://www.anzfa.gov.au/GMO/ (May 2001).

Australia New Zealand Food Authority. "Labelling Genetically Modified Foods." http://www.anzfa.gov.au/documents/fs036.asp (August 2000).

Australia-New Zealand Food Authority. "Labelling Genetically Modified Foods: Compliance Guide to Standard A18." http://www.anzfa.gov.au/whatsinfood/gmfoods/ complianceguidea18gm.cfm (October 2000).

Becker, Gary S. *Accounting for Tastes*. Harvard University Press (1998).

Becker, Gordon, M., Morris H. DeGroot and Jacob Marschak. "Measuring Utility by a Single Response Sequential Method." *Behavioral Science* 9 (July 1964): 226-236.

Bernauer, Thomas. "Agricultural Biotechnology: Why do Regulations in the European Union, the United States, and Japan Differ?" Center for International Studies, Swiss Federal Technical Institute, Zurich, (June 2001).

Boskin, Michael J., Ellen R. Dulberber, Robert J. Gordon, Zvi Griliches, and Dale Jorgensen. "Toward a More Accurate Measure of the Cost of Living." In D. Baker eds. Getting Prices Right: the Debate Over the Consumer Price Index (1998): 5-77.

Caswell, Julie A. "Should Use of Genetically Modified Organisms Be Labeled?" *AgBioForum*, 1 http://www.agbioforum.missouri.edu (1998): 22-24.

Caswell, Julie A. "Labeling Policy for GMOs: To Each His Own?" *AgBioForum*, 3 http://www.agbioforum.missouri.edu (2000): 53-57.

Caswell, Julie A. and Daniel I. Padberg. "Toward a More Comprehensive Theory of Food Labels." *American Journal of Agricultural Economics* 74 (May 1992) 460-467

CBC News. "Meetings begin on GM food labelling." http://cbc.ca/cgi- bin/templates/view.cgi?category=Consumers&story=/news/2000 /05/09/Consumers/gmlabel000509 (May 9, 2000).

Cherry, T., T. Crooker and J. Shogren. "Rationality Spillovers." *Journal of Environmental Economics and Management*. Forthcoming (2002).

CNN. "Europe Approves Tough GM Food Rules" http://www.cnn.com/2001/WORLD/europe/02/14/eu.gm/index.html (Feb. 14, 2001).

Comsumer Reports "Genetically Altered Foods, Recommendations." http://www.consumerreports.org/main/detail.jsp?CONTENT%3C%3Ecnt_id=19339 &FOLDER%3C%3Efolder_id=18151&bmUID=1011290002896 (September 1999).

Council for Biotechnology Information. "Frequently Asked Questions." http://www.whybiotech.com/en/faq/default.asp?MID=10. (Retrieved October 2001).

Coursey, D., J. Hovis and W. Schulze, 1987, The Disparity Between Willingness to

Accept and Willingness to Pay Measures of Value." *Quarterly Journal of Economics*, 102, (1987): 679-690.

Crespi, John M. and Stephan Marette. "How Should Food Safety Certification be Financed?" *American Journal of Agricultural Economics* 83 (November 2001): 852-861.

Davis, Jeanie. "'Frankenfoods' – Friend of Foe?". WebMD, http://my.webmd.com/content/article/1728.80187 (May 22, 2001).

Department of Health and Human Services, Food and Drug Administration. "Statement of Policy: Foods Derived From New Plant Varieties: Notice." *Federal Register*. 57 (May 1992).

Dixit, Avinash K. and Robert S. Pindyck. *Investment under Uncertainty*. Princeton University Press (1994).

Feder, Gershon and Roger Slade. "The Acquisition of Information and the Adoption of New Technology." *American Journal of Agricultural Economics* 66 (August 1984): 312-320.

Fitzgerald, Anne. "Biotech Crops Spread Worldwide." http://desmoinesregister.com/news/stories/c4789013/16885943.html (December 30, 2001).

Foster, William and Richard E. Just. "Measuring Welfare Effects of Product Contamination with Consumer Uncertainty." *Journal of Environmental Economics and Management* 17 (1989): 266-283.

Fox, John A., Dermot J. Hayes and Jason F. Shogren. "Consumer Preferences for Food Irradiation: How Favorable and Unfavorable Descriptions Affect Preferences for

Irradiated Pork in Experimental Auctions." *Journal of Risk and Uncertainty*, 24 (January 2002): 75-95.

Fox, John A. Jason F. Shogren, Dermot J. Hayes and James Kliebenstein. "CVM-X: Calibrating contingent values with experimental auction markets." *American Journal of Agricultural Economics* 80 (1998): 455-465.

Franciosi, R., R. M. Isaac, D. Pingry, and S. Reynolds. "An Experimental Investigation of the Hahn-Noll Revenue Neutral Auction for Emissions Licenses." *Journal of Environmental Economics and Management*, 24 (1993): 1-24.

Friends of the Earth. "The Need for Labeling Genetically Engineered Foods" http://www.foe.org/safefood/factshtgelabel.htm. (March 2001).

Galang Jr., Jose M. "Market Forces, Rise and Shine." http://www.monsantoindia.com/news/archives/march2001/050301.html (March 2001).

Gates, Bill. "Will Frankenfood Feed the World?" *Time*. Visions of the 21st Century. http://www.time.com/time/reports/v21/tech/mag_food.html (Retrieved December 2001).

Glaeser, Edward L., David I. Laibson, Jose A. Scheinkman, and Christine L. Soutter. "Measuring Trust." *The Quarterly Journal of Economics* 115 (2000): 811-846.

Golan, Elise, Barry Krissoff, and Fred Kuchler. "Traceability for Food Marketing and Food Safety: What's the Next Step?" *Agricultural Outlook* (January-February 2002): 21-25.

Golan, Elise, Fred Kuchler, Lorraine Mitchell, Cathy Greene, and Amber Jessup.

"Economics of Food Labeling." Economic Research Service, U.S. Department of Agriculture. *Agricultural Economic Report No. 793* (December 2000).

Green, Gareth, David Sunding, David Zilberman, and Doug Parker. "Explaining Irrigation Technology Choices: A Microparameter Approach." *American Journal of Agricultural Economics* 78 (November 1996): 1064-1072.

Greene, William H. *Econometric Analysis: Fourth Edition*. 2000.

Greenpeace International. "Greenpeace Launches Genetech Labelling Policy as European Commission fails to do so." http://www.greenpeace.org/pressreleases/geneng/1997nov3.html (November 1997).

Greenpeace International. "The Grinch and Frankentony return Gene-altered Starlink corn to Kellogg's." http://www.greenpeace.org/~geneng/ (December 2000).

Greenpeace International. "We Want Natural Food!" http://www.greenpeace.org/~geneng/ (March 2001).

Greenpeace International. "7. Public Concern" http://www.greenpeace.org/%7Egeneng/reports/food/intrfo07.htm (March 2001).

Greenpeace International. "11. The Potential For Allergic Reactions" http://www.greenpeace.org/%7Egeneng/reports/food/intrfo11.htm (March 2001).

Griffiths, William E., R. Carter Hill, and George G. Judge. *Learning and Practicing Econometrics*. 1993.

Griliches, Zvi. "Hybrid Corn: An Exploration in the Economics of Technical Change." *Econometrica* 25 (October 1957): 501-522.

Griliches, Zvi. "Hybrid Corn and the Economics of Innovation." *Science* 132 (July 29, 1960): 275-280.

Hammitt, James K. and John D. Graham. "Willingness to Pay for Health Protection: Inadequate Sensitivity to Probability?" *Journal of Risk and Uncertainty* 18 (April 1999): 33-62.

Hayes, Dermot J., Jason F. Shogren, Seung Youll Shin, and James B. Kliebenstein. "Valuing Food Safety in Experimental Auction Markets." *American Journal of Agricultural Economics* 77 (February 1995): 40-53.

Herrmann, Robert O., Rex H. Warland and Arthur Sterngold. "Who Reacts to Food Safety Scares? Examining the Alar Crisis." *Agribusiness* 13 (1997): 511-520.

Hoban, Thomas J. "Consumer Acceptance of Biotechnology: An International Perspective." *Nature Biotechnology* 15 (1997): 232-234.

Hoban, Thomas J. "American Consumers' Awareness and Acceptance of Biotechnology." In A. Eaglesham, S. G. Pueppke, and R. W.F. Hardy eds. NABC Report 13, Genetically Modified Food and the Consumer (2002): 103-115.

Hoffman, E., D. Menkhaus, D. Chakravarti, R. Field and G. Whipple. "Using Laboratory Experimental Auctions in Marketing Research: a Case Study of New Packaging for Fresh Beef." *Marketing Science*, 12 (1993): 318-338.

Huffman, Wallace E. and Abebayehu Tegene. "Public Acceptance of and Benefits from Agricultural Biotechnology: A Key Role for Verifiable Information," in V. Santaniello, R. E. Evenson, and D. Zilberman, eds. *Market Development for Genetically Modified Food*. CAB International, (2002).

Hur, Jae. "Snack Recalls Exacerbate Biotech Fuss." *Reuters*. (June 23, 2001).

Kagel, John H. "Auctions: a Survey of Experimental Research." IN J. Kagel and A. Roth ed, *Handbook of Experimental Economics*. Princeton University Press. Princeton, NJ (1995): 501-585.

Kirchhoff, Stefanie and Angelo Zago. "A Simple Model of Mandatory vs Voluntary Labeling of GMOs." Working Paper, Istituto Nazionale di Economia Agraria (2001).

Klein, Nicole L. and Gary W. Brester. "Economic Impacts of the Zero Tolerance Directive of the Cost Structure of Beef Packing Companies." Paper presented at the 1997 Western Agricultural Economics Association Meetings. (February 1997).

Klotz, C., A. Saha, and L.J. (Bees) Butler. "The Role of Information in Technology Adoption: the Case of rbST in the California Dairy Industry." *Review of Agricultural Economics* 17 (September 1995): 287-298.

Knetsch, J., F.F. Tang, and R. Thaler. "The Endowment Effect and Repeated Market Trials: Is the Vickrey Auction Demand Revealing?" *Experimental Economics* 4 (December 2001): 257-269.

List, John A. and David Lucking-Reiley. "Demand Reduction in Multiunit Auctions: Evidence from a Sportscard Field Experiment." *The American Economic Review* 90 (September 2000): 961-72

Lusk, J., M.S. Daniel, D. Mark, and C. Lusk. "Alternative Calibration and Auction Institutions for Predicting Consumer Willingness to Pay of Nongenetically Modified Corn Chips." *Journal of Agricultural and Resource Economics* 26 (July 2001): 40-57.

Lusk, Jayson L., John A. Fox, Ted C. Schroeder, James Mintert, and Mohammad Koohmaraie. "In Store Valuation of Steak Tenderness." *American Journal of Agricultural Economics* 83 (August 2001): 539-550.

Lusk, Jayson L., Jutta Roosen, and John A. Fox. "Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A Comparison of Consumers in France, Germany, the United Kingdom, and the United States. *American Journal of Agricultural Economics*, Forthcoming, 2002.

McClusky, Jill J. "A Game Theoretic Approach to Organic Foods: An Analysis of Asymmetric Information and Policy." *Agricultural and Resource Economics Review* 29 (April 2000): 1-9.

Melton, Bryan E., Wallace E. Huffman, Jason F. Shogren and John Fox. "Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops." *American Journal of Agricultural Economics* 78 (November 1996): 916-23.

Midwest Profiles. Department of Economics, Iowa State University. http://www.profiles.iastate.edu/. August 2001.

Milgrom, Paul and John Roberts. "Relying on the Information of Interested Parties." *Rand Journal of Economics* 17 (Spring 1986): 18-32.

Miller, G. and C. Plott. "Revenue Generating Properties of Sealed-bid Auctions" An Experimental Analysis of One-price and Discriminative Actions." In V. Smith, ed., *Research in Experimental Economics, vol. 3* (JAI press, Inc., Greenwich, CT), (1985): 159-182.

New York Times Search Engine. http://query.nytimes.com/search/advanced. (Retrieved January 30, 2002).

Noussair, Charles, Stephane Robin and Bernard Ruffieux. "Consumer Behaviour with

Regard to Genetically Modified Organisms in the Food Supply." Manuscript, Purdue University, (April 2002).

Noussair, Charles, Stephane Robin and Bernard Ruffieux. "Do Consumers not Care about Biotech Foods or do they Just Not Read the Labels?" *Economics Letters* 75 (March 2002): 47-53.

Olsen, Mancur. *The Logic of Collective Action: Public Goods and the Theory of Groups.* (1965) Harvard University Press, Cambridge, MA.

Phillips, Peter W.B. and Heather Foster. "Labeling for GM foods: Theory and Practice." Paper presented to the International Consortium on Agricultural Biotechnology Research (ICABR) on "The Economics of Agricultural Biotechnology" Ravello, (Italy) (August 24-28, 2000).

Phillips, Peter W.B. and Heather McNeill. "A Survey of National Labeling Policies for GM foods." *Agbioforum* 3 http://www.agbioforum.missouri.edu (2000): 219-224.

Phillips, Peter W.B. and Stuart Smyth. "Competitors Co-Operating: Establishing a supply chain to manage genetically modified canola." Presentation to the Economics of Quality Control in Agriculture Conference (1999).

Purvis, Amy, William G. Boggess, Charles B. Moss, and John Holt. "Technology Adoption Decisions under Irreversibility and Uncertainty: An *Ex Ante* Approach." *American Journal of Agricultural Economics* 77 (August 1995): 541-551.

Putnum, Judith Jones and Jane E. Allshouse. "Food Consumption, Prices, and Expenditures, 1970-1997." Economic Research Service, U.S. Department of Agriculture, *Statistical Bulletin No. 965* (April 1999).

Runge, C. Ford and Lee Ann Jackson. "Negative Labeling of Genetically Modified

Organisms (GMOs): The Experience of rBST." *AgBioForum* 3 http://www.agbioforum.missouri.edu (2000) 310-314.

Ruttan, Vernon V. *Technology, Growth, and Development.* Oxford University Press (2001).

Shipman, David R. "Marketing of Grains in Today's Evolving Markets." Presentation at the meeting "Strategies for Coexistence of GMO, Non-GMO, and Organic Crop Production." Minneapolis, MN. (November 28, 2001).

Shoemaker, Robbin *et al* "Economic Issues in Agricultural Biotechnology." Economic Research Division, U.S. Department of Agriculture. *Agriculture Information Bulletin No. 762* (February 2001).

Shogren, Jason F., "Experimental Methods and Valuation," in K. G. Maler and J. Vincent, eds. *Handbook of Environmental Economics*. Amsterdam, the Netherlands, forthcoming.

Shogren, Jason F., John A. List and Dermot J. Hayes. "Preference Learning in Consecutive Experimental Auctions." *American Journal of Agricultural Economics* 82 (November 2000): 1016-21.

Shogren, Jason F., M Margolis, C Koo, John A. List, "A Random *n*th-Price Auction." *Journal of Economic Behavior and Organization* 46 (December 2001): 409-421.

Shogren, Jason F., Seung Y. Shin, Dermot J. Hayes and James B. Kliebenstein. "Resolving Differences in Willingness to Pay and Willingness to Accept." *The American Economic Review* 84, No. 1 (March 1994): 255-270.

Smyth, Stuart and Peter W.B. Phillips. "Science and Regulation: Assessing the impacts of incomplete information and information in the global agricultural biotechnology industry." Paper presented to the International Consortium on Agricultural Biotechnology Research (ICABR) on "The Economics of Agricultural Biotechnology" Ravello, (Italy) (August 24-28, 2000).

Stigler, George J. "The Economics of Information." *Journal of Political Economy* 69 (June 1961): 213-225.

Tambling, Grant. "Labelling of Genetically Modified Food." http://www.anzfa.gov.au/documents/mr24_99.asp (Retrieved May 2001).

Thrane, Linda. "About Us." Council for Biotechnology Information. http://www.whybiotech.com/en/whoarewe/con35.asp?MID=2. (Retrieved September 2001).

Teisl, Mario F., Nancy E. Bockstael and Alan Levy. "Measuring the Welfare Effects of Nutrition Information." *American Journal of Agricultural Economics* 83 (February 2001): 133-149.

U.S. Census Bureau. http://www.census.gov/ (Retrieved June 21, 2002)

U.S. Food and Drug Administration. "Guidance for Industry: Voluntary Labeling Indicating Whether Foods Have or Have Not Been Developed Using Bioengineering." http://vm.cfsan.fda.gov/~dms/biolabgu.html (January 2001).

Vickrey, William. "Counterspeculation, Auctions, and Competitive Sealed Tenders." *Journal of Finance* 16 (March 1961): 8-37.

Viscusi, Kip W. "Alarmist Decisions with Divergent Risk Information." *The Economic Journal* 107 (November 1997): 1657-1670.

Viscusi, Kip W. and William N. Evans. "Utility Functions that Depend on Health Status:

Estimates and Economic Implications." *American Economic Review* 80 (June 1990): 353-374.

Viscusi, Kip W., Wesley A. Magat, and Joel Huber. "An Investigation of the Rationality of Consumer Valuations of Multiple Health Risks." *The Rand Journal of Economics* 18 (Winter 1987): 465-479.

Vogel, David. "The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics." Prepared for a workshop on trans-Atlantic differences in GMO regulation sponsored by the Council of Foreign Relations. (2001).

Wozniak, Gregory D. "Joint Information Acquisition and New Technology Adoption: Late Versus Early Adoption." *The Review of Economics and Statistics* 75 (August 1993): 438-445.

CHAPTER 10: APPENDIX

10.1. Demographic Characteristics of Polk County, IA (including Des Moines area) and Ramsey County, MN (including St. Paul area)

Variable	Definition	Polk	Ramsey	Weighted 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	57.3
Education	Years of schooling **	13.52	13.76	13.6
Income	The median households income level (in thousands)	46.1	45.7	46.0
White	1 if participant is white	0.9	0.8	0.87

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.

10.2. Third Party, Verifiable Information Given to Participants

The following is a statement on genetic modification approved by a third party group, consisting of a variety of individuals knowledgeable about genetically modified foods, including scientists, professionals, religious leaders, and academics. These parties have no financial stake in genetically modified foods.

General Information

Bioengineering is a type of genetic modification where genes are transferred across plants or animals, a process that would not otherwise occur (In common usage, genetic modification means bioengineering). With bioengineered pest resistance in plants, the process is somewhat similar to the process of how a flu shot works in the human body. Flu shots work by injecting a virus into the body to help make a human body more resistant to the flu. Bioengineered plant-pest resistance causes a plant to enhance its own pest resistance.

Scientific Impact

The Food and Drug Administration standards for GM food products (chips, cereals, potatoes, etc.) is based on the principle that they have essentially the same ingredients, although they have been modified slightly from the original plant materials.

Oils made from bioengineered oil crops have been refined, and this process removed essentially all the GM proteins, making them like non-GM oils. So even if GM crops were deemed to be harmful for human consumption, it is doubtful that vegetable oils would cause harm.

Human Impact

While many genetically modified foods are in the process of being put on your grocers' shelf, there are currently no foods available in the U.S. where genetic modification has increased nutrient content.

All foods present a small risk of an allergic reaction to some people. No FDA approved GM food poses any known unique human health risks.

Financial Impact

Genetically modified seeds and other organisms are produced by businesses that seek profits. For farmers to switch to GM crops, they must see benefits from the switch. However, genetic modification technology may lead to changes in the organization of the agri-business industry and farming. The introduction of GM foods has the potential to decrease the prices to consumers for groceries.

Environmental Impact

The effects of genetic modification on the environment are largely unknown. Bioengineered insect resistance has reduced farmers' applications of environmentally hazardous insecticides. More studies are occurring to help assess the impact of bioengineered plants and organisms on the environment. A couple of studies reported harm to Monarch butterflies from GM crops, but other scientists were not able to recreate the results. The possibility of insects growing resistant to GM crops is a legitimate concern.

10.3. Instruction Packet Given to all Participants

Welcome! Thank you for choosing to participate in an experiment about decision making. In this folder is a packet of information that you will need during the experiment. Once you have looked at a form during the experiment, feel free to go back and examine that form again if need be, but please do not look ahead, until we reach the right point in the experiment.

Please follow the instructions carefully. To ensure accuracy, please do not talk to any other participants.

I would like to emphasize that all information obtained today will be used only for group comparisons. No information on any individual will be divulged for any reason.

Please turn to the next page, and fill out the questionnaire.

I.D. # _____.

Please answer the following questions by circling the appropriate choice or filling in the appropriate line

1. What is the population of the city that you live in?
    a. Less than 5,000
    b. Between 5,000 – 99,999
    c. More than 100,000

2. What best describes your marital status?
    a. Married
    b. Single with live-in partner
    c. Single
    d. Other

3. What is your gender?
    a. Male
    b. Female

4. What is your age? ________

5. When you buy a food product for the first time, how often do you read the information on the label before you buy?
    a. Never
    b. Rarely
    c. Some of the time
    d. Often
    e. Always

6. How many people live in your household? ________

7. What was your religious affiliation when you were young?
    a. Baptist
    b. Catholic
    c. Jewish
    d. Lutheran
    e. Methodist
    f. Other
    g. No religion when young

8. How many children in each age group are living in your household? (if you have no children, enter zero for all age groups)
    a. 0-3 years old ________
    b. 4-7 years old ________
    c. 8-12 years old ________
    d. 13-18 years old ________
    e. Older than 18 ________

9. What is the highest level of schooling that you have completed?
    a. Some high school
    b. Graduated from high school
    c. Some college
    d. 2 year college degree
    e. 4 year college degree
    f. Beyond 4 year college degree

10. What is your ethnic background?
    a. Hispanic
    b. White (non-Hispanic)
    c. African-American
    d. Asian-American
    e. Native American
    f. Other (please fill in) ________________

11. What was your total household income (before taxes) in 2000?
    a. Under 10,000
    b. $10,000-$14,999
    c. $15,000-$19,999
    d. $20,000-$24,999
    e. $25,000-$29,999
    f. $30,000-$34,999
    g. $35,000-$39,999
    h. $40,000-$49,999
    i. $50,000-$59,999
    j. $60,000-$74,999
    k. $75,000-$99,999
    l. $100,000-$124,999
    m. $125,000-$149,999
    n. Over $150,000

12. How many people do you think get sick from genetically modified foods each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

____

13. How many people do you think get sick from irradiated foods each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

____

14. How many people do you think get sick from artificial growth hormones each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

____

15. How many people do you think get sick from vaccines for diseases each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

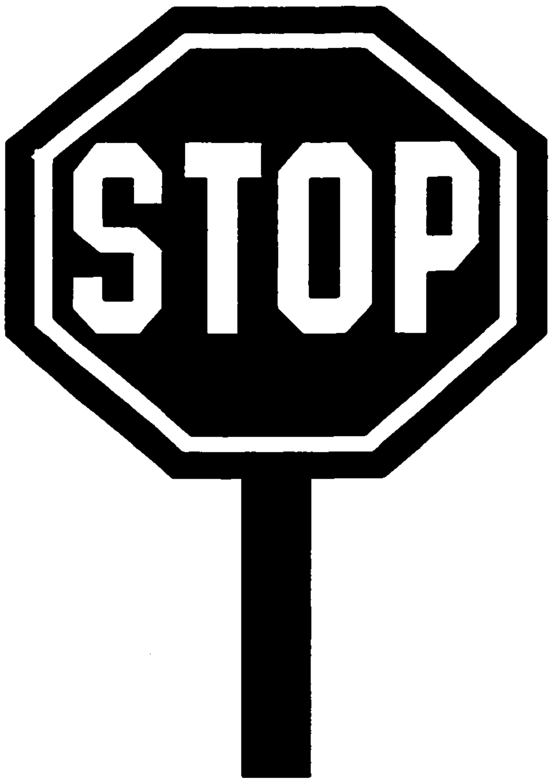
____

16. How much control do you have over your exposure to risk from genetically modified foods?
    a. Total control
    b. A lot of control
    c. Some control
    d. A little control
    e. No control
    f. I don't know

17. Regarding genetically modified foods, how informed do you consider yourself?
    a. Extremely well informed
    b. Well informed
    c. Somewhat informed
    d. Not very informed
    e. Not informed at all
    f. I don't know

18. Are you employed in agriculture or farming?
    a. Yes
    b. No

19. Are you a member of an environmental group?
    a. Yes
    b. No



Please do not turn the page until instructed by your monitor.

Once again, I would like to thank you for participating in this experiment today.

Today we will be holding auctions of some common products. There will be some detailed instructions of how the auction works shortly.

Because we are trying to determine values for different products, we ask that you please refrain from communicating with the other participants. If you have any questions, the monitors can assist you.

Stage One – How the Auction Works

Step one: Explanation of auction format

The n^{th} price auction

We are going to hold what is called an n^{th} price auction today. This type of auction has you write down your bids on a sheet of paper (the bids are private). The way this auction works can be shown in 4 steps.

1. Examine the products
   Before we ask you to bid on a product, we will let you come up to the front of the room and examine the products that you will be bidding on.

2. Write down your bid for the product
   After the products are examined, you can write down what you would like to bid for the product on your "bid sheet".

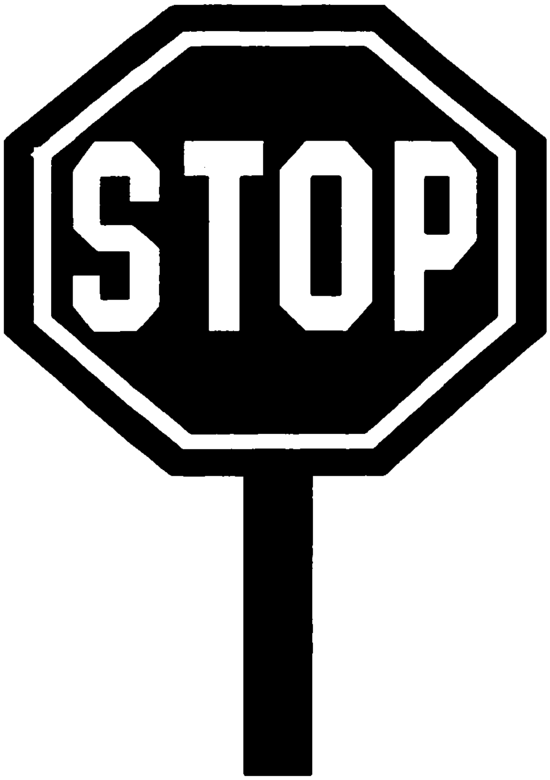
3. Choosing of the n^{th} price
   Once everyone has bid, we will determine what will be called the n^{th} price.
   Everybody who bids **higher** than this price will win the product, and pay the n^{th} price.

   (Your monitor will go through an example of this)

4. Determining who wins the auction

   (Your monitor will go through an example of this)

Please note that in this auction it is always in your best interest to bid your true value for a product. Unlike many auctions, in which you might bid less to try to get a deal, this auction does not reward that. This is because you do not necessarily pay your price, but you pay the n^{th} price that is chosen randomly. Likewise, it is not in your interest to bid more than you are truly willing to pay, because you may have to pay more than you wanted to for the product.



Please do not turn the page until instructed by your monitor.

Step two: Short quiz on auction format (this sheet will not be collected)

Short Quiz on auction format

True or False

1. The people who win will always pay the amount they bid for a product.

a) True
b) False

2. If you have the fourth highest bid, and the randomly drawn nth price is the 2nd, you will win your auction.

a) True
b) False

3. I might get to pay less than my bid for a product, but I will never have to pay more than my bid for a product.

a) True
b) False

Multiple choice

4. If the binding price that is randomly drawn is the 7th price, how many people win the good?

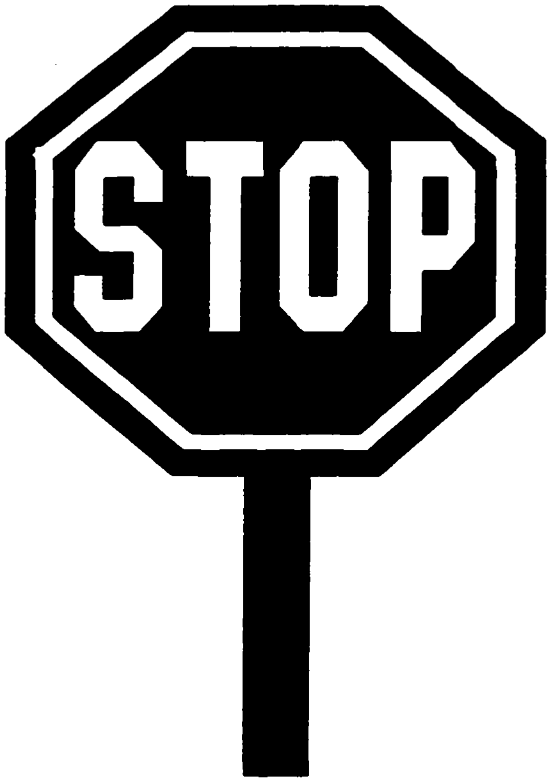
    a) 4

    b) 5

    c) 6

    d) 7

    e) 8



Please do not turn the page until instructed by your monitor.

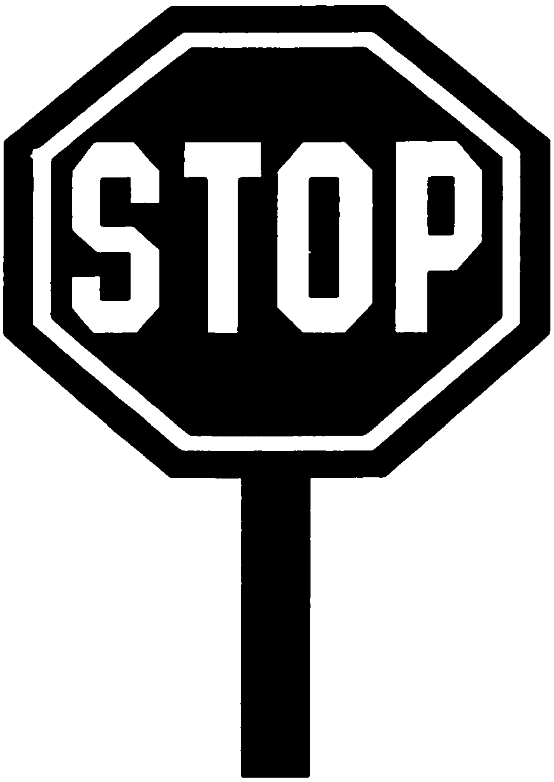
Stage 2, Practice Rounds (7 steps)

Step one: Explanation of the practice Rounds

There will be two rounds of bidding in the practice rounds. We are about to begin the first practice round. Since some of the products are similar, only one of the two practice rounds will be binding. That is, only one of the two practice rounds will be chosen as the round where people will win goods (i.e. only one round "counts"). Since you do not know which round will be chosen, it is in your best interest to bid your true value for the products in both practice rounds. The round that binds has been computer generated, and will be revealed after the second practice round.

Step two: Examining the product in practice round one (candy bar)

Step three: Bidding on the candy bar, please fill out your bid on the bid sheet provided on the next page



Please do not turn the page until instructed by your monitor.

Stage 2, Practice Rounds (continued)

Step 4: Examine the three products available in the second stage of the practice round.

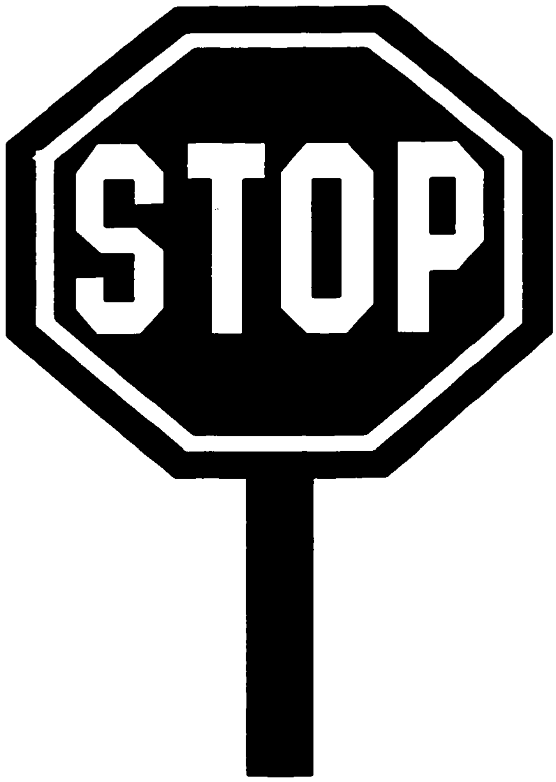
Step 5: Turn to next page, and fill out bids for the three products on the bid sheets provided.

Now instead of one product to bid on, there are three. Please bid on these three products, and remember that only one of these two rounds will bind.

Step 6: Determination of the binding round (computer generated)

Step 7: Determine the n^{th} prices for each product (computer generated)

Step 8: Announcement of the auction winners for each product (goods and money will be exchanged at the end of the auction).



Please do not turn the page until instructed by your monitor.

Stage 3, first round

Step one: Please take a few minutes and read the following information given on the next two pages.

The following is a collection of statements and information on genetic modification from Greenpeace, a leading environmental group.

General Information

Genetic modification is one of the most dangerous things being done to your food sources today. There are many reasons that genetically modified foods should be banned, mainly because unknown adverse effects could be catastrophic! Inadequate safety testing of GM plants, animals, and food products has occurred, so humans are the ones testing whether or not GM foods are safe. Consumers should not have to test new food products to ensure that they are safe.

Scientific Impact

The process of genetic modification takes genes from one organism and puts them into another. This process is very risky. The biggest potential hazard of genetically modified (GM) foods is the unknown. This is a relatively new technique, and no one can guarantee that consumers will not be harmed. Recently, many governments in Europe assured consumers that there would be no harm to consumers over mad-cow disease, but unfortunately, their claims were wrong. We do not want consumers to be harmed by GM food.

Human Impact

Genetically modified foods could pose major health problems. The potential exists for allergens to be transferred to a GM food product that no one would suspect. For example, if genes from a peanut were transferred into a tomato, and someone who is allergic to peanuts eats this new tomato, they could display a peanut allergy.

Another problem with genetically modified foods is a moral issue. These foods are taking genes from one living organism and transplanting them into another. Many people think it is morally wrong to mess around with life forms on such a fundamental level.

Financial Impact

GM foods are being pushed onto consumers by big businesses, which care only about their own profits and ignore possible negative side effects. These groups are actually patenting different life forms that they genetically modify, with plans to sell them in the future. Studies have also shown that GM crops may get lower yields than conventional crops.

Environmental Impact

Genetically modified foods could pose major environmental hazards. Sparse testing of GM plants for environmental impacts has occurred. One potential hazard could be the impact of GM crops on wildlife. One study showed that one type of GM plant killed Monarch butterflies.

Another potential environmental hazard could come from pests that begin to resist GM plants that were engineered to reduce chemical pesticide application. The harmful insects and other pests that get exposed to these crops could quickly develop tolerance and wipe out many of the potential advantages of GM pest resistance.

The following is collection of statements and information on genetic modification provided by a group of leading biotechnology companies, including Monsanto and Syngenta.

General Information

Genetically modified plants and animals have the potential to be one of the greatest discoveries in the history of farming. Improvements in crops so far relate to improved insect and disease resistance and weed control. These improvements using bioengineering/GM technology lead to reduced cost of food production. Future GM food products may have health benefits.

Scientific Impact

Genetic modification is a technique that has been used to produce food products that are approved by the Food and Drug Administration (FDA). Genetic engineering has brought new opportunities to farmers for pest control and in the future will provide consumers with nutrient enhanced foods. GM plants and animals have the potential to be the single greatest discovery in the history of agriculture. We have just seen the tip of the iceberg of future potential.

Human Impact

The health benefits from genetic modification can be enormous. A special type of rice called "golden rice" has already been created which has higher levels of vitamin A. This could be very helpful because the disease Vitamin A Deficiency (VAD) is devastating in third-world countries. VAD causes irreversible blindness in over 500,000 children, and is also responsible for over one million deaths annually. Since rice is the staple food in the diets of millions of people in the third world, Golden Rice has the potential of improving millions of lives a year by reducing the cases of VAD.

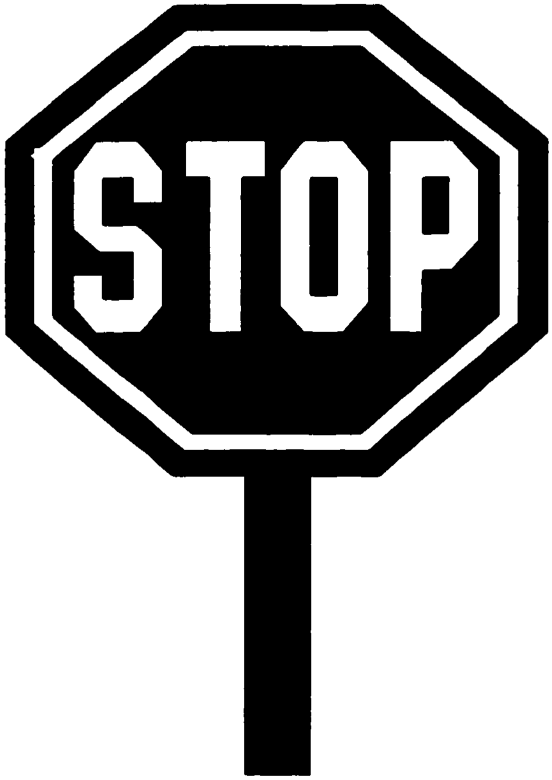
The FDA has approved GM food for human consumption, and Americans have been consuming GM foods for years. While every food product may pose risks, there has never been a documented case of a person getting sick from GM food.

Financial Impact

Genetically modified plants have reduced the cost of food production, which means lower food prices, and that can help feed the world. In America, lower food prices help decrease the number of hungry people and also lets consumers save a little more money on food. Worldwide the number of hungry people has been declining, but increased crop production using GM technology can also help further reduce world hunger.

Environmental Impact

GM technology has produced new methods of insect control that reduce chemical insecticide application by 50% or more. This means less environmental damage. GM weed control is providing new methods to control weeds, which are a special problem in no-till farming. Genetic modification of plants has the potential to be one of the most environmentally helpful discoveries ever.



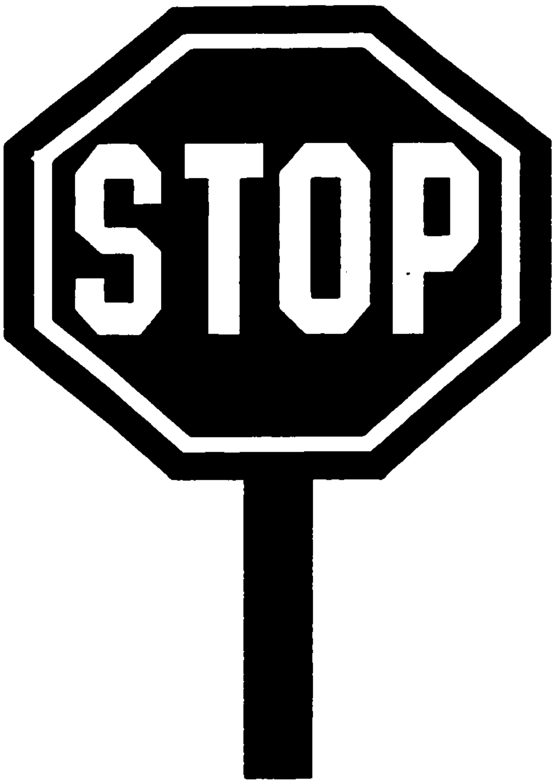
Please do not turn the page until instructed by your monitor.

Stage 3, first round (continued)

Step 2: Examining the three products that are in the auction

Step 3: Please turn to the next page, where there will be three bid sheets. Please bid on these three products.

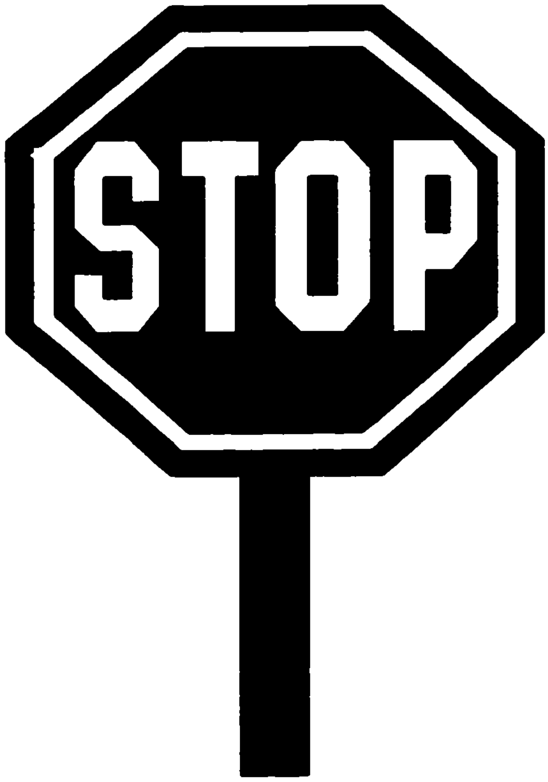
Again, there will be 2 rounds of bidding, but only one of the two rounds will be chosen as binding



Please do not turn the page until instructed by your monitor.

Stage 4, second round

Step 1: Examining the three products
Step 2: Please turn to the next page, where there will be three bid sheets. Please bid on these three products.



Please do not turn the page until instructed by your monitor.

Stage 4, second round (continued)

Step 3: Choose the binding round (computer generated)
Step 4: Choose the n^{th} price for all three goods
Step 5: Post the winning prices
Step 6: Please fill out the post auction questionnaire on the next page
Step 7: The exchange of money and goods

I.D. # ______.

Post-Auction Questionnaire

1. How many people do you think get sick from genetically modified foods each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

   ____

2. How many people do you think get sick from irradiated foods each year in the United States? (note: there are approximately 300,000,000 people in the U.S.)

   ____

3. How much control do you have over your exposure to risk from genetically modified foods?
   a. Total control
   b. A lot of control
   c. Some control
   d. A little control
   e. No control
   f. I don't know

4. Regarding genetically modified foods, how informed do you consider yourself?
   a. Extremely well informed
   b. Well informed
   c. Somewhat informed
   d. Not very informed
   e. Not informed at all
   f. I don't know

5. If a source were to give you verifiable information on genetically modified foods, who would you trust most?

   ____