An Experimental Investigation of Consumer Willingness to Pay for Non-GM Foods When an Organic Option Is Present

John C. Bernard, Chao Zhang, and Katie Gifford

This research compared bids that consumers placed on non genetically modified (GM), organic, and conventional versions of food products in order to determine if the organic market well serves those seeking to avoid GM foods. Auction experiments using potato chips, tortilla chips, and milk chocolate were conducted with 79 subjects. Bids were modeled as a function of consumer demographics using a heteroskedastic tobit regression model. Results with the non-GM attribute nested into the organic characteristic showed that the latter's marginal effects were insignificant. This suggested the potential to further develop non-GM products for consumers not willing to pay extra for the remaining organic attributes.

Key Words: auction experiments, GM foods, organic foods, willingness to pay

Two trends that have had a substantial impact on the U.S. food system are the increased availability and variety of organic food products and the development and spread of genetically modified (GM) foods. The annual rate of growth in organic food sales has been 20 percent or more over the past decade (Dimitri and Greene 2002). At the same time, GM ingredients have gone from being nearly nonexistent to being found in approximately 70 percent of processed foods (Hallman et al. 2003). The growth in these two groups appears to have been generated by opposite ends of the food system. Organic foods appear to be primarily driven by consumer demand whereas GM food products are primarily due to farmers' desires to improve production and profits.

Existing GM crop varieties offer desirable production traits such as herbicide tolerance or insect resistance. The non-crop biotechnology rBST, which aids in increasing milk production, has also been aimed at the farm, with little evident consumer benefit. The success farmers have had with these products has led to the widespread use of such ingredients in the food system over the past decade. Despite this, polls consistently show that a large number of consumers have reservations about the inclusion of GM ingredients in the foods they eat. These consumer concerns include a spectrum of health, food safety, and environmental issues. Importantly, these are the same issues that had already been leading many consumers to organic foods (Gregory 2000). Thus, the spread of GM foods may be a significant factor in continuing changes in consumer demand patterns involving organic foods.

The U.S. government assessed labeling of both organic and GM foods. As discussed in Golan, Kuchler, and Mitchell (2001), however, the government selected different approaches. The U.S. Department of Agriculture's and the U.S. Food and Drug Administration's policies toward GM foods requires labeling only if the food is substantially different from the common variety, has different nutritional value, or includes an unexpected allergen. The majority of available GM foods have been classified as substantially equivalent to their traditional counterparts and do not require labeling. Voluntary labeling is allowed,

John Bernard is Associate Professor, Chao Zhang a former graduate student, and Katie Gifford Research Associate in the Department of Food and Resource Economics at the University of Delaware. The authors wish to thank three anonymous reviewers for their comments and Daria Bernard for her comments and help with the experiments. This research was supported by the University of Delaware General University Research Fund and by USDA/NRI Grant No. 2003-35400-13812.

Agricultural and Resource Economics Review 35/2 (October 2006) 374–385

although suppliers of non-GM foods may not suggest that health benefits exist from avoiding GM foods. Coupled with a lack of third-party certification services, there has so far been only minimal use of non-GM labeling.

In contrast, the government established a national standards and certification program for organic foods, which became effective in October 2002. Part of this standardized definition prohibited GM foods from being classified as organic regardless of the practices used in production.[1] Thus buying organic is the only guaranteed method for consumers to avoid GM foods. It has been argued that having only one alternative is sufficient for consumers trying to avoid GM foods. This could, however, be creating inefficiency in that the premium for organic foods includes other attributes the consumers may not desire or be interested in paying an additional premium for. Part of the organic food demand as observed in grocery stores may thus include the demand for the missing non-GM food market, and thus may not accurately reflect consumer preferences.

The goal of this research was to measure the determinants of consumer willingness to pay for organic and non-GM foods relative to one another and to conventional foods. The objective was to identify and compare the different bids that consumers would place on non-GM and organic foods over conventional versions of the same food products. By including all three versions of the food, we help determine if indeed the organic market well serves those seeking to avoid GM foods. Bids were modeled as a function of consumer demographic characteristics using a heteroskedastic tobit regression that allowed the nesting of the non-GM attribute into the organic characteristic.

Background

While previous studies have examined consumer willingness to pay (WTP) for GM, non-GM, or organic foods, the Loureiro and Hine (2002) study is one of only a few that examine all three simultaneously. Using surveys conducted in local supermarkets, the authors looked at WTP for locally grown, organic, and GM-free potatoes. As age increased, WTP for organic potatoes decreased, while having graduate education along with a household income over $75,000 increased the WTP for both organic and GM-free potatoes. Govindasamy and Italia (1999) found the same results for age and income with respect to WTP for organic, and also found that smaller households and more educated consumers also had higher WTP. Other studies have found few significant differences across demographic categories. For instance, Williams and Hammitt (2000) found attitudinal variables such as trust in food safety and perceived risks and benefits from organic and conventional methods to be of primary importance.

Other studies have looked at WTP for GM or non-GM foods. A useful summary and analysis of many of these can be found in Lusk et al. (2005). One important finding is that how information is presented to consumers can be quite influential. For example, Boccaletti and Moro (2000) used a survey of consumers in Italy to look at the premium for GM foods when they are described with desirable characteristics. Most relevant to this study, they found higher WTP for GM foods described as requiring less use of pesticides, an attribute that should appeal to consumers of organic food. Income and education were both significant demographic variables. Unfortunately, this was not compared to WTP for GM food when consumers also had the choice of organic.

Information was also important in the study of Huffman et al. (2003). They used an experimental auction to look at WTP for GM foods. Experiments typically can yield much better estimates of WTP; their strengths lie in the ability to control conditions to isolate the variables of interest and by having subject responses based on financial incentives [for a comparison of WTP methodologies, see Lee and Hatcher (2001)]. Their study reported results from auction experiments involving three food categories (russet potatoes, tortilla chips, and vegetable oil) with labeling treatments of no ingredient information and "made using genetic modification (GM)." They found that consumers were willing to pay significantly more for the versions with no label information.

Lusk (2004) and Lusk et al. (2001) also examined WTP using experimental auctions. For the experiments, student subjects were given a bag of

[1] The initial proposal would have allowed correctly produced GM foods to be classified as organic. This was altered after a record number of predominantly negative comments were received from the public (Golan, Kuchler, and Mitchell 2001).

GM corn chips (Lusk et al. 2001) or a cookie (Lusk 2004), and auctions were conducted to exchange it with a non-GM bag. Consumption of the food item at the conclusion of the experiment was mandatory. The researchers concluded that some consumers would pay a premium for non-GM foods, and that an estimated 10 percent of U.S. consumers are opposed to biotechnology.

Our study is different from previous research in several important ways. First, products here were labeled as being non-GM, rather than GM as in most of the studies above. Huffman (2003) suggested that it would be producers of non-GM products that would voluntarily label this attribute, thus making a non-GM designation more likely than a GM designation to reflect market conditions. Runge and Jackson (2000) have similarly argued for the use of "contains no GM" labels. Currently, non-GM labels can be found in stores, but to our knowledge no producers are labeling food that is genetically modified. Second, the study attempts to accurately reflect markets by including the organic option for consumers to select. These steps together present consumers with a more realistic market setting than has been previously considered and should thus allow us to gain better insight into actual purchase decisions. These steps together present consumers with a more realistic market setting than has been previously considered, allowing us to gain better insight into actual purchase decisions and to take into account the nested aspect of the non-GM attribute of organic food in the analysis. By including both non-GM and organic as choices, with non-GM clearly presented as a component of organic, we can analyze how well the existence of an organic market satisfies consumers trying to avoid GM foods.

Experimental Design

Thirteen experiment sessions of between 6 and 8 subjects each, for a total of 82 participants, were held across varying dates in 2003. Three subjects failed to provide the necessary demographic information needed for analysis, leaving a usable sample of 79. All were from northern Delaware and had been recruited through a combination of classified advertisements in local newspapers and an online campus site, flyers placed in the entryway of numerous grocery stores, and announcements through local organizations.[2] During recruiting, subjects were informed that they would be paid approximately $30 in cash for taking part in an economic research project involving consumer interest in foods produced with different attributes.

Each session consisted of four steps.[3] The first step involved explaining the auction mechanism and conducting practice periods to improve subject understanding. Vickrey's (1961) sealed-bid second-price auction was employed. This type of auction has been used rarely in the economy, except in specialized applications such as auctions for paper collectibles including stamps (Lucking-Reiley 2000). However, it has been commonly applied in WTP experiments. This is due to the favorable theoretical demand-revealing nature of the mechanism. In a second-price auction, bidders bid secretly and simultaneously. The highest bidder wins the item being sold and pays a price equal to the second highest bid.

The auction is truth-revealing since the final auction price depends on the bid of an independent bidder. However, there have been questions about its demand-revealing properties in practice. Several studies in the induced value framework have found a strong tendency toward subjects overbidding (see for example Harstad 2000), while others have not observed this problem (see for example Noussair, Robin, and Ruffieux 2004). Some recent studies have employed a random *n*th price auction instead. However, there is limited evidence of the benefit of the random *n*th price auction, and Parkhurst, Shogren, and Dickinson (2004) showed that the second price auction may perform better at eliciting true values.

A concern with Vickrey auctions is that the mechanism is not transparent enough for subjects to readily grasp the best strategy. A commonly used solution to help subjects understand the Vickrey is to employ repeated trials. In this format, popularized by Shogren et al. (1994), the same item is auctioned multiple times with a price announced after each trial and a final binding price randomly selected after all the trials. How-

[2] Local organizations included two different church groups, a 4-H chapter, and a grade school association. Subjects recruited through these organizations represented about half the sample.

[3] Instructions and questionnaires used in the experiments are available from the authors upon request.

ever, there are concerns that this strategy can lead to subject affiliation—in other words, simply following the prices from the previous trial. For instance, Knetsch, Tang, and Thaler (2001) and Harrison, Harstad, and Rutström (2004) argue against the use of repeated trials. List and Shogren (1999) found some affiliation of values over repeated trials, particularly for items where consumers did not possess good *ex ante* information. Due to concerns, the design here instead included a brief lecture on the mechanism, including examples showing the best strategy, and three practice periods with induced values.[4]

In the practice auctions, subjects bid for an imaginary commodity for which they were each given a sheet with its value (randomly generated from the range $0 to $1). To make sure most subjects were involved, three units were offered for sale and it was explained that the price would thus be set at the fourth-highest bid. Subjects that purchased a unit earned the difference between their assigned value and the auction price. Results from each round were announced before the next round began and earnings were added to subjects' final payments.

In the second stage, the categories of the food products were explained. Each food item was presented to subjects in three categories: conventional, non-GM, and organic. Each category was explained prior to the experiment, and descriptions were neutral to avoid influencing subject behavior. GM foods were described as being mostly plants that contain genes inserted to make them herbicide-tolerant or pest- or disease-resistant, and also milk from cows administered the genetically engineered cow growth hormone rBST. Non-GM foods were described as not containing any ingredients that are a product of genetic modification. Organic foods were described based on the definition from the USDA certification program, including emphasis on the non-GM requirement. Conventional foods were defined as definitely not being organic but as foods for which the presence or absence of GM ingredients is indeterminate.[5]

The third stage was the food auctions. Subjects were informed that while there would be several auctions, only one would count and thus they would at most be purchasing only one food product. The three food items selected for this research were potato chips (5.5 oz. bag), tortilla chips (14.5 oz. bag), and milk chocolate (3.5 oz. bar). These were selected based on four factors: availability, likelihood that the conventional version would have GM ingredients, ease of handling, and ability to avoid zero bids. The three versions of each food item were displayed for close inspection in transparent storage bags.[6] They were removed from their original packages so that the brand would not influence subject behavior. No deception was used in the experiment and all products were as presented to the subjects.

Bids for all three versions of each product were collected simultaneously. As noted by Alfnes and Rickertsen (2003), this is an efficient method for eliciting WTP differences since all bids can be used. It was stressed that bids should reflect what the subjects were willing to pay, not what they believed actual grocery store prices to be. No bidding information was given between products to avoid any chance of affiliation or order effects. After all three sets of food auctions, a binding auction was randomly selected. This was done by having one subject pull a slip from a bag. At that point, the reigning price for that food was announced and the buyer identified.

---

[4] Induced values were used so that subject bids could be directly compared with assigned values and in order to avoid affiliation if an actual commodity were auctioned. By the last practice period, bids were different from induced values by an average of only 0.0002, suggesting that the lesson was successful.

[5] The exact description given to subjects in the instructions was as follows: "Genetically modified foods are those with ingredients created through modern biotechnology using recombinant DNA techniques. Most current genetically modified food ingredients come from plants that have had one or more genes from other species inserted to make the plants herbicide-tolerant, or disease- or pest-resistant. Plants modified in this way include soybeans, corn, canola, and potatoes. They have been grown since the mid-1990s and have been approved by the FDA, USDA, and EPA. The other major product in this category is milk that comes from cows treated with rBST, a genetically engineered version of a natural cow growth hormone, in use since 1994. *Non-GM foods*, therefore, are those that do not contain any ingredients that are a product of genetic modification. *Organic food* is produced without using synthetic pesticides, hormones or antibiotics, irradiation, petroleum or sewage sludge based fertilizers, or genetically modified ingredients. *Conventional foods* are items that are not organic and may or may not contain GM ingredients."

[6] This is different from the typical presentation on store shelves where only tortilla chips tend to be visible through the packaging. However, due to the lack of familiarity it was expected many subjects would have with the varying versions, it was decided to make the contents visible. In general, few visual differences existed.

In the final step, subjects were asked to fill out a post-experiment questionnaire. The purpose of the questionnaire was to collect the necessary demographic questions for modeling, including gender, age, race, education, income, and children in the household. Upon completion, subjects were paid their earnings in cash and dismissed.

Model and Hypotheses

Past studies, such as Lusk et al. (2001), have designed models to include both demographic and attitude and knowledge variables commonly collected on surveys accompanying experiment sessions. However, there should be concern about the possibility that an individual's bids or attitudes are jointly determined by his or her demographics. If such were the case, this would create an endogeneity problem that would lead to a violation of model assumptions. The concern for this stems from the lack of significance of many typical demographic variables in some previous studies. To alleviate this potential concern, the model here was constructed solely with demographic variables.

Variable definitions and descriptive statistics for the 79 subjects are presented in Table 1. A closer look at the sample demographics reveals that the majority were female (62 percent), that the vast majority were white (90 percent), and that less than half had a college or advanced degree (46 percent). A comparison with census figures revealed the sample to be somewhat more highly educated and less racially diverse than the state population (U.S. Census Bureau 2000). However, since the demographics were the characteristics to be modeled and each was still well represented, this was not seen as a concern.

Since zero bids were possible, analysis needed to be conducted using censored regression techniques. Specifically, a tobit model was used to account for the potential of lower-bound censoring (Long 1997). In this model it is assumed there exist latent variables $bid_{i,j,k}$* representing subject i's bid for product $j \in$ {potato chips, tortilla chips, chocolate} and characteristic $k \in$ {conventional, non-GM, organic}. These latent variables are related to the observed bids, $bid_{i,j,k}$, by

$$\text{bid}_{i,j,k} = \begin{cases} 0 & \text{if } \text{bid}^*_{i,j,k} \le 0 \\ \text{bid}^*_{i,j,k} = \mathbf{x}\beta + \varepsilon_i & \text{if } \text{bid}^*_{i,j,k} > 0, \end{cases}$$

where, in this general form, **x** represents the vector of independent variables, and ε_i is normally distributed with mean 0 and standard deviation σ. The initial formation of the vector **x** was as follows:

x = (age, income, college, post-grad, female, child, non-white),

where the variables are as in Table 1.

To capture the marginal effects from the differing product characteristics, the following specific regression model was constructed:

$$\text{bid}^*_{i,j,k} = x_i\beta_j + \delta_N x_i \beta^N_j + \delta_O x_i \beta^O_j + e_{i,j,k},$$

where δ_N is a dummy variable equaling 1 for k = non-GM or organic, and δ_O is a dummy variable equaling 1 for k = organic. Notice that this formation allows for the capturing of the nested aspect of the non-GM characteristic in both the non-GM and organic versions of each food product. Thus, β^N_j is a vector of parameters capturing the marginal effect of x_i on bids for the jth product containing the non-GM characteristic, β^O_j is a vector of parameters capturing the marginal effect of x_i on bids for the jth organic product, while β_j is a vector of parameters capturing how x_i influences the bids for the jth conventional product. Lastly, $e_{i,j,k}$ is the normally distributed error.

A potential concern with this model would be the existence of heteroskedasticity. It is possible that differences in variations in bids exist across all three major components: subject, product, and product characteristic. To test and if necessary correct for this, a heteroskedastic tobit regression was proposed with the following assumption about the variance of $e_{i,j,k}$:

$$\text{var}(e_{i,j,k}) = \sigma^2_{i,j,k} = \sigma^2_i \sigma^2_j \sigma^2_k,$$

thus allowing for multiplicative heteroskedasticity across the three key model components. In practice, however, the model cannot be correctly estimated with separate variances for every subject, and so subject heteroskedasticity was instead tested for the demographic components of the vector **x**.

Table 1. Definition of Demographic Variables and Simple Statistics

Variable	Definition	Mean	Std. Dev.
Age	Age of subject, in years	44.9625	16.1037
Female	1 if subject was female	0.6220	0.4879
Non-white	1 if subject's race was non-white	0.0976	0.2985
Income	Subject income (in $ thousands)	33.7975	25.1593
Child	Number of children under 18 in the household	0.6220	1.0140
College	1 if subject's maximum education was college	0.3902	0.4908
Post-grad	1 if subject's maximum education was a post-graduate degree	0.0732	0.2620

Hypotheses needed to be formed in terms of the effect of each demographic variables on the bids for the conventional products, as well as the marginal effect of being non-GM or organic for each food product. Considering first the conventional bid effect, income was believed to have the largest potential effect, where it was expected that those with higher incomes would have higher bids for all the food products. Having a college education, being female, and having children under 18 were also suspected to have a positive influence on the bids, albeit to a lesser extent. There was no initial reason to believe a racial difference would be present.

In terms of hypotheses on the marginal effects from non-GM, all variables were anticipated to be significant, although the signs were not always clear. Perhaps most clearly, it was expected that having children under the age of 18 would increase bids for non-GM foods, as parents might wish to avoid feeding GM products to their children. Education was more complicated, but it was hypothesized that in general higher levels of education would lead to higher bids. This would conform to the idea that those who understand genetic modification better are more interested in avoiding GM products. The alternative would be the argument that more educated consumers would be less concerned with GM foods, and thus have lower bids.

For age, the hypothesis was again complex in that younger consumers may be more accepting of technology such as GM foods, or more concerned about any possible effects on health or the environment. Thus no *a priori* hypothesis on the sign was made. Next, it was hypothesized that females would be more concerned about GM foods and thus bid higher. The remaining variable for race was included without a specific hypothesized sign, but with a belief in its potential relevance.

The hypotheses for the marginal effects from being organic were clearer, with almost all variables expected to have a positive effect on bids. Beginning again with parents, it was assumed that they would want to minimize their children's exposure to additional conventional methods such as synthetic pesticides (see for example Curl, Fenske, and Elgethun 2003). Higher income was again anticipated to lead to higher bids since consumers then should be more able to pay for the extra attributes available with organic production. Those with higher education were expected to see more benefits with organic production and thus bid higher. Females and younger subjects were also believed to be more interested in any benefits from organic production. Race was once again included without specifics to sign but rather to see if any effects were in evidence.

Results and Discussion

Before examining the model, the reader is referred to the summary statistics for the bids, displayed in Table 2. While it had been hoped that the selected products could eliminate the existence of zero bids, at least one was present for all categories except conventional milk chocolate. The average progression of bids was as expected,

Table 2. Summary Statistics for the Bids

Product	Characteristic	Mean	Std. Dev.	Minimum	Maximum
Potato chips	conventional	0.9713	0.6093	0.00	3.00
	non-GM	1.1294	0.6331	0.00	3.00
	organic	1.6093	0.8118	0.00	3.00
Tortilla chips	conventional	1.4691	0.9201	0.00	3.75
	non-GM	1.5794	0.9901	0.00	4.00
	organic	1.8859	1.2425	0.00	7.00
Milk chocolate	conventional	1.0849	0.9531	0.20	7.00
	non-GM	1.1688	1.0523	0.00	7.50
	organic	1.3785	1.1610	0.00	8.00

with the conventional version receiving the lowest bid, followed by non-GM, and then organic for each food. The ranges of some of these averages were narrower than had been anticipated, with the exception of potato chips, giving an early suggestion of limited willingness to pay for the extra attributes beyond conventional production.

The bid distributions are shown in detail for potato chips, tortilla chips, and milk chocolate in Figures 1 through 3, respectively. These show a clear trend toward higher bids and wider bid distribution for the organic and non-GM versions of each product, but with some interesting differences. In particular, bids for tortilla chips were the most uniform across the ranges, with no category quite reaching even 20 percent. This seemed to suggest a lack of consensus over the value of this product and its different versions. The other two products were far from uniform, with most bids falling in the \$0.50 to \$0.99 range followed by the \$1.00 to \$1.49 range in each.

The model was run using the QLIM procedure in SAS.[7] After initial runs, two changes were made to the components of the **x** vector, and the final form of the error variance was specified. First, the variable *non-white* was removed due to its lack of significance according to *p* values and likelihood ratio tests. Given the above uncertainty over the sign and relevance of the race variable, removing it was not seen as onerous. Arguably more controversial was the removal of the *post-grad* variable, again after the performance of likelihood ratio tests. This implied that the influence of having a post-graduate education did not differ from having less than a college education.

In terms of the error variance, tests rejected the null hypothesis of homoskedasticity with respect to both product type and product characteristics at the 1 percent level. Tests showed significantly higher variability for potato chips and milk chocolate, as could be expected given the figures above. In terms of product characteristics, bids for the organic products demonstrated the largest variance. In accounting for possible subject heteroskedasticity, only two demographics—gender and education—were shown to be of concern. Neither of these was a surprise, particularly education, where, as noted earlier, feelings toward GM products could move to either end of the spectrum as education increases. More unexpected was the lack of variance differences related to income, where it may have been anticipated that those with higher incomes had greater variance in bids. The value of the products may have been sufficiently low enough for this not to appear. The final model thus corrected for heteroskedasticity by gender, college education, and product type and characteristics.

The heteroskedastic tobit regression results are displayed in Table 3. Two variables stood out quickly as having an especially strong influence on bids: age and education. Beginning with age, older subjects bid significantly more for conventional and non-GM versions of all three foods. For the latter category, this may give some credence to the idea that younger consumers are more willing to accept the new GM technology.

[7] *Sas OnlineDoc 9.1*, SAS Institute Inc., Cary, NC.

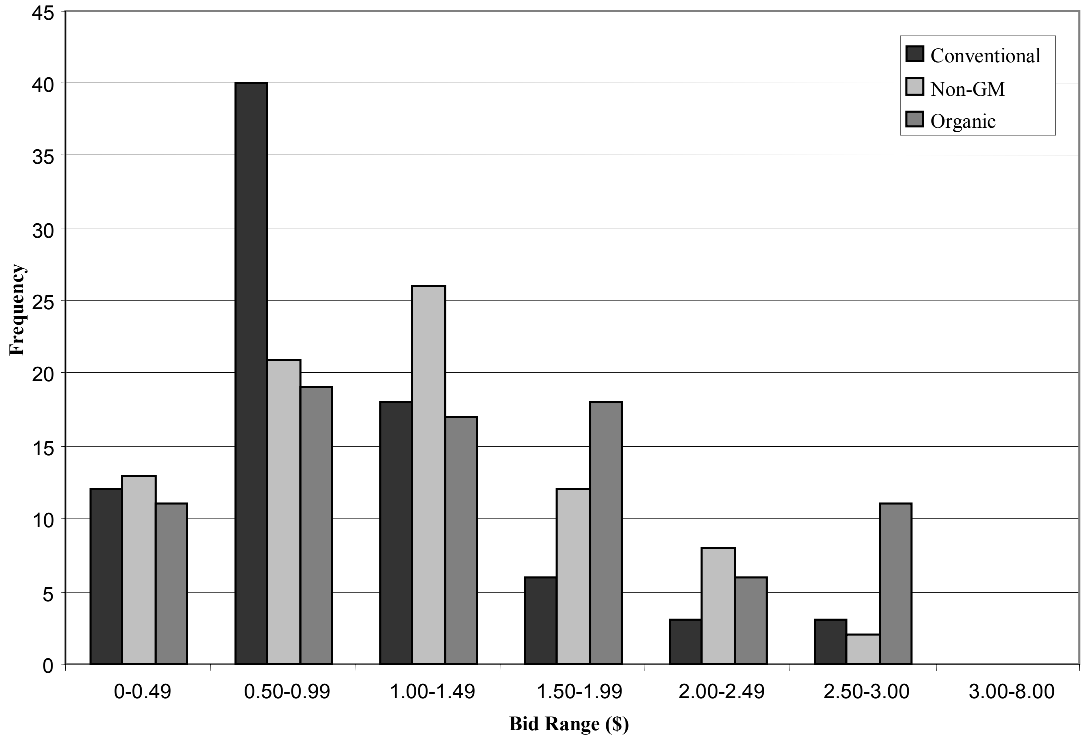

Figure 1. Potato Chip Bid Distribution

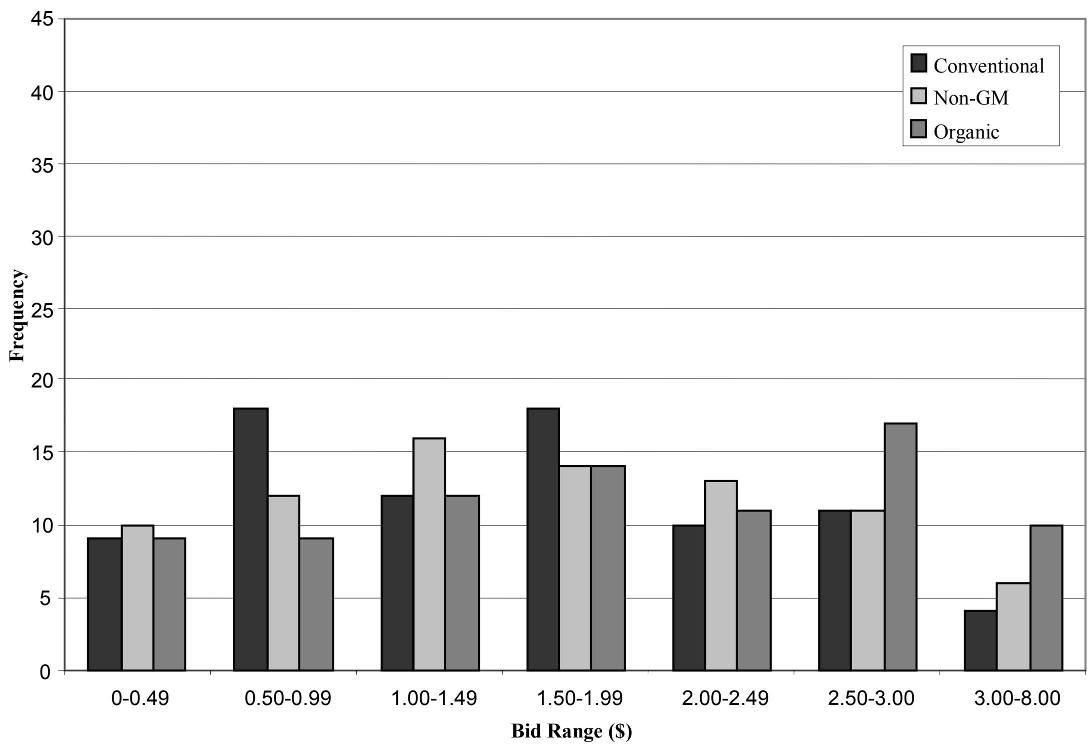

Figure 2. Tortilla Chip Bid Distribution

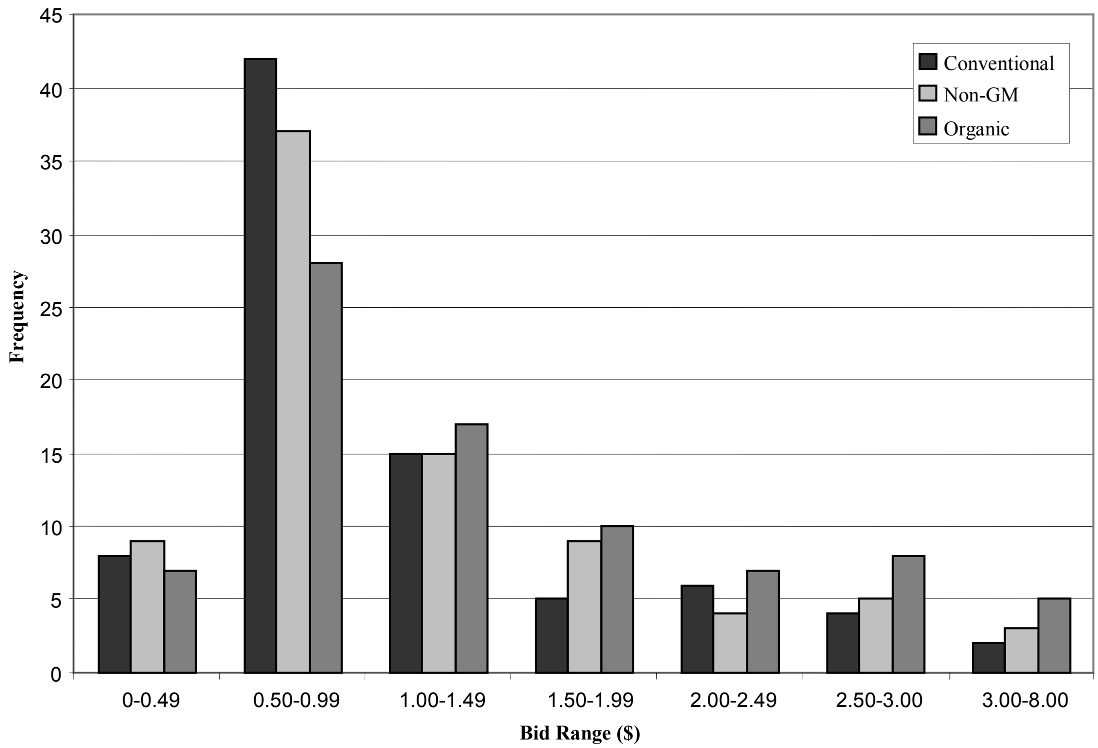

Figure 3. Milk Chocolate Bid Distribution

Table 3. Tobit Regression Results

Interaction Terms Variable	Food Category	Parameter Estimate	p Value	Marginal Effect from Non-GM	p Value	Marginal Effect from Organic	p Value
Age	potato chips	**0.0095**	0.0024	**0.0083**	0.0083	-0.0005	0.9104
	tortilla chips	**0.0135**	0.0057	**0.0143**	0.0037	0.0002	0.9819
	milk chocolate	**0.0111**	0.0008	**0.0112**	0.0007	-0.0008	0.8719
Income	potato chips	**0.0058**	0.0193	**0.0065**	0.0084	0.0020	0.5922
	tortilla chips	**0.0078**	0.0414	**0.0076**	0.0455	0.0030	0.6135
	milk chocolate	0.0034	0.1969	0.0025	0.3463	0.0027	0.4963
College	potato chips	**0.3217**	0.0318	**0.5401**	0.0003	0.1524	0.5063
	tortilla chips	**0.4772**	0.0386	**0.6103**	0.0082	0.3842	0.2779
	milk chocolate	**0.3880**	0.0142	**0.6228**	0.0001	0.1593	0.5119
Female	potato chips	0.2478	0.1230	**0.3305**	0.0396	0.1890	0.4418
	tortilla chips	0.2882	0.2457	0.2979	0.2309	0.1061	0.7800
	milk chocolate	0.3211	0.0581	0.2947	0.0821	0.1472	0.5715
Children	potato chips	0.0890	0.1679	**0.1659**	0.0099	-0.0073	0.9413
	tortilla chips	**0.3036**	0.0021	**0.3145**	0.0015	-0.0177	0.9068
	milk chocolate	0.1048	0.1220	**0.1659**	0.0147	0.0113	0.9133

Note: Bold indicates significant at the 5 percent level.

Similarly, those with a college education bid significantly more for conventional and non-GM versions of all the foods than did less educated respondents. The non-GM marginal effect result corresponds with the theory that those who might better understand GM technology are more interested in avoiding such products. The findings for college must also take into account the results of the heteroskedasticity test, which showed that those with a college education had a larger bid variance than those at other education levels. Thus while the overall mean difference showed higher bids, there was a large variability within that group of subjects. For neither age nor college were the marginal effects for the organic attribute significant.

Income was found to be significant with regard to bids for potato chips and tortilla chips for conventional and non-GM versions. These variables were positive as expected. Also as expected were the positive and significant variables from bids of parents with children under 18 for all non-GM marginal effects. This reinforced the belief that parents were more concerned about feeding GM foods to their children. As noted with earlier variables, though, this concern did not carry over to the marginal effects for the organic attribute.

Some gender differences appeared, although these were minimal compared with the other variables discussed. While the signs were positive as hypothesized, the only difference significant at the 5 percent level was for non-GM potato chips. One other non-GM bid and a conventional bid difference would be significant if a 10 percent level was considered and again no marginal effects for the organic attribute mattered. The weak significance of gender was particularly interesting since gender was one of the two demographics for which heteroskedasticity was an issue. This implied that while mean bids between males and females were essentially the same, women, by the test results for heteroskedasticity, had a smaller bid variance.

Combining the above, the primary finding was that none of the marginal effects for the organic attribute were significant. This implied that the extra attributes of organic foods beyond being non-GM, such as a lack of synthetic pesticides, did not significantly increase subject bids. This result was in sharp contrast with hypotheses. It suggested that avoiding GM foods may be the largest factor in the premium consumers are willing to pay for organic foods.

Since this is an unexpected conclusion, some thought must be given to why it may have arisen. As a large emphasis was placed on GM foods and ingredients, and since this may have been new knowledge for the study participants, the bids could have been influenced accordingly. However, the additional attributes of organic foods were also well covered and were not particularly well known. This was especially true with regard to subjects' responses to learning of the potential use of sewage sludge based fertilizers in conventional production, which elicited more negative and surprised verbal reaction than GM foods. It was thus deemed that subjects were presented with enough evidence to still have cause to bid significantly more for organic once the nested nature of non-GM was accounted for. However, it has been left for continuing investigation to determine if the focus of experiments has an influence on subjects.

Lastly, it should be noted that the importance of many of the variables discussed above was somewhat in contrast to findings of other studies, such as Loureiro and Hine (2002) and Huffman et al. (2003), particularly with respect to age and income. This seems to suggest that the inclusion of attitudinal and knowledge variables in similarly structured studies hinders the ability to determine the underlying demographic differences in subject bidding behavior. Care should thus be used in the interpretation of such models. Certainly, for many audiences, understanding the underlying demographic differences would be of more use than the more difficult to observe opinion and attitudes.

Conclusion

The purpose of this research was to determine consumer willingness to pay for non-GM foods in a situation where both a conventional and organic option would also be available in order to accurately reflect market conditions. It was believed that consumers interested in non-GM foods might be, to a large extent, the same ones interested in organic foods, and that inclusion of the non-GM option might change subjects' bidding patterns for organic. Indeed, by nesting the non-GM attribute into the organic characteristic in the analysis, subjects were found to not be willing to bid significantly extra for the remaining attributes of being organic.

This result suggests two things. First, that non-GM is an important, if not primary, attribute for consumers when purchasing organic foods. An examination of organic products on grocery store shelves revealed that in addition to the USDA-certified organic seal, emphasis was placed on the product being non-GM. This may indicate that food companies have also noted the importance of the non-GM attribute to consumers when making food choices. This finding suggests that firms have an incentive to label their products as being non-GM and that the current system of voluntary labels is sufficient.

Second, a market inefficiency exists when a non-GM version of the product is not readily available. Consumers desiring to purchase non-GM products must pay a larger premium for organic products due to the value of the additional attributes associated with them. Provided that food companies could produce non-GM food products less expensively than organic products, the market would be better served with the introduction of this niche market. The overall result would be to increase competition and thus lead to a decrease in the price paid by all consumers for a particular product.

These results do suggest further study in a number of regards. For example, research currently underway will expand on the categories of products tested. Important differences might exist based on the level of processing, which was not examined here. In particular, consumers might show wider differences in bidding when considering fresh food products rather than snack foods. Future research should strive to sample more diverse geographical areas to make sure results are not contingent on regional differences. Lastly, a more complete understanding of the values consumers place on each of the main attributes of organic foods may be appropriate.

References

Alfnes, F., and K. Rickertsen. 2003. "European Consumers' Willingness to Pay for U.S. Beef in Experimental Auction Markets." *American Journal of Agricultural Economics* 85(2): 396–405.

Boccaletti, S., and D. Moro. 2000. "Consumer Willingness to Pay for GM Food Products in Italy." *AgBioForum* 3(4): 259–267.

Curl, C.L., R.A. Fenske, and K. Elgethun. 2003. "Organophosphorus Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets." *Environmental Health Perspectives* 111(3): 377–382.

Dimitri, C., and C. Greene. 2002. "Recent Growth Patterns in the U.S. Organic Foods Market." Agricultural Information Bulletin No. 777, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Golan, E., F. Kuchler, and L. Mitchell. 2001. "Economics of Food Labeling." *Journal of Consumer Policy* 24(2): 117–184.

Govindasamy, R., and J. Italia. 1999. "Predicting Willingness to Pay a Premium for Organically Grown Fresh Produce." *Journal of Food Distribution Research* 30(2): 44–53.

Gregory, N.G. 2000. "Consumer Concerns About Food." *Outlook on Agriculture* 29(4): 251–257.

Hallman, W.K., W.C. Hebden, H.L. Aquino, C.L. Cuite, and J.T. Lang. 2003. "Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion." Food Policy Institute Publication No. RR-1003-004, Rutgers University, New Brunswick, NJ.

Harrison, G.W., R.M. Harstad, and E.E. Rutström. 2004. "Experimental Methods and Elicitation of Values." *Experimental Economics* 7(2): 123–140.

Harstad, R.M. 2000. "Dominant Strategy Adoption and Bidders' Experience with Pricing Rules." *Experimental Economics* 3(3): 261–280.

Huffman, W.E. 2003. "Consumers' Acceptance of (and Resistance to) Genetically Modified Foods in High-Income Countries: Effects of Labels and Information in an Uncertain Environment." *American Journal of Agricultural Economics* 85(5): 1112–1118.

Huffman, W.E., J.F. Shogren, M. Rousu, and A. Tegene. 2003. "Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions." *Journal of Agricultural and Resource Economics* 28(3): 481–502.

Knetsch, J.L., F.F. Tang, and R.H. Thaler. 2001. "The Endowment Effect and Repeated Market Trials: Is the Vickrey Auction Demand Revealing?" *Experimental Economics* 4(3): 257–269.

Lee, K.H., and C.B. Hatcher. 2001. "Willingness to Pay for Information: An Analyst's Guide." *Journal of Consumer Affairs* 35(1): 120–140.

List, J.A., and J.F. Shogren. 1999. "Price Information and Bidding Behavior in Repeated Second-Price Auctions." *American Journal of Agricultural Economics* 81(4): 942–949.

Long, J.S. 1997. *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications, Inc.

Loureiro, M.L., and S. Hine. 2002. "Discovering Niche Markets: A Comparison of Consumer Willingness to Pay for Local (Colorado Grown), Organic, and GMO-Free Products." *Journal of Agricultural and Applied Economics* 34(3): 477–487.

Lucking-Reiley, D. 2000. "Vickrey Auctions in Practice: From Nineteenth-Century Philately to Twenty-First-Century E-Commerce." *The Journal of Economic Perspectives* 14(3): 183–192.

Lusk, J.L. 2004. "United States and European Consumer Demand for Genetically Modified Food in an Experimental Market." Purdue Agricultural Economics Report, Department of Agricultural Economics, Purdue University, West Lafayette, IN. Available at http://www.agecon.purdue.edu/extension/pubs/paer/lusk.asp (accessed February 18, 2005).

Lusk, J.L., M.S. Daniel, D.R. Mark, and C.L. Lusk. 2001. "Alternative Calibration and Auction Institutions for Predicting Consumer Willingness to Pay for Nongenetically Modified Corn Chips." *Journal of Agricultural and Resource Economics* 26(1): 40–57.

Lusk, J.L., M. Jamal, L. Kurlander, M. Roucan, and L. Taulman. 2005. "A Meta-Analysis of Genetically Modified Food Valuation Studies." *Journal of Agricultural and Resource Economics* 30(1): 28–44.

Noussair, C., S. Robin, and B. Ruffieux. 2004. "Revealing Consumers' Willingness-to-Pay: A Comparison of the BDM Mechanism and the Vickrey Auction." *Journal of Economic Psychology* 25(6): 725–741.

Parkhurst, G., J.F. Shogren, and D.L. Dickinson. 2004. "Negative Values in Vickrey Auctions." *American Journal of Agricultural Economics* 86(1): 222–235.

Runge, C.F., and L.A. Jackson. 2000. "Negative Labeling of Genetically Modified Organisms (GMOs): The Experience of rBST." *AgBioForum* 3(1): 58–62.

Shogren, J.F., S.Y. Shin, D.J. Hayes, and J.B. Kliebenstein. 1994. "Resolving Differences in Willingness to Pay and Willingness to Accept." *American Economic Review* 84(1): 255–270.

U.S. Census Bureau. 2000. *State and County Quickfacts—Delaware*. U.S. Bureau of the Census, Washington D.C. Available at http://quickfatcs.census.gov/qfd/states/10000.html (accessed January 2006).

Vickrey, W. 1961. "Counterspeculation, Auctions, and Competitive Sealed Tenders." *Journal of Finance* 16(1): 8–37.

Williams, P.R.D., and J.K. Hammitt. 2000. "A Comparison of Organic and Conventional Fresh Produce Buyers in the Boston Area." *Risk Analysis* 20(5): 735–746.