Consumer Willingness to Pay Premiums for Non-GM and Organic Foods

The goal of this research was to measure the determinants of consumer willingness to pay premiums for organic and non-GM foods relative to one another and to conventional foods. Auction experiments involving the three versions of potato chips, tortilla chips, and milk chocolate were conducted with 79 subjects in Delaware. Premiums were modeled as a function of consumer demographics, attitudes and knowledge using tobit regression. Results showed significant premiums for both non-GM and organic versions, with the largest for the latter. Attitudes tended to be most important, especially the percentage chance the consumer believed the conventional version contained GM ingredients.

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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 foods sales has been 20% or more over the past decade (Dimitri & Greene, 2002). At the same time, GM ingredients have gone from nearly nonexistent to being contained in approximately 70% of processed foods (Hallman, Hebden, Aquino, Cuite & Lang, 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 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 USDA and FDA policies towards GM foods only require labeling 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, although non-GM suppliers may not suggest 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.[iii] Thus buying organic is the only certified 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. Part of the organic food demand as observed in grocery stores may thus include the demand for the missing non-GM food market, and not accurately reflect consumer preferences.

The goal of this research was to measure the determinants of consumer willingness to pay (WTP) for organic and non-GM foods relative to one another and to conventional foods. The objective was to identify and compare the different premiums consumers would place on non-GM and organic foods over conventional versions of the same food products. Differences in premiums were modeled as a function of consumer demographic characteristics and attitude and knowledge variables using tobit regression.

Background

While previous studies have examined consumer WTP for GM, non-GM, or organic foods, Loureiro and Hine (2002) are one of few to examine all three simultaneously. Using surveys conducted in local supermarkets, they looked at WTP for locally grown, organic, and GMO-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 GMO-free potatoes. Govindasamy and Italia (1999) found the same results for age and income with respect to willingness to pay for organic, and also found that smaller households and more knowledgeable 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. How information is presented to consumers has been shown to be influential in many of these studies. For example, Boccaletti and Moro (2000) used a survey of consumers in Italy to look at WTP a 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 organics. 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, Shogren, Rousu and Tegene (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 & 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 consumers willing to pay significantly more for the versions with no label information.

Lastly, Lusk, et al. (2001) and Lusk (2004) also examined WTP using experimental auctions. For the experiments, student subjects were given a bag of GM corn chips (2001) or a cookie (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% 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 this more likely to reflect anticipated market conditions. Runge and Jackson (2000) have similarly argued for the use of "contain no GM" labels. Currently, non-GMO 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 two together present consumers with a more realistic market setting than has been considered in previous literature and should thus gain better insight into actual purchase decisions. Lastly, additional information on consumers views of the chances specific food products contain GM ingredients was collected and incorporated in the models, bringing additional understanding to the formation of their bids for conventional versions and why they may not see a need for a non-GM version.

Experimental Design

Thirteen experiment sessions of between 6 and 8 subjects each, for a total of 79 participants, were held across varying dates in 2003.[iv] All were from northern Delaware and had been recruited through a combination of classified advertisements, flyers in grocery stores, and announcements through local organizations. During recruiting, subjects were informed 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 five steps. In the first step, subjects were given a pre-experiment questionnaire[v]. This included questions pertaining to the subject's knowledge, opinions and consumption of GM and organic foods, use of food labels, and food preferences. To go beyond self-reported knowledge of GM foods, two test questions were asked. The first question pertained to whether or not there had ever been a recall involving GM foods. The second asked if they had ever eaten any foods with GM ingredients. The questionnaire was administered prior to information being given on either GM or organic foods, capturing subjects' incoming impressions and understanding.

The second 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 strong tendency towards subjects overbidding (see for example Harstad, 2000) while others have not observed this problem (see for example Noussair, Robin & Ruffieux, 2004). Some recent studies have employed a random n^{th} price auction instead of the second price auction. 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. One approach to help subjects understand the Vickrey is to employ repeated trials. In this format, popularized by Shogren, Shin, Hayes and Kliebenstein (1994), the same item is auctioned multiple times with a price announced after each and a final binding price randomly selected after all the trials. However, 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. The design here instead included a brief lecture on the mechanism, including examples showing the best strategy and three practice periods with induced values, to address this concern.[vi]

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) on it. 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 third 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 designed to be neutral to avoid influencing subject behavior. GM foods were explained 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 explained as not containing any ingredients that are a product of genetic modification. Organic foods were explained based on the definition from the USDA certification program, including emphasizing the non-GM requirement. Conventional foods were defined as definitely not being organic but the presence or absence of GM ingredients is indeterminate.[vii]

The fourth 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 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.[viii] They were removed from their original packages so that 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 they 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.

In the final step, subjects were asked to fill out a post-experiment questionnaire. This included asking subjects what percentage chance they thought there was that each conventional version of the food items included GM ingredients. This was done to avoid assumptions about their impression of the product as in Huffman et al. (2003), where it was arguably uncertain how subjects perceived the unlabeled versions. It also covered necessary demographic questions for modeling, including gender, age, race, education, income, and children in the household.

Model and Hypotheses

Models were designed to include both the demographic variables and attitude and knowledge variables from the questionnaires, similar to Lusk, et al. (2001). Variable definitions and descriptive statistics for the 79 subjects are presented in Table 1. A closer look at the sample demographics revealed that the majority of the subjects were female (62%), the vast majority white (91%), and less than half had a college or advanced degree (43%). Both knowledge of GM foods and the opinion of them were significantly lower than for organic foods at better than the 1% level. The fairly low self-reported knowledge rating for GM matched well with the low overall score on the two knowledge test questions. These findings align with many past informal polls showing low awareness, and were in line with surveys such as Lusk and Sullivan (2002) and Hallman et al. (2003). Subjects did have a very high confidence in the government's ability to keep food safe, and most tended to read food labels at least somewhat regularly. Subjects overall estimated slightly greater than 50% chance that each conventional version contained GM ingredients, but with wide variability.

Table 1
Definition of demographic variables and simple statistics

Category	Variable	Definition	Mean	Std. Dev.
Subject Characteristics:				
	Age	Age of subject, in years	44.9625	16.1037
	Female	1 if subject was female	0.6220	0.4879
	NonWhite	1 if subject's race was non-white	0.0976	0.2985
	Income	Subject income in 1,000's	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
	PostGrad	1 if subject's maximum education was a post-graduate degree	0.0732	0.2620
Subject Attitudes and Beliefs:				
	KnowGM	Self-reported knowledge of GM foods from 1 (no knowledge) to 5 (high knowledge)	2.2683	1.1764
	KnowOrg	Self-reported knowledge of organic foods (1 to 5)	3.2439	1.2127
	TestKnow	Number of correct answers to GM knowledge questions (0 to 2)	0.1341	0.3429
	OpinGM	Opinion of GM foods from 1 (Very negative) to 5 (very positive)	2.9000	1.0262
	OpinOrg	Opinion of organic foods (1 to 5)	3.7000	1.0602
	Confid	Confidence in government to keep food safe from 1 (no confidence) to 4 (very confident)	3.0366	1.1380
	RdLabel	Label reading frequency from 1 (never) to 4 (always)	2.9146	0.8635
	PChipGM	Percent chance the conventional potato chips had GM ingredients	0.5404	0.3162
	TChipGM	Percent chance the conventional tortilla chips had GM ingredients	0.5527	0.3322
	MChocGM	Percent chance the conventional milk chocolate had GM ingredients	0.5451	0.3378

Nine models needed to be estimated given the three possible premiums and the three food types. The bid distributions are shown in Figures 1 through 3, with a clear trend towards higher bids and wider bid distribution for the organic and non-GM versions of each product. The bids do not appear normally distributed, an observation that was confirmed using the proc univariate procedure in SAS. None of the bids fit a normal distribution. Summary statistics for the premiums and their significance is displayed in Table 2. Because the data was not normally distributed, the nonparametric Wilcoxon test was performed using the NPAR1WAY procedure in SAS (Cody and Smith, 1997). The test constructs an approximate Z and a corresponding p-value to perform a one-tailed test the null hypothesis that the premium is equal to zero. A one-tailed test was used since the alternative hypothesis was that the premium would be greater than zero. For the organic over conventional bids, statistically significant premiums were seen for all three food items. For non-GM over conventional, only milk chocolate had a significant premium at the 5% level. For non-GM over conventional, only potato chips had a statistically significant premium.

Table 2
Summary Statistics for the Premiums

Premium	Food	Mean premium	Approximate Z*	p value
Non-GM over Conventional	Potato Chips	0.1580	-2.207	0.0144
	Tortilla Chips	0.1102	-0.7217	0.2358
	Milk Chocolate	0.0839	-0.7217	0.2353
Organic over Non-GM	Potato Chips	0.2102	-1.5260	0.0635
	Tortilla Chips	0.3064	-1.3877	0.0571
	Milk Chocolate	0.2098	-1.6453	0.0500
Organic over Conventional	Potato Chips	0.3683	-3.2571	0.0007
	Tortilla Chips	0.4167	-2.2201	0.0139
	Milk Chocolate	0.2937	-2.3362	0.0104

*An approximate Z is constructed using a one-tailed, nonparametric Wilcoxon test performed in SAS. The test is determining if the premium is significantly greater than zero, taking into account the non-normal distribution. Z scores and p-values based on a normal distribution cannot be used, since it was determined that the distribution of bids was not normal.

Since there was a likelihood of occasional zero bids, analysis needed to be conducted using censored regression techniques. Specifically, a double tobit model was used for analysis given the possibility of a zero bid on either of each pair of food categories, or for both, implying premiums were potentially upper and lower censored (Long, 1997). In this model it is assumed there exists latent variables $prem_{i,jk}*$ representing subject i's actual premium for type j over type k that is related to the observed difference between the two bids, $prem_{i,jk}$, by:

$$
\begin{aligned}
prem_{i,jk} &= 0 && \text{if} \quad b_{i,j} = b_{i,k} >= 0 \\
prem_{i,jk} &= b_{i,j} && \text{if} \quad b_{i,j} > 0 \text{ and } b_{i,k} = 0 \\
prem_{i,jk} &= -b_{i,k} && \text{if} \quad b_{i,j} = 0 \text{ and } b_{i,k} > 0 \\
prem_{i,jk} &= prem*_{i,jk} = \chi\beta + \varepsilon_i && \text{if} \quad b_{i,j} > 0 \text{ and } b_{i,k} > 0
\end{aligned}
$$

Where: $b_{i,j}$ and $b_{i,k}$ = subject i's bids for types j and k,
x = the vector of independent variables, and
ε_i = normally distributed error with mean 0 and standard deviation σ.

As can be noticed, any time one of the bids is zero we do not have enough information to model the true difference between them. For instance, if $b_{i,j} > 0$ and $b_{i,k} = 0$, then the only information on the true difference is that it lies in the interval $[b_{i,j}, \infty)$. Since these must be censored, the model estimated for each premium is based on the latent variable for the premium. The censored regression model used here was:

$$
\begin{aligned}
prem*_{i,jk} = {} & \beta_0 + \beta_1 \text{ Age} + \beta_2 \text{ Income} + \beta_3 \text{ College} + \beta_4 \text{ PostGrad} + \beta_5 \text{ Female} + \beta_6 \text{ Child} + \beta_7 \text{ NonWhite} + \\
& \beta_8 \text{ KnowGM} + \beta_9 \text{ OpinGM} + \beta_{10} \text{ KnowOrg} + \beta_{11} \text{ OpinOrg} + \beta_{12} \text{ Confid} + \beta_{13} \text{ TestKnow} + \\
& \beta_{14} \text{ RdLabel} + \beta_{15} \text{ FoodGM} + \varepsilon_i
\end{aligned}
$$

where the variables are as in Table 1, except for FoodGM which is PChipGM, TChipGM, or MChocGM from Table 1 as appropriate for the food being modeled.

The following hypotheses were made about the impact of the attitude and belief variables. Of primary interest was the percent chance subjects believed each conventional version contained GM ingredients. It was hypothesized that as this estimate increased the premiums would increase for both the non-GM and organic versions over conventional. Less certain was the potential effect on the non-GM over organic premium, although it was left in the respective models. Across all models it was hypothesized that higher confidence in food safety would lower premiums, as consumers would be satisfied with conventional versions. Similarly, label reading was expected to increase premiums reflecting more careful and concerned consumers. Both the knowledge and opinion of organic food variables were expected to increase the size of premiums in all models. Incoming knowledge of GM foods, both self-reported and from the test questions was viewed as possibly having either positive or negative effects on premiums with the key being consumer response to the knowledge. Lastly, higher opinions of GM foods were expected to decrease all premiums, although only to a lesser extent for the organic over non-GM premium.

Some of the hypotheses for the demographic variables were less clear. The main exception was the number of children under 18, believed to increase premiums in all models assuming parents may want to minimize exposure to conventional methods such as synthetic pesticide use (see for example Curl, Fenske and Elgethun, 2003). Higher income also was anticipated to lead to higher premiums since consumers then should be more willing and able to pay for the extra attributes, especially organic. Education was more complicated, but it was hypothesized that in general higher levels of education would lead to higher premiums. The alternative would be the argument that more educated consumers would be less concerned with GM foods, and thus have smaller premiums. For age, the hypothesis was again complex in that younger consumers may be more accepting of technology such as GM foods, or more interested in the environment and organic foods. Gender and race were included without a specific hypothesized sign, but a belief in their potential relevance.

Results

Tobit regression results by premium type are displayed in Table 3. A few results were notable across all regressions before looking closer at individual findings. To start, in no instance was age, income, or gender found to be significant. For the models involving GM products, this was consistent with the findings of Huffman et al. (2003). This result is also similar to Loureiro and Hine (2002) for age, except for the organic case, and gender. Still, the lack of significance across all models was unexpected.

In terms of the other demographic variables included in the model, the two education variables, when significant, had opposite effects on WTP. Specifically, college education increased WTP for organic over conventional for both tortilla chips and milk chocolate and organic over non-GM for tortilla chips. Postgraduate education, though, decreased WTP for non-GM over conventional for both tortilla chips and milk chocolate. This second finding was possible evidence of the alternative suggestion that better educated consumers would be less concerned with GM foods. The presence of children under 18 in the household was found to be significant only in models involving organic over conventional and non-GM over conventional. In each instance, the effect was an increased premium as expected. The lack of significance in the organic over non-GM premium models may suggest that GM was the major element of concern for this group. Lastly, reporting race as non-white was found to be significant in only three models and had a negative effect on WTP.

Significance was more widespread among the attitude and knowledge variables. All of these had at least one occurrence of being significant at the 10% level or better. Interestingly, the weakest of these seemed to be the self-reported knowledge of both organic and GM foods as well as the test question knowledge results for GM foods. It could be that there was too little variation in values across subjects to allow for significant differences. Another possible explanation was that subjects, recognizing their limited knowledge, used the information given in the experiment as the most relevant to their bidding, a situation that could not be captured by the model variables.

In contrast, it was quickly evident that subject's belief about the chance the conventional versions contained GM ingredients was meaningful in many models. Specifically, it was found that a larger percentage chance that the relevant conventional version contained GM ingredients was associated with higher WTP in the following models: non-GM over conventional for both tortilla chips and milk chocolate; organic over non-GM for potato chips; and organic over conventional for potato chips. As GM foods increase in the food supply and awareness of this chance spreads, this result could have large implications not recognized in previous studies. For instance, a consumer going from believing there was a 50% chance conventional tortilla chips contained GM ingredients to feeling certain they did would be willing to pay about a 12 cent higher premium for a non-GM version.

Opinions regarding GM or organic foods also mattered in many models. Positive opinions of GM foods were associated with lower WTP in the following models: non-GM over conventional in all three cases; and organic over conventional for both potato chips and milk chocolate. Surprisingly the opinion of GM foods variable was not significant in any of the models for organic over non-GM. This may imply that consumers with a more positive opinion of GM foods may be less concerned about food safety issues associated with agricultural techniques and therefore are not willing to pay a premium for organic either. In addition, a more positive opinion of organic was associated with higher WTP for the following models: organic over conventional for both tortilla chips and milk chocolate and non-GM over conventional for potato chips. Surprisingly this variable was also not significant in any of the cases for organic over non-GM. This may indicate that consumers with a higher opinion of organic foods are not necessarily willing to pay more for these products.

Table 3
Tobit Regression Results – Parameter estimates and Goodness of Fit

	Non-GM over Conventional			Organic over Non-GM			Organic over Conventional		
Parameter	Potato Chips	Tortilla Chips	Milk Chocolate	Potato Chips	Tortilla Chips	Milk Chocolate	Potato Chips	Tortilla Chips	Milk Chocolate
Intercept	0.1459	0.1536	-0.3417	-0.2701	-0.9404	-0.2747	-0.1589	-0.6726	-0.6153
Age	-0.0043	-0.0007	0.0028	0.0029	0.0103	0.0017	-0.0013	0.0086	0.0044
Income	-0.0006	-0.0014	-0.0025	-0.0007	0.0023	0.0012	-0.0012	0.0015	-0.0013
College	0.1155	0.0733	0.1803	0.0957	0.5414**	0.1739	0.1985	0.5640**	0.3509**
Postgrad	-0.0247	-0.3561**	-0.5409***	0.0413	0.3706	0.3308	0.0030	-0.0712	-0.2135
Female	0.0413	0.0492	-0.0530	0.1092	0.1525	0.1750	0.1549	0.1763	0.1218
Child	0.1074**	0.0394	0.1601***	0.0374	-0.0893	0.0113	0.1515**	-0.0314	0.1717**
NonWhite	-0.3062**	0.0896	-0.0690	0.0697	-0.6829**	-0.0984	-0.2327	-0.7339**	-0.1654
KnowGM	0.0551	-0.0037	-0.0325	-0.0827*	0.0658	0.0185	-0.0244	0.0816	-0.0128
OpinGM	-0.1373***	-0.0808**	-0.1135**	-0.0503	-0.0540	-0.0197	-0.1907**	-0.1606	-0.1338*
KnowOrg	-0.0498	0.0268	0.0436	0.1404**	-0.0639	0.0090	0.0853	-0.0616	0.0515
OpinOrg	0.0823**	0.0592	0.0665	-0.0321	0.1346	0.0625	0.0595	0.2122*	0.1301*
Confid	0.0705**	0.0184	0.0711*	0.0183	-0.1397	-0.0828*	0.0932	-0.1219	-0.0120
TestKnow	-0.0281	0.1777*	0.2109	-0.0239	-0.2363	-0.0342	-0.0531	-0.0337	0.1772
RdLabel	-0.0124	-0.0991**	-0.0278	0.0129	0.2641*	0.0614	0.0010	0.1301	0.0324
PChipGM	0.1687	-	-	0.2940*	-	-	0.4675**	-	-
TChipGM	-	0.2396**	-	-	-0.0670	-	-	0.2740	-
MChocGM	-	-	0.2941*	-	-	0.0015	-	-	0.2993
AIC	67.85	46.37	97.4	102.81	190.76	112.21	151.19	204.54	149.97

*, **, and *** denote significance at the 10%, 5%, and 1% levels respectively.
The AIC is calculated using the formula "AIC=-2*LogL* +2*npar*" where *npar* is the number of parameters in the estimated model.

Another interesting result was that greater confidence in government to keep food safe was associated with higher WTP in the following models: non-GM over conventional for both potato chips and milk chocolate and lower WTP in the case of organic over non-GM for milk chocolate. This was not expected as it was hypothesized that consumers who had greater confidence in government regarding food safety would be willing to pay a significantly lower premium for both organic and non-GM.

One final observation regarding the model results was that the largest number of variables were significant in the models for non-GM over conventional. To summarize the results, the following profiles of consumers WTP higher premiums are given for each product: potato chips – households with children under 18, higher opinion of organic and greater confidence in government regarding food safety; tortilla chips – a higher score on the GM test knowledge questions and a belief there was a higher percent chance that the conventional version had GM ingredients; milk chocolate – households with children under 18, greater confidence in government regarding food safety, and a belief that there was a higher percent chance that the conventional version had GM ingredients. The following factors contributed to a lower WTP: potato chips – nonwhite and a higher opinion of organic; tortilla chips – postgraduate education, a higher opinion of GM foods, and the more frequent use of labels; milk chocolate – postgraduate education, and higher opinion of GM foods.

Conclusion

The purpose of this research was to determine consumer willingness to pay for non-GM foods in a situation where an organic option would also be presented 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 inclusion of the non-GM option may change subject's bidding patterns for organic. Results supported the hypothesis that significant premiums exist for both non-GM and organic versions of the foods used in the experiments, with the largest for the latter. Two factors that had a significant effect in several models were the subject's belief of the percent chance that the conventional version contained GM ingredients and the subject's opinion of GM foods. The model results showed that consumers who had a more positive opinion of GM foods were not willing to pay a premium for organic or non-GM, whereas consumers that estimated a greater percent chance of GM ingredients in the conventional version were willing to pay more for organic and non-GM.

As knowledge of the extent of GM ingredients in the food system spreads this could have large implications on consumer acceptance of conventional products and lead to increased calls for labeling. Previous research (see for example Zago and Pick, 2004) has investigated the welfare effects of labeling, and found that the administrative costs of regulation such as labeling are an important component of the effect that the regulation will have on consumer welfare. While Zago and Pick found that producers and consumers of "higher quality" products do benefit from regulation such as labeling, there is likely to be acrimonious debate as to whether non-GM and organic products are necessarily of higher quality. That judgment may well rest on consumer opinion more than scientific evidence, and according to research including this study consumers are currently positive towards organic and less decided on biotechnology.

These results suggest future study. 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 may be willing to pay higher premiums when considering fresh food products rather than snack foods. Future research should also expand to more diverse geographical areas and attempt to include more minority members in the sample pool, especially in light of the findings here that some differences may exist.

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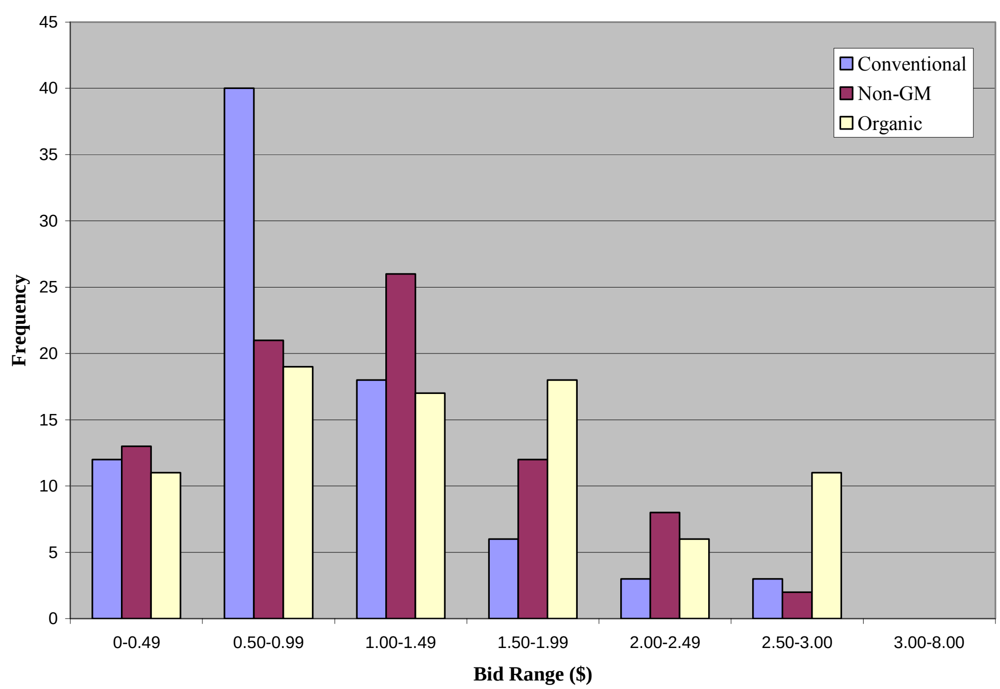
Figure 1: Potato Chip Bid Distribution



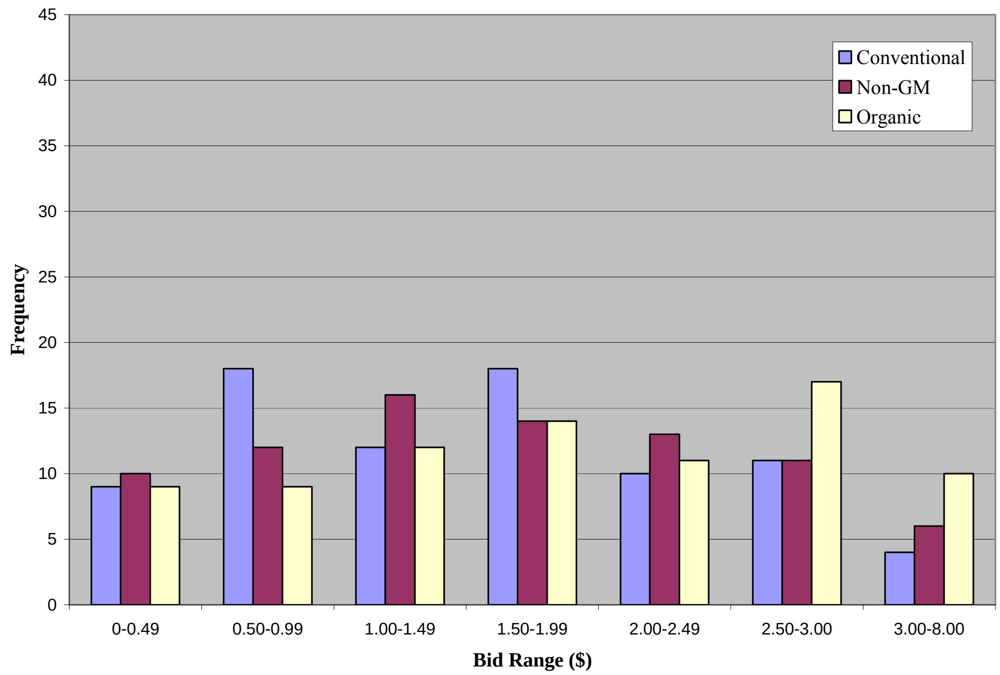


Figure 2: Tortilla Chip Bid Distribution

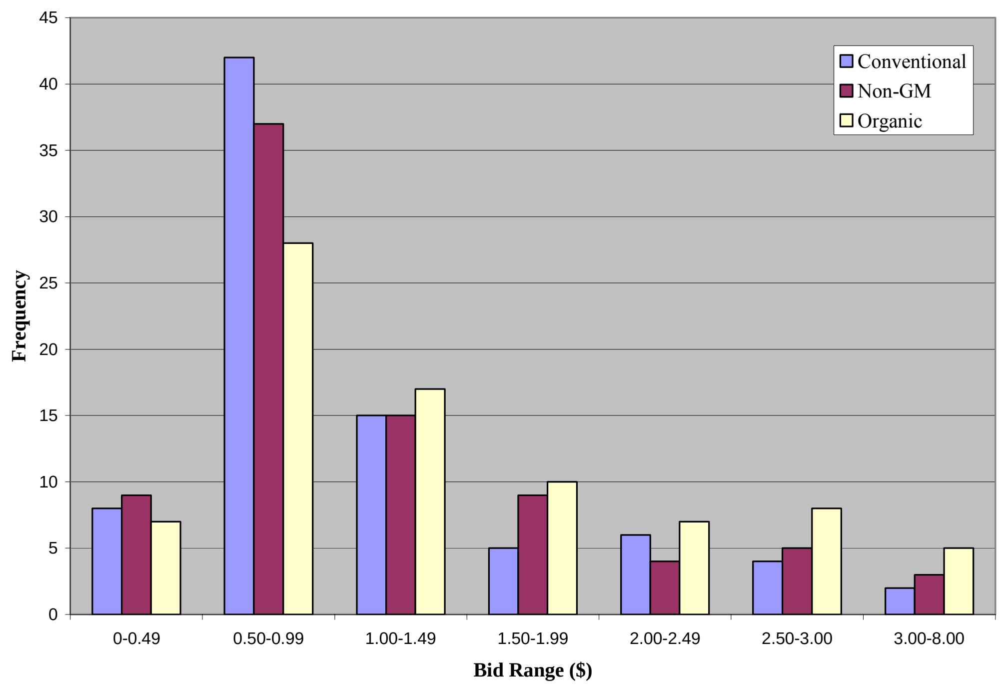


Figure 3: Milk Chocolate Bid Distribution

Endnotes

[i] John C. Bernard is a Professor in the Department of Food and Resource Economics at the University of Delaware.

[ii] Katie Gifford is a Research Associate in the Department of Food and Resource Economics at the University of Delaware.

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

[iv] Eighty-two subjects participated in the experiments but three failed to provide demographic information.

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

[vi] Induced values were used so subject bids could be directly compared with assigned values and 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 the lesson was successful.

[vii] 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-1990's 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."

[viii] 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.