An Experimental Investigation of Willingness to Pay for Non-GM and Organic Food Products

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Abstract

The appearance and rapid adoption of genetically modified (GM) foods and the strong growth in organic foods are two of the major trends that have influenced the food system over the past several years. The purpose of this research was to determine consumer willingness to pay (WTP) for non-GM and organic foods relative to conventional foods and to see if WTP differences between the three categories vary between fresh and processed food products. Experimental auctions with 133 subjects from three states (Delaware, Maryland, and Pennsylvania) were conducted. Tobit models were run with the bids as functions of demographic and knowledge and attitude variables. Results suggest an untapped market exists for non-GM products at a substantial premium over conventional, yet less than organic. This segment may be difficult to identify though as attitude variables were more important explainers of bids than demographics.

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

Introduction

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 and Greene, 2002). At the same time, GM ingredients have gone from nearly nonexistent to being contained in approximately 70% 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 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 requires 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.[1] 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 conventional foods. The main 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. Bids were modeled as a function of consumer demographic characteristics and attitude and knowledge variables using Tobit regression.

Literature Review

While previous studies have examined consumer WTP for GM, non-GM, or organic foods, few have considered all three simultaneously. In the only study the authors were aware of to include a consumer analysis of both organic and non-GM, Loureiro and Hine (2002) used surveys conducted in local supermarkets to look at WTP for locally grown, organic, and GMO-free potatoes. Age of consumer was found to have a significantly negative impact on the WTP for organic potatoes. Upper class, a variable which captured the cross effect of graduate education and household income over $75,000, was found to positively effect the WTP for both organic and GMO-free potatoes. Their results indicated that consumers had the highest WTP for locally grown. With the survey design, consumers selected among possible ranges for premiums in each of the categories, not allowing for exact measurement. This gave some suggestion of the type of results that could be expected, and demonstrated that consumers could successfully separate three types of food products objectively.

A large number of studies have looked at WTP for organic foods. For instance, Govindasamy and Italia (1999) surveyed grocery store customers in New Jersey and found most consumers willing to pay more for organic produce. They identified a household with the highest WTP as one that is younger, smaller, higher earning, and more knowledgeable of food production methods. 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 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 consumers willing to pay significantly more for the versions with no label information, which they apparently viewed as non-GM.

Lastly, Lusk, et al. (2001) also examined WTP using experimental auctions. For the experiments, student subjects were given a bag of GM corn chips and auctions were conducted to exchange it with a non-GM bag. Consumption of a bag of corn chips at the conclusion of the experiment was mandatory. Despite their small sample, they concluded

that some consumers would pay a premium for non-GM foods. It remained unknown, however, how consumer's WTP would be expressed with an organic option available.

This study is different from previous research in several important ways. First, products here were labeled as being non-GM, rather than GM as in 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. Second the study attempts to accurately reflect markets by including the organic option for consumers to select. These two together present consumers with an actual purchase decision as could be expected in the marketplace. Lastly, additional information on consumers views of the chances specific food products contain GM ingredients was collected and incorporated in the models.

Experimental Design

Six experiment sessions were held across 2004-2005, for a total of 133 participants. Subjects were primarily from Delaware, Pennsylvania, and Maryland, where experiments were held, although some participants were residents of other states who had traveled for the experiment. During recruiting, subjects were informed they would be paid approximately $35 in cash for taking part in an economic research project involving consumer interest in foods produced with different attributes.

Each session consisted of questionnaires, a presentation, and a series of practice and food auctions. The auction mechanism was explained and two practice sessions were held to improve subject understanding of the most favorable bidding strategy, that of bidding the subject's true value for the good. Vickrey's (1961) sealed-bid n^{th}-price

auction was employed. This type of auction is used rarely in the economy, but it has been commonly applied in WTP experiment due to the favorable theoretical demand-revealing nature of the mechanism. In the n^{th}-price auction, bidders bid secretly and simultaneously. The highest bidder wins the item being sold and pays a price equal to the n^{th} highest bid[1]. 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. 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.

For the food auctions, six food items were presented to subjects in at least three versions: conventional, non-GM, and organic. Fresh and processed foods were included in pairs, with potatoes, potato chips, milk, milk chocolate, corn, and tortilla chips as the six products. Each version 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, as well as the milk from cows treated with rBST. The most common plant crops were listed for subjects, as well as the fact that GM crops have been grown since the mid 1990's. Non-GM food was defined as a lack of any GM ingredients. Organic foods were explained based on the definition from the USDA certification program, including emphasizing the non-GM requirement along with four other major requirements: no usage of synthetic pesticides, hormones or antibiotics, irradiation, or petroleum/sewage sludge fertilizers. Conventional foods were defined as not organic, and with uncertain GM content.

[1] The n^{th} price was randomly chosen by the researchers prior to the experiment.

Bids for all 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. To assist subjects who were not primary food shoppers, however, average grocery store prices were given for the conventional version of the products. After all six sets of food auctions, the binding auction (randomly chosen by researchers before the experiment) was revealed.

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 sex, age, race, education, income, and children in the household.

Data, Descriptive Statistics, and Empirical Approach

On an incoming WTP survey, participants indicated that they had a WTP of approximately 4% more for fresh or processed foods with the attribute "non-GM". This was lower than their WTP for almost all the other attributes, including organic, for which the incoming WTP was 8%. In actual bidding, 50% of the subjects bid higher for non-GM and 68% bid more for organic. Of the respondents who did bid higher for non-GM than for conventional, the average premium was 22%. Of the respondents who bid higher for organic than conventional, the average premium was 32%. There were also

subjects who were indifferent, bidding the same for the non-GM or organic versions as for conventional (34% and 16%, respectively) and also about 10% of subjects submitted bids that were lower for non-GM or organic than for conventional. Many of these 'protest' bids were zero for the non-GM or organic version.

In order to model the factors affecting the bids, a double-Tobit model was used to because of the censored nature of the bidding (for a discussion of the Tobit procedure see for example Long, 1997). With a minimum bid of $0.00, we are unable to determine if a person would have a negative bid (that is, actually pay to avoid eating the food). We also advised participants of a $10.00 limit on bidding, creating a theoretical upper ceiling to the bids (which no one reached), which must also be included in the modeling due to the design of the experiment. Twelve models were estimated, using identical sets of variables (described in Table 1) to model bids for the non-GM and organic versions of all six food products.

Models were designed to include both the demographic variables and attitude and knowledge variables from the questionnaires, similar to Lusk, et al (2001). The sample demographics revealed that the majority of the subjects were female (55%), white (86%), had a college or advanced degree (54%), and were married (56%). Subjects estimated slightly greater than 50% chance that each conventional version contained GM ingredients, but with wide variability. Table 1 shows the variables, their descriptions and mean values. The same variables were hypothesized to affect bids for non-GM and organic versions. For the demographic variables, older subjects and males were expected to have lower bids; higher income or more highly educated participants were expected to

have higher bids. It was hypothesized that race may have an effect but the direction is unclear.

Self-reported knowledge and opinion of GM products were expected to decrease bids for non-GM products and organic products, since a more positive opinion or more knowledge should lead to a greater comfort level with the products. Self-reported knowledge and opinion of organic products were predicted to increase bids for the organic versions, as well as for the non-GM versions, since it is hypothesized that the same individuals may be interested in both versions. Trust in the U.S. government as a regulator of the food supply was expected to decrease bids for non-GM foods (since GM are approved by the government, and a trusting individual may therefore see GM foods as safe) and to increase bids for organic foods (since they are certified by the government, lending credibility to their designation as organic). People who are aware that GM foods have been recalled in the past are expected to bid higher for non-GM and organic, as are label readers. People who believe there is a higher percent chance that the conventional versions contain GM ingredients are hypothesized to bid higher for both non-GM and organic. Tables 2 and 3 show the estimated parameters from Tobit regression results, conducted in SAS.

Demographic variables were sparsely significant, with older subjects having higher predicted bids for both non-GM and organic corn, and higher income respondents having lower bids for both non-GM and organic. This was an unexpected result, since higher income people could presumably afford higher prices. Education, sex, having children under 18 at home, and being nonwhite had no consistent effect. Looking at the knowledge and attitude variables, some surprising results can be seen. Having higher

self-reported knowledge of GM foods significantly lowered the bids for three of the organic products, but had no significant effect on bids for any of the non-GM products. Opinion of organic foods was significant for many of the non-GM and organic products, tending to increase the bids for both. Having a higher opinion of GM foods, logically, decreased the bids for non-GM potatoes and organic potato chips, but was unexpectedly insignificant in the other models. Knowledge that there had been a recall of GM foods increased bids for non-GM potatoes, but no other products. Self-reported higher frequency of label reading decreased bids in two of the non-GM models, and a belief that conventional versions contained higher GM content increased bids in two of the non-GM models. None of these last three were significant in any of the models of organic food bids.

Concluding Remarks

It appears that a substantial untapped market exists for both non-GM and organic products, with over half of respondents bidding higher for one or both, and offering a 20 to 30% premium on average. Organic foods, with the advantage of a government certification and clear labeling, appear especially well-positioned for growth. However, there is clearly a middle area for farmers or food companies who wish to provide a non-GM product without meeting the other aspects of the organic standard which are arguably more difficult and certainly add cost to production. The premium offered for non-GM, while lower than for organic, was likely high enough to offset the cost of providing such a product.

Model estimation showed that many demographic variables were either insignificant or had an unexpected effect on bidding behavior, and that opinion variables were better predictors of the offered price. This presents a difficulty for marketers, since targeting a specific slice of the population is not likely to be an effective strategy and opinions can be difficult to measure. In recent years, sales of organic foods in mainstream outlets and grocery stores have dramatically increased. However, selling products in a specialty store or natural food store may still be the most direct way to target a receptive population, if a supplier is a new entrant to the market or has a limited amount to sell. Mainstream grocery stores would offer advantages for bigger suppliers, and the untapped market for non-GM and organic products is more likely to be shoppers in these mainstream stores rather than in specialty stores.

Ongoing research is increasing the sample size examined, and taking into account the perceived risk from conventional farming methods as well as past shopping behavior and purchase frequency of the items offered for bidding. Categories such as 'certified pesticide-free' and 'no antibiotics used' are also being examined to ascertain the market and relative appeal of those products.

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Table 1: Variable Descriptions and Means

Variable Name	Description	Mean
AGE	Entered as number written; participants ranged in age from 18-81	37.7
INCOME	Categories with midpoints/endpoints as follows: 5, 13, 20, 30, 43, 63, 83, 125, 175, 220 (all numbers in thousands)	67.7
EDUC	1 if Less than High School, 2 if High School, 3 if Some College, 4 if College, 5 if Postgrad	3.39
MALE	Sex: 1 if Male, 0 if Female	0.45
KIDS	Number of kids under 18 at home, range from 0 to 4	0.73
nonwhite	0 if Caucasian, 1 if other race	0.14
GM_KNOW	Self-reported knowledge of GM crops, answer choices from 1 to 5, where 1=”No Knowledge” and 5=”Very Knowledgeable”	2.53
GM_OPIN	Opinion of GM foods, answer choices from 1 to 5, where 1=”Very Negative” and 5=”Very Positive”	2.83
preknow	Number of points known about organic food, out of 5 (range 0-5)	3.13
ORG_OPIN	Opinion of organic foods, answer choices from 1 to 5, 1 as “Very Negative” and 5 as “Very Positive”	3.86
GOV	Confidence in the USDA with 1 as “Not at all confident,” and 5=”Very Confident”	3.28
RECALL	Has there been a recall of GM foods: 1 if “Yes,” 0 if “No”	0.23
LAB_READ	Scale from 1 to 5, 1 if “Never,” 5 if “Always”	3.55
%_GM	Percentage chance that conventional version of the product contained GM ingredients, range from 0 to 100% (0 to 1.0)	0.52

Table 2: Tobit Regression Parameter Estimates of Bids for Non-GM Products

	Parameter Estimates (significance denoted by asterisks)					
Variable	Potato Chips	Potatoes	Milk Chocolate	Milk	Tortilla Chips	Corn
AGE	-0.0026	-0.0009	0.0015	0.0002	0.0013	0.0060***
INCOME	-0.0032**	-0.0012	0.0006	-0.0028***	-0.0017	-0.0044***
EDUC	0.0417	0.0054	-0.2051***	0.0283	0.0147	-0.0348
MALE	0.0319	0.0624	-0.0007	0.0071	0.0459	0.0145
KIDS	-0.0197	-0.0295	-0.0308	-0.0095	0.0479	-0.0061
nonwhite	0.0159	0.0227	0.1301	-0.0586	-0.0541	0.0502
GM_KNOW	-0.0214	-0.0324	-0.0220	0.0040	0.0137	-0.0189
GM_OPIN	-0.0412	-0.0488*	0.0521	-0.0261	-0.0248	0.0050
preknow	0.0275	-0.0069	0.0771	0.0257	-0.0067	0.0157
ORG_OPIN	0.0436	0.0564**	-0.0340*	0.0546***	0.0382	0.0608**
GOV	0.0067	-0.0125	-0.0559	-0.0299	0.0225	-0.0099
RECALL	0.1005	0.1251*	0.0164	-0.0308	-0.0347	0.0623
LAB_READ	-0.0207	0.0081	0.0490	-0.0348*	-0.0192	-0.0527**
%_GM	0.0008	0.0013	-0.0010	0.0010*	0.0017**	0.0010
Log Likelihood[2]	-41.784	-27.826	-72.618	6.507	-41.305	-38.49

*, **, and *** denote significance at the 10%, 5%, and 1% levels respectively.

[2] There is no direct R^2 value for the double Tobit model, so the Log Likelihood statistic is used as a proxy for model fit. Lower values indicate a better fit of the model. In a few cases where the Log Likelihood statistic is low but few variables are significant, such as for organic milk, the explanation is that the intercept of the model (not shown) was highly significant.

Table 3: Tobit Regression Parameter Estimates of Bids for Organic Products

	Parameter Estimates (significance denoted by asterisks)					
Variable	Potato Chips	Potatoes	Milk Chocolate	Milk	Tortilla Chips	Corn
AGE	-0.0023	-0.0036	0.0027	0.0003	0.0009	0.0048***
INCOME	-0.0051***	-0.0012	-0.0025	-0.0020*	-0.0018	-0.0037***
EDUC	0.0988***	0.0059	-0.0349	0.0310	0.0213	-0.0134
MALE	-0.0087	0.1223*	0.0797	0.0371	0.0029	-0.0157
KIDS	-0.0249	-0.0244	0.0145	-0.0430	0.0481	-0.0208
nonwhite	0.1563	0.0543	0.0506	-0.0131	-0.0596	-0.0118
GM_KNOW	-0.0611*	-0.0709**	-0.0605*	-0.0163	0.0120	-0.0282
GM_OPIN	-0.0587*	-0.0300	-0.0231	-0.0054	-0.0008	-0.0205
preknow	0.0247	0.0160	0.0287	0.0245	-0.0164	-0.0018
ORG_OPIN	0.0685**	0.0987***	0.0042	0.0362*	0.0604**	0.0423*
GOV	0.0175	-0.0113	-0.0101	-0.0198	0.0081	0.0141
RECALL	0.0499	0.0245	-0.0137	-0.0796	0.0146	-0.0224
LAB_READ	0.0009	0.0268	0.0089	0.0091	-0.0090	-0.0079
%_GM	0.0000	0.0005	-0.0006	0.0006	0.0003	0.0005
Log Likelihood	-52.52	-46.25	-56.74	9.30	-26.36	-23.65

*, **, and *** denote significance at the 10%, 5%, and 1% levels respectively.