Differences in WTP and Consumer Demand for Organic and Non-GM Fresh and Processed Foods

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Auction experiments were used to examine demand and premium differences between organic, non-GM (genetically modified), and conventional versions for two pairs of fresh and processed foods. Results showed processed foods had greater substitutability among the versions than fresh products. Conventional versions were the least price sensitive, while non-GM versions were the most sensitive. Significant premium differences were found between fresh and processed foods for sweet corn and tortilla chips, but not for potatoes and potato chips. Results from random effects models mirrored these findings. In general, the extent of premium differences between fresh and processed versions appears dependent on the food product.

Key Words: auction experiments, willingness to pay, organic, non-GM, fresh, processed food

Certified organic food has a growing presence in the marketplace. The Organic Trade Association (2006) found that in 2005, total sales of organic foods were \$13.8 billion, with a growth rate of 16.2 percent. The largest component of these was fresh foods, with fruits, vegetables, and dairy accounting for 39 percent of total sales. They also noted that organic processed foods, such as packaged/prepared foods and snack foods, have been expanding rapidly, with growth rates of 19.7 percent and 18.3 percent, respectively. The total sale of packaged/prepared foods was \$1.8 billion (13 percent) and snack food was \$667 million (5 percent) in 2005. This growth of the organic market has notably occurred during a time when farmer usage of agricultural biotechnology has rapidly increased.

Genetically modified (GM) crops, created through biotechnology, have become prevalent in the food system. Examples of GM seeds that have been developed include corn, soybeans, and potatoes. In addition to being consumed in their fresh forms, these products are often standard ingredients in a wide variety of processed foods. It was estimated that 60-70 percent of processed foods on supermarket shelves in North America contain some GM ingredients (Heslop 2006). Although the technology is widespread, studies have shown that some consumers perceive risks from GM foods (see Burton et al. 2001, Onyango et al. 2003, Costa-Font, Gil, and Traill 2008). To avoid GM foods, consumers have limited options. Since U.S. government regulations do not include a labeling requirement for GM foods, consumers can either buy certified organic food, which includes a non-GM requirement, or purchase from the small non-GM market segment.

This study was designed to examine the differences between fresh and corresponding processed food markets for both organic and non-GM food products. Specifically, the first objective was to compare the demand between the fresh and processed categories, which was investigated through the construction of demand curves and the calculation of own- and cross-price elasticities. The second objective was to determine whether premiums for either organic or non-GM foods were significantly different depending on the level of processing. This was analyzed using a random effects model based on demographic characteristics as well as subjects' opinions about organic and GM foods.

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To investigate these objectives, two pairs of food items were considered. Each pair consisted of a whole, fresh food and a processed food based on that main ingredient. The two pairs were potatoes and potato chips, and sweet corn and tortilla chips. It was believed that the results obtained from this study could provide insight into consumers' decisions and help policy makers and food companies improve marketing strategies for organic and non-GM food products.

Literature Review

Fresh products have been considered in numerous studies on organic and GM foods. Wolf et al. (2002) studied consumer attitudes toward organic and conventionally grown lettuce using a survey conducted in California. They indicated that freshness along with quality, price, and environmental impact were of concern to consumers when purchasing lettuce. Findings suggested that approximately 29 percent of lettuce purchasers in California expected to purchase an organically grown lettuce product. They also reported that organic lettuce purchasers were more likely to be female, had a higher household income, and had a higher level of education. In another study by Wolf (2002), 30 percent of respondents indicated a WTP for a 50 percent price premium for organic grapes.

Lin, Smith, and Huang (2008) studied organic premiums for five major fresh fruits (apples, bananas, strawberries, grapes, and oranges) and five major fresh vegetables (carrots, onions, peppers, tomatoes, and potatoes) in the United States. They estimated a hedonic price model based on data from the 2005 A.C. Nielsen Homescan panel, and their results suggested significant organic price premiums for all fresh products. The premiums ranged from 20 percent for grapes to 42 percent for strawberries, and from 15 percent for carrots and tomatoes to 60 percent for potatoes.

Yiridoe, Bonti-Ankomah, and Martin (2005) conducted an extensive review of the available literature concerning consumer awareness and knowledge of—and attitudes and perceptions about—organic food as well as WTP and organic consumers' characteristics. One of their conclusions from this literature review was that consumers tended to be willing to pay higher price premiums for organic products with a shorter shelf life, such as fruits and vegetables, compared to organic products with a longer shelf life, such as cereals.

Bukenya and Wright (2007) studied consumer acceptability of GM tomatoes based on data from a consumer survey conducted at several grocery stores in Alabama. Specifically, they examined the impact of factors such as consumer knowledge, beliefs, and attitudes on the acceptability of GM tomatoes. The results suggested that attitudes towards the use of genetic modification technology in food production, opinions about labeling, and perceptions about the safety of GM foods strongly influenced consumers' decisions. They reported that consumers were willing to buy non-GM tomatoes at a price premium of \$0.39 per pound.

Bernard, Zhang, and Gifford (2006) used auction experiments for processed foods (potato chips, milk chocolate, and tortilla chips) to determine if the organic market well served those seeking to avoid GM food. Results from a heteroskedastic tobit model suggested that the additional attributes of organic foods, beyond being non-GM, did not significantly increase subject bids. Avoiding GM foods may be the largest factor in the premium consumers were willing to pay for organic foods. Results suggested the potential to further develop non-GM products as a niche market.

Lusk et al. (2005) conducted a meta-analysis of GM food studies that included the food characteristics fresh and processed. Their study reported 57 valuations of 25 studies for GM food. The authors classified the food being valued into one of four categories: fresh, processed, oil, or meat. They compared the effects of products being fresh, processed, and oil with the reference of meat and reached the conclusion that consumers would pay a lower percentage premium for non-GM over GM for both fresh and processed foods than for a meat product. However, they did not directly look into the difference between fresh and processed foods.

The effect of demographic characteristics—such as household income, gender, education, and age—on WTP has been widely investigated for organic and GM food products. Most of these studies concluded that higher income households were more likely to have a higher WTP for organic food products (see for example Loureiro and Hine 2002, Yiridoe, Bonti-Ankomah, and Martin 2005, Bernard, Zhang, and Gifford 2006, Krystallis, Fotopoulos, and Zotos 2006, Lin, Smith, and Huang 2008). Organic buyers were mainly women, who were more likely to purchase organic food products in larger quantities and more frequently than men (Govindasamy and Italia 1999, Yiridoe, Bonti-Ankomah, and Martin 2005, Bernard, Zhang, and Gifford 2006, Krystallis, Fotopoulos, and Zotos 2006).

The effect of age and education on WTP remains uncertain. For the latter, some evidence has suggested that more educated consumers would have a higher WTP for organic food (Wolf et al. 2002). However, Govindasamy and Italia (1999) reported that consumers' WTP for organic produce decreased as the level of education increased. Furthermore, Lin, Smith, and Huang (2008) found no significant differences between educational attainment and prices paid for fresh fruits.

As for age, Loureiro and Hine (2002) and Govindasamy and Italia (1999) suggested that younger participants had a higher WTP for organic produce. Krystallis, Fotopoulos, and Zotos (2006) conducted a review of several studies on organic food consumption and found that age does not seem to play an important role, although younger consumers seem slightly more willing to buy organic, and at higher prices, due to their greater environmental consciousness. However, this willingness did not always translate into demand due to their lower purchasing power.

This study, then, is different from previous research in several ways. First, the products considered here include both a fresh and corresponding processed food product. This should directly reveal any impacts the freshness characteristic may have on the price premiums of these food products. Second, organic and non-GM versions were considered along with conventional versions, rather than including only one version, as is common. This further allowed investigation of WTP for non-GM as a nested attribute of organic to help understand consumers' values for the remaining organic attributes. Third, demand curves were constructed, and own- and cross-price elasticities were calculated, using the auction data.

Experimental Design

Seven experimental auction sessions of between 15 and 25 subjects each were conducted between September 2004 and May 2005. There were 154 participants representing four states: Delaware, Maryland, Pennsylvania, and New Jersey. Each session lasted for an hour and thirty minutes. Participants were recruited locally through a combination of classified advertisements, flyers at area supermarkets, and announcements through civic and religious organizations.

At the beginning of the experiment, each participant completed a questionnaire designed to collect their knowledge and opinions of various food production technologies and practices. For knowledge, simple self-reported questions were asked, and for both these and the opinion questions a five-point scale was used. To further help avoid potential influence on subject bidding later on, questions were asked about practices not included in the study, such as eco-friendly and produced on family farms. It was believed important to ask these questions prior to the auctions, as learning the purpose of the study and information about the various attributes would certainly influence subjects' knowledge and may also affect their opinions.

Next, the auction mechanism was explained and three practice auctions were conducted to improve participant understanding. A generalization of Vickrey's (1961) second price auction, where the number of subjects in a session who would purchase a unit was set at one fourth of the group size, was employed. This was typically either a fourth or fifth price auction, meaning for example with the fifth-price version, that the highest four bidders would obtain the food product while paying a price equal to the fifth highest bid. As noted in Lusk and Shogren (2007) this mechanism is incentive compatible, meaning that the best strategy for the subjects was to bid their true value. Since this may not be obvious, the best strategy, and the reasoning behind it, was gone over carefully. The explanation included examples showing subjects the possibility of losing money by bidding more than their value, or missing an opportunity to earn money by bidding less than their value. The lessons from the presentation were reinforced in the practice rounds using induced values between \$0 and \$1.00. By the last practice round, bids were less than 1 percent different from the values given.

After answering any remaining questions about the mechanism, the food auctions were conducted. The fresh food items were potatoes (white baking potatoes, 5-pound bag) and sweet corn (five ears). The corresponding processed products were potato chips (5.5-ounce bag) and tortilla chips (14.5-ounce bag). Subjects bid on three versions of each food item: conventional, non-GM, and organic. None of the products were displayed to the subjects before the auctions. This was decided for several reasons. First, for the processed versions, displaying the products may have allowed subjects to determine the brand, and a goal was to avoid brand effects in the bidding. Additionally, for potato chips the typical packaging is opaque, so this would match the standard purchasing situation. For the fresh products, it would have been difficult to maintain a consistent look and quality across multiple sessions, and the interest was in the WTP for the attributes without consideration of slight visual differences.

Definitions for each version were presented prior to the food auctions and were neutrally phrased, using information from the U.S. Department of Agriculture (USDA). Organic foods were noted as certified by the USDA and defined as having no GM ingredients, no irradiation, no hormones/antibiotics, no synthetic pesticides, and no petroleum/sewage sludge fertilizers. GM food products were explained to be products created with biotechnology to transfer a gene with a known function into existing crop varieties. These crops were explained as having been planted since the mid-1990s and having the approval of the USDA, the U.S. Environmental Protection Agency (EPA), and the U.S. Food and Drug Administration (FDA). Non-GM foods consequently were described as not containing any ingredients that were GM. Conventional foods were defined as not being organic but with the presence or absence of GM ingredients unknown. It was further noted that any use of the other attributes from the organic list would be within government-approved limits and that irradiation would require a label.

Subjects were informed that only one food auction was randomly selected to be binding and would be revealed after the auctions. Therefore, they would at most purchase one food product. Bids were collected in a single trial to avoid the possibility of affiliation of values with repeated trial auctions (Harrison, Harstad, and Rutström 2004, Bernard 2005). Additionally, bids for all three versions of each product were collected simultaneously, which was suggested by Alfnes and Rickertsen (2003) to be an efficient way to elicit WTP differences since all bids can be used.

After all the food auctions, subjects completed a post-experiment questionnaire designed to collect demographic data including gender, age, race, education, income, and number of children in the household. A volunteer was selected to open the envelope containing the food item that was previously selected as being the binding auction. The purchase price was calculated and the four highest bidders were announced. Participants were then paid their earnings in cash with each receiving approximately $35, which included any earnings from practice auctions minus any food purchased.

Data

Bids for the three versions of each of the four food items were collected from all 154 subjects. Using the bids, the percent premiums of organic over conventional, organic over non-GM, and non-GM over conventional versions for both fresh and processed products were calculated. Summary statistics are presented in Table 1. For the four food items, the mean percent premium of organic over conventional was the largest for both fresh and processed food products. The mean percent premium was the smallest for non-GM over conventional in each case. Results from t-tests indicated that the means of percent premiums between the versions for all food items were significantly different from zero at the 5 percent level. Tortilla chips had the lowest means for all three versions comparisons' percent premiums. Sweet corn had the highest mean percent premiums of non-GM over conventional and organic over conventional, at 13 percent and 31.9 percent. The highest mean percent premium of organic over non-GM was 17.6 percent from potato chips. Of particular interest was the mean percent premium for organic over conventional for potatoes, which was 24.7 percent. This was substantially lower than the 60 percent premium reported by Lin, Smith, and Huang (2008), a difference that could be due in part to the different data collection methods employed: surveys versus experimental auctions. The average premiums, especially for organic, were also smaller than in the marketplace, where organic products often are priced at as much as twice their conventional counterparts. This suggested that prices for both organic fresh and processed products would need to come down a substantial amount if they were to capture a large portion of the market rather than continuing in their current niche.

Table 1. Summary Statistics of Percent Premiums

Food	Premium	Mean (%)	Std.Dev	Min (%)	Max (%)
Potatoes:					
	Non-GM over Conventional	**8.86**	0.1800	-49.49	100
	Organic over Conventional	**24.66**	0.3030	-50	150
	Organic over Non-GM	**14.88**	0.2370	-51.61	101
Potato Chips:					
	Non-GM over Conventional	**6.90**	0.1638	-55.06	50.51
	Organic over Conventional	**26.67**	0.3354	-97.04	166.67
	Organic over Non-GM	**17.57**	0.2789	-97.04	147.5
Sweet Corn:					
	Non-GM over Conventional	**13.00**	0.2416	-62.5	130
	Organic over Conventional	**31.92**	0.4389	-50	300
	Organic over Non-GM	**16.32**	0.3832	-25	400
Tortilla Chips:					
	Non-GM over Conventional	**4.11**	0.1473	-66.67	51.52
	Organic over Conventional	**12.64**	0.2260	-40.11	182.86
	Organic over Non-GM	**6.80**	0.1412	-33.33	98

Note: Values in bold are significantly different from zero at the 5 percent level.

The descriptive statistics for the independent variables of the random effects models are presented in Table 2[1]. A closer examination of the sample demographics revealed that the majority was female (55 percent), and more than half had a college degree or higher education (58.3 percent). Subject age ranged from 18 years to 81 years of age with a mean of 39 years. Household income ranged from $15,000 to $250,000, with a mean of $78,000. Lastly, 55 percent of households had at least one child under 18 years of age. In addition to demographic questions, subjects were asked their opinions about organic and GM products on a scale of 1 to 5, with 1 meaning very negative and 5 meaning very positive. The mean was 3.775 for organic and 2.933 for GM, which was significantly lower at the 5 percent level.

Empirical Specification

Several methods were used to examine the differences in the fresh and processed markets for organic and non-GM foods. First, demand curves were constructed for a graphical analysis of the bid data. Next, demand relationships were further explored by calculating own- and cross-price elasticities. Third, the premium differences between fresh and processed foods were compared. Lastly, a random effects model was estimated to determine whether or not premiums were significantly

[1] There were two datasets: one for potatoes and potato chips and the other for sweet corn and tortilla chips. The means for independent variables in the two datasets varied slightly but not significantly. In the interests of space, the means for just the potato and potato chips data set were reported here.

Table 2. Summary Statistics for Demographic Variables

Variable	Definition	Mean	Std.Dev.
Freshp	1 if potatoes, 0 if potato chips	0.5000	0.5010
Freshc	1 if sweet corn, 0 if tortilla chips	0.5000	0.5010
Age	Age of subject, in years	39.1750	13.6469
Income	Subject income (in $ thousands)	78.0208	48.4971
College or more	1 if subject has at least a college education, 0 otherwise	0.5833	0.4940
Male	1 if subject is male, 0 if subject is female	0.4500	0.4985
Hchild	1 if subject has a child, 0 otherwise	0.5500	0.4985
OpinionORG	Subject's opinion about organic product	3.7750	1.0142
	Scaled from very negative (1) to very positive (5)		
OpinionGM	Subject's opinion about GM product.	2.9333	1.0568
	Scaled from very negative (1) to very positive (5)		

different, depending on whether the product was fresh or processed.

Demand curves were constructed by plotting the sorted bids against the frequency of the sample, with bids greater than particular prices. After calculating the cumulative percentages at particular prices, the demand curve for the sample was obtained by plotting both bids and cumulative percentages. Own- and cross-price elasticities were calculated following Lusk and Schroeder (2006). The own-price elasticity was obtained by the ratio of the share changes to price changes. In this study, an initial baseline was constructed as the mean value of bids for each version, and the share changes were calculated as the price increased 5 percent from the initial baseline. For example, the own-price elasticity of the conventional sweet corn version when the price increases from $1.51 to $1.59 is:

(1) $[(S_{conv}^{1.59} - S_{conv}^{1.51})/S_{conv}^{1.51}]/[(1.59 - 1.51)/1.51]$,

where S is the share of consumers that would purchase the conventional sweet corn, and the superscript stands for the price at which the share is calculated. Cross-price elasticities were calculated by a similar process.

Next, the premium differences between potatoes and potato chips as well as sweet corn and tortilla chips were compared. Since the distributions of the percent premiums were determined to be non-normal, nonparametric tests needed to be used. The correct nonparametric test additionally depended on whether or not the variances of the distributions were homogeneous. Thus, for the first step, Brown and Forsythe's test was used to check the homogeneity of the distributions. For distributions that were found to be homogeneous, the Wilcoxon test was used to compare premium differences, while for heterogeneous distributions the Fligner-Plicello test was conducted. All calculations and tests were conducted in SAS (SAS Institute Inc. 2003).

Lastly, random effects models were estimated for each pair of food products. The differences of WTP (percent premium) of organic over conven-

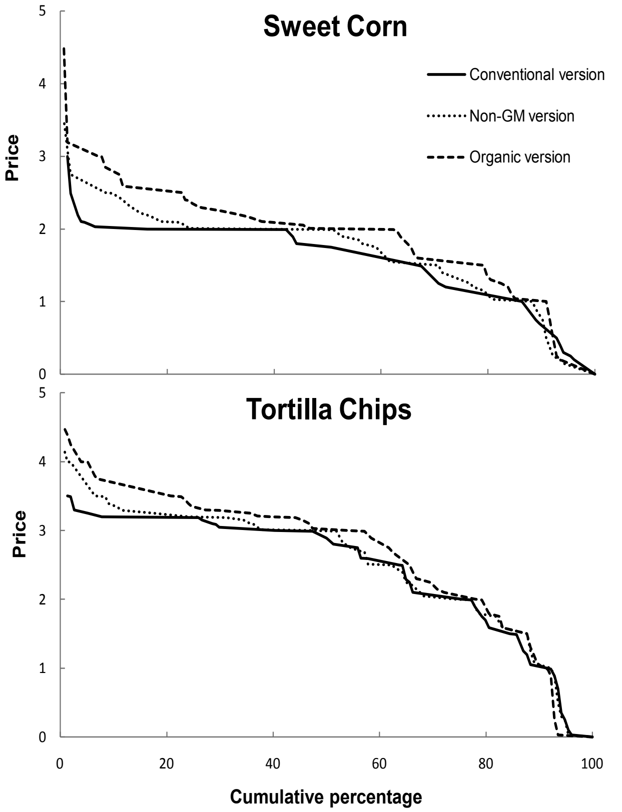

Figure 1. Demand Curves for Sweet Corn and Tortilla Chips

tional, non-GM over conventional, and organic over non-GM versions may come from two aspects: demographic characteristics and product attributes. This study focused on whether or not fresh products had significantly higher premiums than their processed counterparts.

The following model was constructed and estimated in Limdep (Greene 2007):

$$\Delta W_{i,k} = X^{'}\beta + \mu_i + \varepsilon_{i,k} \tag{2}$$

where ΔW = {percent premiums}, $X^{'}$ = {$Fresh_k$, Z_i , $Opinion_{i,k}$}, and k = {potato, potato chips} or{sweet corn, tortilla chips}. $Fresh_k$ is a dummy variable, which is 1 if the product is fresh and 0 if the product is processed. Z_i consists of the demographic variables for consumer i: income, age, children under 18, and having at least a college education. $Opinion_{i,k}$ is consumer i's opinion of the organic or GM version for the kth product. μ_i depicts individual heterogeneity among consumers and is constant across products. $\varepsilon_{i,k}$ is the error term whose mean is zero across the products and consumers.

The hypotheses regarding the demographic variables were that being female, presence of children under 18 in the household, and higher income would have positive effects on the premiums. The effect of education was uncertain, as a case could be made for either a positive or negative effect. The effect of age was expected to be negative, since younger people may be more interested in environmental issues, while older people may be less likely to change to unfamiliar foods. Having positive opinions about organic foods was hypothesized to have a positive influence on premi-

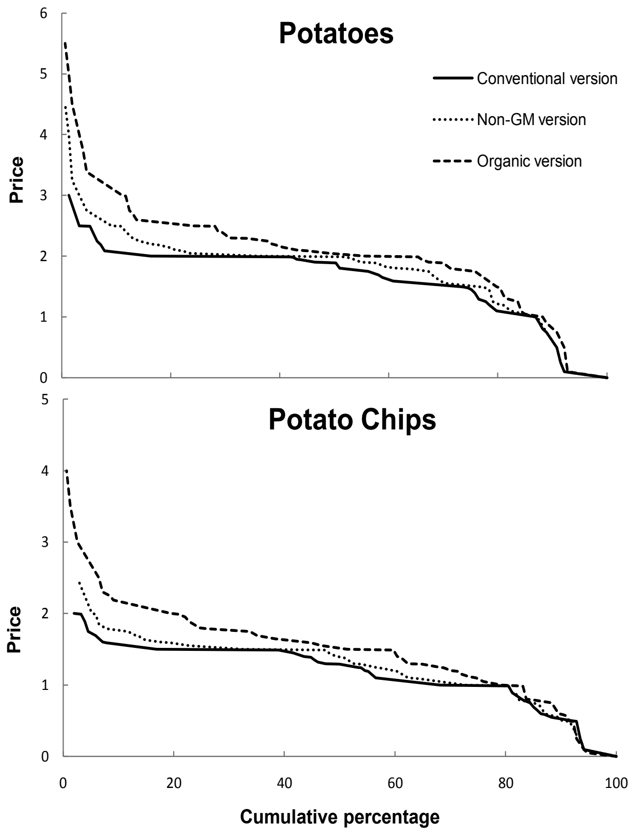

Figure 2. Demand Curves for Potatoes and Potato Chips

ums of organic over conventional and non-GM, while positive opinions about GM technology were hypothesized to have a negative effect on premiums of non-GM over conventional.

Results

Demand curves for each pair of food products are presented in Figure 1 and Figure 2. Each graph has three demand curves representing the three versions for each food product. The upper portion of each figure contains the fresh version of the product, while the lower half displays the demand curves for the processed version. The first result was that at most price levels, the demand curves for the organic version lie above the demand curves of the other two versions for all four foods. The exceptions are at very low price levels where either the curves are indistinguishable, as with the potato products, or conventional demand appears higher, as with the corn products. Intuitively, it could be considered that consumers would be skeptical of the quality of organic foods below \$0.30 and indeed possess lower demand at such price levels.

The second result was that while the demand curves for the non-GM version were predominantly above those for the conventional versions, this did not hold consistently. Each graph instead shows areas at mid-range prices where the demands for non-GM and conventional versions appeared to be virtually identical. Only at the highest price levels was the demand for non-GM versions clearly superior to those for their respective conventional versions. These results together suggested consumers viewed organic as an option

Table 3. Elasticities

a. Elasticities for Sweet Corn

Corn Version % Share Change	Corn Version – 5% Price Change		
	Conventional	Non-GM	Organic
Conventional	-3.044	1.995	0.375
Non-GM	3.909	-6.400	2.404
Organic	0.790	4.022	-4.537

b. Elasticities for Tortilla Chips

Tortilla Version % Share Change	Tortilla Chip Version – 5% Price Change		
	Conventional	Non-GM	Organic
Conventional	-4.075	3.007	5.424
Non-GM	9.640	-14.940	8.985
Organic	2.009	2.767	-9.981

c. Elasticities for Potatoes

Potato Version % Share Change	Potato Version – 5% Price Change		
	Conventional	Non-GM	Organic
Conventional	-3.146	1.966	1.200
Non-GM	4.258	-5.893	2.122
Organic	0.485	1.999	-3.024

d. Elasticities for Potato Chips

Potato Chip Version % Share Change	Potato Chip Version – 5% Price Change		
	Conventional	Non-GM	Organic
Conventional	-3.987	3.793	0.276
Non-GM	5.366	-13.667	8.287
Organic	3.096	3.153	-5.577

Note: Column headings represent price changes while the row headings represent quantity changes.

more favored over conventional than non-GM versions, perhaps suggesting limited market potential for the latter.

For further analysis, own- and cross-price elasticities are presented in Table 3. In reading the table, the column headings represent price changes, while the row headings represent quantity changes. Using sweet corn as an example, if the price of the non-GM version increased one percent, there was a 1.995 percent increase in sales for conventional sweet corn. First, the own-price elasticities results revealed that demands for the conventional versions were the least sensitive to changes in their own prices. The only exception was potatoes, where the organic version was the least price sensitive. Even in this case, the difference was small. These seemed to match well with the price sensitivity findings of Lin, Yen, and Huang (2008) and their examination of conventional and organic fruits.

An additional result was that the non-GM food versions were the most price-sensitive. In contrast to conventional versions, price fluctuations of the non-GM versions seem to have the potential to greatly alter consumer demand. This suggests producers may benefit substantially if they could achieve even small decreases in the prices of such versions. Own-price elasticities for organic fell mostly in the middle but were much less price sensitive than non-GM versions. These findings suggest that consumers are more likely to continue purchasing products they are familiar with, such as conventional versions of foods, while being more likely to change their demand for niche versions such as non-GM and organic.

Turning to the cross-price elasticity results, of note were the strong substitute relationships among the organic, non-GM, and conventional versions for all the foods. Examining the results closely showed a strong tendency for consumers to want to shift to the next "closest" version of the food product in the event of a price increase. Specifically, for conventional versions, it could be seen that price increases increased the demand for non-GM versions more so than organic. It could be that consumers perceive a benefit to the non-GM attribute that becomes attractive as the conventional price rises. The much smaller movement to organic suggests it would take more than conventional price changes to make consumers switch.

In a similar fashion, an increase in the price of organic was not seen as enough to move consumer demand back to conventional. Again, taking what was likely viewed as the next best option, consumers could be seen moving instead to non-GM and thus retaining at least one component of organic. This finding of consumers continuing to avoid GM if they have the option, but being unwilling to pay the full organic premium, is similar to the findings of Bernard, Zhang, and Gifford (2006). For the middle, non-GM versions, consumer demand would typically divide between the other two versions in the event of a price increase. Thus, about the same portion would be willing to downgrade to conventional as would upgrade to organic. The exception was with sweet corn, where demand would shift heavily towards organic. This suggested a stronger adversity to GM sweet corn than to GM versions of the other three products.

Also of note in the patterns of substitution were some of the asymmetries. Perhaps most apparent, increases in the price of conventional versions led to a much greater increase in demand for non-GM than would be seen by conventional if the non-GM versions increased in price. Asymmetries between conventional and organic also existed, matching relationships observed in Lin, Yen, and Huang (2008) and Bernard and Bernard (2009), although not with as consistent a pattern. For non-GM and organic, the largest asymmetries were for the processed foods where the movement from organic to non-GM was much greater than the reverse.

Lastly, the processed food versions stood out as having higher own-price and cross-price elasticities. The only exceptions were the cross-price elasticity of organic with respect to non-GM for the corn pair and the conventional version with respect to organic price changes for the potato pair. Processed foods' higher cross elasticities implied individuals had less loyalty to any particular version of processed than of fresh food products. Of issue here could be the lack of brand information that typically appears on such products. Further research could explore this relationship.

The differences in percent premiums between fresh and processed foods are displayed in Table 4. Results showed significant differences in percent premiums for sweet corn over tortilla chips but not for potatoes over potato chips. This inconsistent finding implied that individuals' perceptions of organic and non-GM were essentially the same for potatoes and potato chips but quite different for sweet corn and tortilla chips. People appeared to value organic and non-GM versions more in sweet corn than in tortilla chips. This conformed to the elasticity results where consumers were less likely to shift to the conventional version if non-GM prices increased. The significant positive difference of percent premiums between sweet corn and tortilla chips suggested that there was a greater potential to profitably develop organic and non-GM versions in the sweet corn market compared with the tortilla chips market. One possible interpretation for the insignificant premium differences for potatoes over potato chips would be how common each is in individuals' diets (USDA 2006), with perhaps less distinction being made between the fresh and processed forms.

Before moving on to the detailed discussion of estimation results, some tests of model specifications should be noted. One potential concern was the existence of endogeneity in the belief varia-

Table 4. Differences in Fresh/Processed Percent Premiums

		Differences in Premium Percents		
Food	Premium	Mean (%)	Std Dev.	p-value
Potatoes over Potato Chips:				
	Non-GM over Conventional	1.86	0.1766	0.4452
	Organic over Conventional	-1.83	0.3058	0.2828
	Organic over Non-GM	-3.47	0.2699	0.2629
Sweet Corn over Tortilla Chips:				
	Non-GM over Conventional	**8.46**	0.2377	0.0160
	Organic over Conventional	**19.12**	0.3677	<.0001
	Organic over Non-GM	**9.46**	0.3210	0.0030

Note: Values in bold significant at the 5 percent level.

bles *Opinion*. The test was implemented with the methodology adopted from Greene (2000) and Wooldridge (2006). Results indicated there was no endogeneity present. The other concern was the presence of individual heterogeneity. If individual heterogeneity does not exist in the model, $\sigma_{\mu}^2 = 0$ (Wooldridge 2002, Jin, Zilberman, and Heiman 2008), then panel estimators were the same as pooled estimators. The test for the model with the premium of non-GM over conventional versions for sweet corn and tortilla chips could not reject the null hypothesis at the 5 percent significance level; therefore, the OLS estimators were reported. However, the likelihood-ratio tests of the other models rejected the null hypothesis $\sigma_{\mu}^2 = 0$ at the 1 percent significance level, which indicated individual heterogeneity did exist, and random effects models were more appropriate.

Table 5 shows the estimation results for sweet corn and tortilla chips, and Table 6 shows the results for potatoes and potato chips. Parameter estimates significant at the 10 percent level are indicated in bold. The dummy variable *Fresh* had a statistically positive effect on premiums in the corn product models at the 5 percent level; however, it was not statistically significant in the potato product models. These confirmed the results in Table 4 that premium percents were only significantly different for sweet corn over tortilla chips.

For the demographic variables, *Male* had a negative effect on the premium of organic over conventional for both corn and potato models, which indicated that females placed higher WTP for the organic version over conventional. This result was consistent with findings from other studies (Govindasamy and Italia 1999, Bernard, Zhang, and Gifford 2006). It was believed that women tend to shop more frequently and to be more informed about nutrition and food safety than males. Moreover, females appear more likely to adopt a healthier diet for the family. However, gender was not significant for any of the other premiums. This may reflect consumers' lack of knowledge and uncertainty regarding GM foods and the differences between them and non-GM versions, giving both genders similar impressions of each.

An unexpected result was that *Income* had a negative effect on the premium for organic over conventional for both the potato and corn models. However, the effects were small (-0.001 and -0.0009) and Krystallis and Chryssohoidis (2005) argued that disposable income affects mainly the

Table 5. Random Effects Models: Results for Corn and Tortilla Chips

	Corn & Tortilla Chip Premiums					
	Organic over Conv		Non-GM over Conv		Organic over Non-GM	
Variable	Estimation	P-value	Estimation	P-value	Estimation	P-value
Freshc	**0.1637**	0.0001	**0.0787**	0.0004	**0.0866**	0.0022
Income	**-0.001**	0.0468	-0.0003	0.1782	-0.0005	0.3548
Male	**-0.0967**	0.0431	-0.0356	0.1127	-0.0600	0.1939
Age	0.0011	0.5495	0.0007	0.4074	-0.0002	0.9151
Children	-0.0336	0.4965	0.0001	0.9999	-0.0636	0.1883
College or more	0.0323	0.5180	-0.0040	0.8689	0.0595	0.2257
OpinionORG	0.031	0.1954			0.0038	0.8697
OpinionGM			**-0.0234**	0.0457	-0.0170	0.4865

Note: Parameter estimates significant at the 10 percent level are indicated in bold.

quantity of organics bought and not general willingness to buy. Having children under the age of 18 years in the household was the only other demographic variable found to be significant and only for the organic over non-GM premium in the potato model. This suggests that what concerns parents are the remaining attributes in organic beyond being non-GM.

The lack of significance of the other demographic variables was not completely unexpected. The insignificant effect of education was also observed by others, such as Krystallis and Chryssohoidis (2005) and Lin, Smith, and Huang (2008). Education has been argued both to potentially lead to greater concerns regarding GM foods and to lead to lower levels of concern. It may be that there is a division in the reactions of educated consumers and thus no clear effect to observe. Lastly, age did not play a significant role in the premiums.

The two opinion variables were significant for a number of the premium models. Consumer opinion about organic and GM versions had signifycant effects on the potato models as expected. More positive opinions about organic led to higher premiums for the organic versions, while more positive opinions about GM technology decreased the premiums for the non-GM over conventional versions. For the corn models, however, the opinion of organic did not matter. Opinion of GM foods though had the same effect as in the potato model. Overall, these variables seem to be almost better guides of premiums than consumer demographics.

Conclusion

As processed food products expand along with fresh ones in organic and non-GM markets, estimates of consumer WTP between processed products and fresh become important in assisting businessmen and policy makers in their product development strategies. In this study, auction experiments consisting of two fresh and two corresponding processed food products, each of which contained three versions (conventional, non-GM, and organic), were used to examine two main issues. The first issue was to investigate whether premiums that consumers were willing to pay for organic and non-GM versions were significantly

Table 6. Random Effects Models: Results for Potatoes and Potato Chips

	Potato & Potato Chip Premiums					
	Organic over Conv		Non-GM over Conv		Organic over Non-GM	
Variable	Estimation	P-value	Estimation	P-value	Estimation	P-value
Freshp	-0.0206	0.4577	7.1E-03	0.6605	-0.0307	0.2147
Income	**-0.0009**	0.0577	**-0.0005**	0.0587	-0.0029	0.4926
Male	**-0.0789**	0.0844	-0.0153	0.4960	0.0429	0.2706
Age	0.0004	0.8297	-0.0006	0.4861	0.0002	0.9153
Children	0.0009	0.9843	0.0344	0.1333	**0.0662**	0.0997
College or more	-0.0043	0.9287	0.0012	0.9601	0.0125	0.7624
OpinionORG	**0.0638**	0.0050			**0.0550**	0.0044
OpinionGM			**-0.0297**	0.0091	0.0201	0.3146

Note: Parameter estimates significant at the 10 percent level are indicated in bold.

different depending on levels of processing. The second was a comparison of the demands between fresh and corresponding processed categories.

The primary finding was fresh foods did not necessarily bring higher premiums for the organic and non-GM versions than for the corresponding processed products. Significant premium differences were found between fresh and processed in the pair of sweet corn and tortilla chips, but not in the pair of potatoes and potato chips. Results from the random effects models also confirmed that the factor of being fresh only impacted premiums for the sweet corn and tortilla chips pair.

Consumers did, however, have different perceptions toward organic and non-GM for certain fresh and processed foods. Compared with tortilla chips, people were more likely to avoid GM in sweet corn. Elasticity estimates showed that an increase in price for non-GM sweet corn brought more consumption to the organic than to the conventional version. As a consequence, it may be more profitable to enlarge the non-GM and organic markets for sweet corn than for tortilla chips.

The results from the model analysis agreed with past literature concerning the importance of demographic characteristics and subjects' opinions in determining organic and non-GM food premiums. Women were found to have higher WTP for organic, while other demographics did not have a significant effect. Both opinion variables were significant, with the expected finding that a more positive attitude towards the organic version and a more negative attitude towards GM results in greater WTP for organic and non-GM food products.

Finally, the elasticity results showed that processed food products typically had greater substitutability among the three versions investigated than did fresh food products. This suggests the price decrease of any version will be much more useful in enlarging the organic or non-GM market for processed food than for fresh food. The demand curves for organic always laid to the right of the other two versions; it confirmed that people still tried to avoid GM and were willing to pay more to buy organic products. Non-GM was the most price sensitive version. As its price increases, individuals expect additional attributes besides non-GM and may consider non-GM to be no longer cost-effective. Furthermore, consumers were almost equally divided between those who chose organic or conventional when the non-GM price increased. Conventional was the least price-sensitive version and was asymmetrical with the non-GM version. Therefore, decreasing the price of the non-GM or organic version will increase sales of conventional more than a direct price decrease of conventional would.

The findings of premium differences between products with two levels of processing suggest further study in the following aspects. The study conducted here considered only two pairs of fresh and processed foods: potatoes, potato chips, sweet corn, and tortilla chips. A possible food category to examine further would be dairy, with products such as milk, cheese, and ice cream. A research study that expands the categories of products may tell a better story about the effect the level of processing has on price premium. Evidence here suggests differences between fresh and processed versions may be highly dependent on the product. In addition, future research could be designed to investigate more diverse geographical areas to determine whether regional differences exist.

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