Organic Price Premiums Paid for Fresh Tomatoes and Apples by U.S. Households: Evidence from Nielsen Homescan Data

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Using multivariate regression on data composed of prices, produce characteristics, demographics, and interactions, this study investigates organic price premiums paid by U.S. consumers for fresh tomatoes and apples, two of the top organic produce sellers, and identifies factors explaining variation in price premiums. The econometric problem of each buyer having multiple records in the purchase data is addressed in the estimation procedure.

Consumer surveys have indicated that people believe organically grown foods are better than their conventional counterparts in terms of personal safety, nutritional quality, taste, and adverse effects on the environment (Jolly et al. 1989; Davies, Titterington, and Cochrane 1995; Hammitt 1990). "Buying organic" may represent a lifestyle choice. Organic buyers have somewhat different lifestyle patterns and behaviors than conventional buyers. For example, Williams and Hammitt (2000) showed that organic buyers are more likely than conventional buyers to be vegetarians, grow their own fruits and vegetables, recycle, and purchase environmentally friendly products.

Using the contingent valuation approach with survey data from two large urban areas in Spain, Sanjuan et al. (2003) investigated consumer willingness to pay for organic produce for different groups (likely consumers, organic consumers, and unlikely consumers) segmented by lifestyle characteristics including various factors pertaining to preference for natural food, balanced life, concerns for health, and social improvement. Their results confirmed that willingness to pay differs among consumer segments, products, and cities. The highest premiums that the most concerned consumers in large cities were willing to pay for organic produce items ranged from 22 to 37 percent for vegetables other than potatoes. For potatoes this range fell to 13–17 percent.

Given the fact that consumer information from organic retailing, other than transaction data, is usually limited to demographic characteristics of customers, previous research results on the relationship between organic consumption with respect to consumer attitudes and lifestyle characteristics are not of much practical use for retailers in formulating effective marketing strategies.

Several studies have investigated consumer demographic factors related to likelihood of consumer willingness to pay more for organic food via surveys. Using data collected from mail surveys of Georgia consumers, Huang (1993) reported that the majority of consumers indicated a willingness to pay up to ten percent more for organically grown produce. A gender difference, which showed females to be more likely than males to pay a premium for organic produce, also was found. Huang (1993) noted that females and households with children were more likely to have higher risk aversions to pesticide residues than their counterparts. Groff, Kreider, and Toensmeyer (1993) also reported that females were more likely than males to place a higher value on organic than conventionally grown produce. With a consumer survey at various grocery retail establishments in New Jersey, Govindasamy and Italia (1999) found that females, those with higher annual incomes, younger individuals, and those who usually or always purchase organic produce are all more likely to pay a premium for organic produce. Their results also indicated that the likelihood of paying a premium for organic produce decreases with the number of individuals living in the household and is also negatively related to educational level.

While surveys using contingent valuation provided useful information on consumer motivations in buying organically grown produce and likelihood of willingness to pay for organic items, it remains unclear whether consumer attitudes translate into real purchases of organic produce and at higher prices. Buzby and Skees (1994) reported that while over half of the respondents in a national survey indicated a preference for organically grown fresh fruits and vegetables, only 25 percent had actually purchased such produce on a regular basis. They

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suggested that price, availability, and cosmetic appearance are the major factors that account for the reported discrepancy between what consumers said they would prefer and what they actually purchased. Consumers who value the benefit associated with consuming organic food may not be willing to pay the higher prices.

There have been very few studies investigating the effect of potentially important demographic characteristics of consumers on price premiums that they are willing to pay or have paid for organic produce items. Using consumer-survey data collected in supermarkets at different locations in the state of Colorado on potato purchases, Loureiro and Hine (2002) studied consumer willingness to pay for organic products and found that the age of the consumer seems to have a negative effect on willingness to pay for organic and that consumers who are wealthy and well-educated, on average, are willing to pay about $0.02 more per pound to obtain organic products.

In summary, the previous works, cited above, using contingent valuation survey methods, found that organic produce price premiums were more likely to be paid by women, households with children, smaller households, higher-income earners, younger consumers, and both less and higher educated (conflicting results with respect to education level). Our study goes a step further and reveals for the most part what actually happened. Using multivariate regression on national-level retail data, our analysis complements previous studies by investigating the magnitude of premiums consumers actually paid for organic fresh tomatoes and apples, two of the top organic produce items, and by identifying household demographic factors and seasonal indicators which explain variation in organic premiums. Based on the results of this study, organic retailers can know the best time and market segment to target to obtain desired levels of organic premiums.

Data and Variables

Observations used in this study are from Nielsen Homescan data. To obtain both purchase records and corresponding household demographic information, Nielsen provided a patented hand-held scanner to each household on its U.S. consumer panel. The hand-held scanner was used to record grocery items purchased at any store throughout a given period. There are 18 known demographic characteristics for each household.

Data for 2003 were used as the latest available at the time of this study; this corresponds to the first year after organic certification was implemented in October 2002. UPC-coded produce items in 2003 are explicitly labeled either with "organic seal" (USDA certified organic) or "organic claim" (producer-claimed organic). In this study, fruits and vegetables with either one of the two organic labels are regarded as organic. Organic produce items sold by random weight were identified by name. We limit our investigation to organic premiums U.S. consumers paid for two fresh produce items in 2003, tomatoes and apples. They are among the most consumed organic vegetables and fruits, respectively.[1]

In 2003 there were 33,779 and 25,927 usable purchase records, made by 7,306 and 7,130 households, for fresh tomatoes and apples, respectively. One problem with the data is inaccuracy of some purchase records due to inadvertent recording or misestimated quantities (especially for some random-weight items sold by count instead of weight). To eliminate inaccurate records, prices were calculated for each purchase record. Observations with zero or unreasonably high prices were deleted. A rule of thumb for outlier detection in statistics is to find measurements outside of three standard deviations from the mean (Anderson, Sweeney, and Williams 2003). Using this criterion for the overall dataset, prices that exceeded $7.98/$4.00 per pound for UPC-coded/random-weight tomatoes and $3.98/$2.99 for UPC-coded/random-weight apples were considered as unreasonable outliers and thus deleted. Lower-end prices except values of zero were kept because they are within three standard deviations of mean prices and it is possible to have very low prices due to sales or promotions. It is acknowledged that deleting records with high outlier prices (organic and conventional) eliminates not only inaccurate data but also eliminates some accurate information.

To reasonably summarize purchase data (expenditure and quantity) of each household and exploit variables contained in the data, purchase data on tomatoes and apples in 2003 were aggregated at the

[1] The top fresh organic fruits and vegetables purchased in the United States in 2002 were tomatoes, leafy vegetables, carrots, apples, potatoes, peaches, bananas, and squash (*The Packer* 2002).

household level within four dimensions (2 × 2 × 2 × 4): organic or not, random weight or not, on sale or not, and four seasons (Table 1). As a result, seven additional dummy variables were created from the purchase data. Unit price was computed as aggregated expenditure divided by quantity. The unit price and seven dummy variables obtained from the purchase data were then merged with 19 household demographic variables (Table 2). For a given household, the number of observations can be as low as one and as high as 32 (2 × 2 × 2 × 4). The final dataset, where each household can have multiple observations, may cause an econometric problem in linear regression because observations from the same household are not likely to be independent. This potential problem is addressed in the next section.

For households that bought tomatoes and apples in 2003, total expenditures on organic and conventional items were aggregated and organic market shares were calculated. The organic market shares were four and three percent for tomatoes and apples, respectively.

Cross tabulation of the ORGANIC variable with the RW and SALE dummy variables using the original transaction-level data shows that organic items were more likely to be sold in loose form (random weight) than were conventional items for both tomatoes and apples. About 84 percent of purchases for organic tomatoes and 90 percent of purchases for organic apples were made in loose form. However, organic items were less likely to be put on sale, especially apples. Only 18 percent of purchases for organic apples were recorded as on sale, which is significantly less than the percentage for conventional apples, 27 percent.

Estimation Procedure

The primary purpose of the estimation is to model the organic premiums of the selected fresh produce items and identify factors which explain variation in organic price premiums. A multivariate linear regression model is proposed as follows:

$$(1)\quad PRICE_i = \alpha + \beta_{1-3}SEASON + \beta_4 SALE + \beta_5 RW + \beta_{6-19}DEMOGRAPHICS + \beta_{20}ORGANIC + \beta_{21-23}(ORGANIC + SEASON) + \beta_{24}(ORGANIC + SALE) + \beta_{25}(ORGANIC + RW) + \beta_{26-39}(ORGANIC + DEMOGRAPHICS) + \varepsilon_i,$$

where $PRICE_i$ is the price consumers paid for produce items, *SEASON* includes three dummy variables to represent the four seasons of the year with spring as the baseline season, *RW* is the dummy variable for produce sold random weight, *DEMOGRAPHICS* include 14 demographic variables described in Table 2, and *ORGANIC* is a dummy variable for organic produce. To account for possible differences in organic price premiums due to variation by season, package form, sales and promotion, and buyer demographics, interaction terms for *ORGANIC* and these variables were added. Interaction variables, if statistically significant, can be considered as important factors explaining organic premiums.

For estimation of the above model, a possible data problem stemming from multiple observations for each household must be addressed. Because observations from the same household are not likely to be independent, Ordinary Least Square (OLS) estimation, which assumes independence among

Table 1. Variables for Produce Characteristics Created from Purchase Data.

Dimensions of Aggregation for Purchase Data	Dummy Variables Created from Purchase Data (1 = yes; 0 otherwise)
Organic/conventional	ORGANIC
Random weight/UPC coded items	RW
On sale/not on sale	SALE
Four seasons	SPRING, SUMMER, FALL, and WINTER

Table 2. Description of Demographic Variables for Consumer Panel Households, 2003.

Variable	Definition	Mean (SE)
Hhsize	Household size	2.60 (1.39)
Income	Total income of the household in $1,000 (midpoint of income category)	54.32 (27.16)
Dummy variable (1 = yes, 0 otherwise)		
Age1*	The higher age of the male and female household heads is less than 40	0.16
Age2	The higher age of the male and female household heads is between 40 and 64	0.62
Age3	The higher age of the male and female household heads is 65 and above	0.23
Educ1*	The higher education of the male and female household heads is high school	0.19
Educ2	The higher education of the male and female household heads is college	0.65
Educ3	The higher education of the male and female household heads is post college	0.16
Child6	Households with children under six years of age	0.09
East	Residents in eastern region	0.21
Central	Residents in central region	0.18
South	Residents in southern region	0.40
West*	Residents in western region	0.21
Urban	Residents in urban areas	0.87
Rural	Residents in rural areas	0.13
White	White households	0.74
Black	Black households	0.13
Hispanic	Hispanic households	0.08
Oriental*	Oriental households	0.03
Households	Total number in Nielsen panel	8,833

Note: As baseline groups, variables marked with an asterisk are not entered in the model.

all observations, may produce results that appear too optimistic. In other words, for our data, OLS regression may overestimate statistical significance of explanatory variables because of smaller standard errors than would otherwise be the case for estimated parameters.

To address this problem, the standard errors of the estimators should be adjusted to account for possible dependence among household-level observations (Wooldridge 2002). Observations used in our study can be considered as data from a clustered sample design where the clusters are households with each having multiple purchases. For the regression with clustered observations, the estimated parameters are the same as those from OLS, but the variance-covariance matrix of $\hat{\beta}$ should be adjusted as follows:

(2) $\hat{V} = (X'X)^{-1}(\sum_{j=1}^{G} u_j' u_j)(X'X)^{-1}$,

where X is the design matrix which includes all explanatory variables for all observations; $u_j = \sum_{i=1}^{N_j} \varepsilon_i x_i$,with N_j being the number of observations in household j, ε_i as the residual for the ith observation, and x_i as a row vector of predictors including the constant; and G is the total number of households (clusters).

After parameters and robust standard errors were estimated, prices of the conventional produce items and organic premiums for different scenarios were calculated. Prices paid by consumers for conventional produce items (*CONPRICE*) were obtained by setting the dummy variable, *ORGANIC*, to zero which leads to

(3) $CONPRICE_j = \hat{\alpha} + \hat{\beta}_{1-3} SEASON + \hat{\beta}_4 SALE + \hat{\beta}_5 RW + \hat{\beta}_{6-19} DEMOGRAPHICS.$

Representative levels of conventional prices can be obtained using Equation 3 with right-hand-side variables set at mean levels.

Note that because interaction terms with *ORGANIC* were added to the model, the estimated parameter (β_{20}) for *ORGANIC* cannot be interpreted directly as the organic premium. Instead, the premium consumers paid for organic (*ORGPREMIUM*) is a linear function of variables included in interaction terms. This linear function can be obtained simply by taking the first derivative of the dummy variable, *ORGANIC* in Equation 1:

(4) $ORGPREMIUM_j = \hat{\beta}_{20} + \hat{\beta}_{21-23} SEASON + \hat{\beta}_{24} SALE + \hat{\beta}_{25} RW + \hat{\beta}_{26-39} DEMOGRAPHICS.$

Representative levels of organic premiums can be obtained by calculating *ORGPREMIUM* with right-hand-side variables set at mean levels.

Estimation Results

For estimation, all variables (including all of the possible organic interaction terms) were considered in the models. Those with coefficients significant at the 15-percent level were kept in the final models. Furthermore, if one of the variables within a dummy variable group had a coefficient significant at the 15-percent level, the entire group was retained. A ten-percent criterion would have worked just as well except for the organic-age interaction variables in the apple model. The regression results for tomatoes and apples are presented in Tables 3 and 4.

Tomato Prices

For tomatoes there were 7,306 households actually making purchases in 2003, with 33,779 observations after aggregation in four dimensions described in Table 1. The R-square (0.30) indicates that the model fits the data reasonably well. The representative price of conventional tomatoes and the organic premium were calculated using Equations 3 and 4, respectively, with all right-hand-side variables set at mean levels. The representative conventional-tomato price, calculated with Equation 3, is \$1.75 per pound, and the organic premium is \$0.38 per pound, calculated with Equation 4. The relative organic premium (organic price premium divided by the price of conventional tomatoes) is 22 percent.

Seasonal variables, both alone and in interaction with *ORGANIC*, have statistically significant coefficients, most at the five-percent level or better. The price of conventional tomatoes is lowest in the summer and highest in the spring, with a difference of about \$0.10 per pound. For organic tomatoes, however, the lowest price level was found in the fall, about \$0.23 per pound lower than the highest organic price level found in the spring. The relative organic price premium for tomatoes is highest in the spring, at 28 percent, followed by that in the summer and the winter, and drops to the lowest level (16 percent) in the fall. This typical seasonal pattern is partly due to availability and partly due to seasonal demand.

Not surprisingly, the dummy variable for purchases on sale is negatively related to prices of conventional tomatoes and significantly more so for organic tomatoes. With organic tomatoes on sale, the average discount is around \$0.27 per pound (13 percent of the original price), which is more than the average discount for conventional tomatoes (\$0.19 per pound, or 11 percent of the original price). Even though organic tomatoes are

Table 3. Results of the Multivariate Regression on Tomato Prices.

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	2.3672	0.0521	<0.0001
Summer	–0.0994	0.0095	<0.0001
Fall	–0.0368	0.0103	0.0003
Winter	–0.0181	0.0109	0.0980
Sale	–0.1851	0.0103	<0.0001
RW	–0.9037	0.0144	<0.0001
Hhsize	–0.0474	0.0058	<0.0001
Income	0.0039	0.0003	<0.0001
Age2	–0.0477	0.0215	0.0262
Age3	–0.1241	0.0248	<0.0001
Educ2	0.0293	0.0176	0.0955
Educ3	0.0370	0.0238	0.1196
Child6	0.0606	0.0277	0.0286
Urban	0.0562	0.0198	0.0045
East	–0.1059	0.0213	<0.0001
Central	–0.1702	0.0233	<0.0001
South	–0.0946	0.0183	<0.0001
White	0.1284	0.0347	0.0002
Black	–0.0327	0.0388	0.3993
Hispanic	–0.0923	0.0391	0.0182
Organic	0.5583	0.0981	<0.0001
Organic × Summer	–0.1308	0.0557	0.0190
Organic × Fall	–0.2164	0.0573	0.0002
Organic × Winter	–0.1319	0.0645	0.0409
Organic × Sale	–0.0870	0.0447	0.0520
Organic × RW	–0.2176	0.0655	0.0009
Organic × Income	0.0019	0.0008	0.0269
Organic × Child6	0.1502	0.0831	0.0708
Number of observations	33,779		
Number of households	7,306		
R-square	0.2968		

Table 4. Results of the Multivariate Regression on Apple Prices.

Parameter	Estimate	Standard Error	Pr > |t|
Intercept	0.8102	0.0223	<0.0001
Summer	0.0274	0.0044	<0.0001
Fall	0.0702	0.0055	<0.0001
Winter	0.0274	0.0054	<0.0001
Sale	–0.1650	0.0051	<0.0001
RW	0.2272	0.0066	<0.0001
Hhsize	–0.0168	0.0023	<0.0001
Income	0.0015	0.0001	<0.0001
Age2	–0.0414	0.0088	<0.0001
Age3	–0.1016	0.0107	<0.0001
Urban	0.0417	0.0084	<0.0001
East	0.0059	0.0100	0.5558
Central	–0.0214	0.0108	0.0473
South	0.0164	0.0092	0.0731
White	0.0310	0.0163	0.0575
Black	0.0087	0.0183	0.6335
Hispanic	–0.0146	0.0195	0.4553
Organic	0.6913	0.1044	<0.0001
Organic × Summer	–0.0105	0.0359	0.7693
Organic × Fall	0.0850	0.0491	0.0834
Organic × Winter	0.0189	0.0419	0.6520
Organic × Sale	–0.1045	0.0385	0.0067
Organic × RW	–0.4196	0.0778	<0.0001
Organic × Hhsize	–0.0508	0.0176	0.0040
Organic × Income	0.0014	0.0008	0.0600
Organic × Age2	–0.0386	0.0586	0.5096
Organic × Age3	–0.1083	0.0735	0.1403
Organic × East	–0.1131	0.0618	0.0676
Organic × Central	0.0483	0.0767	0.5290
Organic × South	–0.0347	0.0489	0.4777
Number of observations	25,927		
Number of households	7,130		
R-square	0.1688		

less likely to be put on sale than are conventional ones, the discount ratio is higher for organic tomatoes on sale. A similar effect was also found for the dummy variable for tomatoes sold random weight. On average, tomatoes sold random weight are $0.90 per pound cheaper for the conventional type and $1.12 per pound cheaper for organic than are those sold in UPC-coded packages.

Only a couple of demographic variables were found to be significant in explaining variation in the organic premium. Even though age is a factor affecting price paid for conventional tomatoes, with older consumers paying less than younger ones, age is not an important factor in explaining the organic price premium for tomatoes. Households

with a child under six years of age paid on average $0.06 per pound more for conventional tomatoes and $0.15 per pound more for organic tomatoes than did households without young children. Wealthier households were found to have paid more for organic tomatoes than did lower-income households. Given an increase in annual household income by $1,000, the household pays $0.02 per pound more for organic tomatoes.

Apple Prices

For apples there were 7,130 households actually making purchases in 2003, with 25,927 observations after aggregation in the four dimensions described in Table 1. As with tomatoes, the representative price of conventional apples and the organic premium were calculated using Equations 3 and 4, respectively, with all right-hand-side variables set at mean levels. The representative conventional apple price is $1.00 per pound, and the organic premium is $0.24 per pound, giving a relative organic premium of around 24 percent.

Slight seasonal variation was found only for conventional apples, with the lowest price found in the spring and the highest in the fall. Interaction terms between seasonal and organic dummy variables were found to be significant only for the fall, indicating that the organic price premium for apples is significantly higher in the fall than in other seasons. The relative organic price premium for apples is highest in the fall, 29 percent, followed by that in the winter and the spring, and drops to the lowest level, 21 percent, in the summer. The seasonal pattern generally reflects availability.

As was similarly found for tomatoes, organic apples on sale tend to be $0.27 per pound (22 percent) cheaper than those not on sale, which is more than the sale discount for conventional apples at $0.17 per pound (17 percent). Prices of conventional and organic apples were also found to be significantly different by form of sale (UPC-coded package or random weight). For conventional apples, UPC-coded packaging results in a $0.23 per pound lower price. However, organic apples in UPC-coded packaging are $0.42 per pound higher in price on average than those sold random weight.

Several demographic variables were found to be significant in explaining the organic price premium for apples. Household size is negatively related to the organic price premium. On average, households with one more member tend to pay $0.05 per pound less. Income is positively related to the organic price premium at the ten-percent significance level, with $0.014 per pound more paid for organic apples given a $1,000 increase in per capita annual income. The age of consumers seems to be negatively related to the price premium paid for organic apples. Younger consumers (household heads under 40) paid $0.11 per pound more than did older consumers (household heads 65 and older) for organic apples, although the coefficient is statistically significant only at the 15-percent level. Interestingly, households in the East were found to have paid $0.11 per pound less for organic apples than those in the West (regional baseline group).

Conclusion and Discussion

Using multivariate regression we were able to estimate organic price premiums paid by U.S. households for fresh organic tomatoes and apples—the top organic produce item—while controlling for heterogeneity in buyer demographic characteristics and seasonal factors. At the same time, interaction terms between the organic dummy variable and other variables provided insight into the factors which explain variation in organic premiums paid by U.S. households for the selected fresh items.

The organic price premiums were 22 and 24 percent on average for tomatoes and apples, respectively, which are in the range of contingent valuation results previously cited for produce. Seasonal variation in the organic premium for tomatoes was significant with the highest organic premium percentage in the spring and the lowest in the fall. The organic price premium for apples, in both absolute value and percentage, is highest in the fall.

Organic tomatoes and apples were less likely to be put on sale than were their conventional counterparts, but organic items had a higher discount ratio if on sale. Even though organic produce was more likely to be sold random weight, organic tomatoes and apples sold in UPC-coded packages were found to be more expensive than those sold random weight. The price difference may perhaps stem from quality or cosmetic appearance.

Household demographic characteristics also are important factors in explaining organic price premiums, though to different extents for the two produce items. For both tomatoes and apples, total household income is positively associated with the organic price premium. For tomatoes, households with young children were found to have paid a significantly higher price for organic than did households without young children. For apples, a different set of household demographic characteristics were found to be important regarding the organic price premium. Larger households tend to pay less for organic than did smaller households. And young households (with household heads under 40 years of age) were found to pay $0.11 a pound more for organic apples than older households.

Generally, high-income households, young households, households with young children, and small households are the desired market segments for organic produce that retailers should target to achieve higher organic price premiums. These demographics perhaps reflect consumer risk attitudes and lifestyle preferences regarding food consumption.

Households with young children appear to be willing to pay higher prices for organic produce reportedly because of concern for the health of the children, as previously cited. Not surprisingly, wealthy and young household heads tend to care more about health and the environment and value more possible benefits associated with consuming organic, as previously cited.

In general, the price-premium findings of this study, using actual market and demographic data, are consistent with the results of previously cited contingent valuation studies. However, with regard to demographics the agreement is less clear. To be sure, for income level there is total agreement—income is positively related to the organic premium. Cited contingent valuation studies were not consistent regarding the effect of education level. Our study did not find a positive effect from education level on the organic premium. Future research should consider how well the relationships found in this study hold over time and should be broadened to encompass other important produce items. Correctly allocated resources by producers and retailers depend on the right market cues and result in the value desired by consumers.

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