Review of Agricultural Economics—Volume 29, Number 4—Pages 783–800
DOI:10.1111/j.1467-9353.2007.00387.x

A Hedonic Analysis of Fresh Tomato Prices among Regional Markets

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This study uses the 2004 ACNielsen Homescan panel data to estimate the price premiums and discounts associated with fresh tomatoes among regional markets, focusing on the organic attribute. The results suggest that consumers paid \$0.25/lb more for organic fresh tomatoes in the New York–Philadelphia market. The organic premiums are estimated to be \$0.14/lb in the Chicago–Baltimore/Washington and Los Angeles–San Francisco markets and \$0.29/lb in the Atlanta–San Antonio market. Furthermore, tomato prices consumers paid in 2004 varied by household characteristics, including income, age, and the race and ethnicity of the head of the household.

America's appetite, like her population, is always changing. The U.S. population is wealthier, older, more educated, and more ethnically diverse than in the past. These features are likely to become more pronounced in the future and consequently affect the demand for agricultural and food products. American consumers are increasingly demanding food products that have been produced or processed in particular ways.

Health concerns and the possibility of environmental degradation may have motivated some U.S. consumers to purchase organically grown ("organic" hereafter) produce. Many consumers tend to believe that organic foods are safer, taste better, and provide better nutritional quality and greater health benefits than their conventionally grown ("conventional" hereafter) counterparts (Huang 1991; Jolly and Norris). In a study of fresh produce buyers in the Boston area, Williams and Hammitt found that more than 90% of survey respondents perceived a risk reduction in pesticide residues associated with the consumption and production of organic produce compared with conventional produce; close to 45% of respondents perceived a lower risk in exposure to natural toxins and microbial

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pathogens. More recently, surveys conducted by the Hartman Group indicated that consumers ranked health and nutrition (66%), taste (38%), food safety (30%), and environment (26%) as the top four motivating factors in purchasing organic foods.

The market for organic foods has grown rapidly in the past decade as they have become increasingly affordable and available in mainstream grocery stores. According to an annual survey conducted by the Organic Trade Association (OTA), growth in the U.S. organic industry has been fairly steady, averaging between 15% and 21% per year since 1997. The survey reported that retail sales of organic foods increased from $3.6 billion in 1997 to $13.8 billion in 2005, representing 2.5% of total U.S. food sales (Organic Trade Association). Among the organic food categories, fruit and vegetables by far comprised the largest retail sales ($5.4 billion in 2005), having grown at an average annual rate of 21% during 1997–2003 (Dimitri and Oberholtzer). Apparently, fresh produce has dominated the current market food basket of organic food consumers.

Organic products are credence goods; the information about the nature of the product is asymmetric because in most cases, consumers do not know whether a product is organic unless they are told (Giannakas). The U.S. Department of Agriculture (USDA) standards for organic foods, implemented in October 2002, aim at boosting consumer confidence in the organic label and, hence, facilitating further growth in the organic food industry. Organic foods, once considered a niche product sold primarily in specialty shops, are gaining wider acceptance among consumers. According to the 2005 Whole Foods Market Organic Trend Tracker, 65% of Americans have tried organic foods and beverages, compared to 54% in both 2003 and 2004 (Whole Foods Market). An estimated 46% of total organic food sales are now handled by the mass-market channel, which includes supermarkets, grocery stores, mass merchandisers, and club stores (Organic Trade Association).

Consumer preference for organic food based on perceived desirable attributes and characteristics has been widely documented. Yiridoe, Bonti-Ankomah, and Martin provided a comprehensive review of literature on consumer perceptions and preference toward organic foods. In general, consumers buy organic products because they appear to have many positive attributes (e.g., pesticide-free, environmentally friendly, better taste, more nutritional value, etc.) (Hartman Group; Huang 1991 and 1996; Jolly and Norris; Williams and Hammitt).

However, there is evidence suggesting that consumers are not consistent in their interpretation of what is organic (Yiridoe, Bonti-Ankomah, and Martin). Studies suggest that most buyers of organic foods tend to be white, female, young, affluent, and well educated (Buzby and Skees; Govindasamy and Italia; Roddy, Cowan, and Hutchinson; Thompson). In contrast, a recent study found that half of the respondents who purchase organic food frequently have income below $50,000 and that African Americans, Asian Americans, and Hispanics purchase more organic products than Caucasians (Hartman Group). These results suggest that the profile of organic consumers has changed over time, reflecting the dynamic nature of the organic industry and suggesting that income and ethnicity may no longer be significant predictors of who buys organic foods.

Many studies, using the contingent valuation approach, have examined how high a price premium consumers are willing to pay for organic products and how socioeconomic and demographic factors affect their willingness to pay. The findings from the extant literature tend to confirm that organic food products command a price premium (Boland and Schroeder; Estes and Smith; Goldman and Clancy; Loureiro and Hine; Maguire, Owens, and Simon; Oberholtzer, Dimitri, and Greene; Thompson and Kidwell). Overall, a price premium of 10–30%, depending on the type of product and location, appears to be acceptable to most consumers.

However, there is substantial variation in organic price premiums being reported in the literature (Yiridoe, Bonti-Ankomah, and Martin). For example, Goldman and Clancy found that a third of respondents in New York were willing to pay a 100% price premium for organic foods in general, while Thompson and Kidwell reported that price premiums for organic produce ranged from 40% to 175% of their conventional counterparts. A study in the U.K. showed that consumer respondents were willing to pay a price premium of up to 30% for organic cereals, fruits, and vegetables (Hutchins and Greenhalgh). By comparison, O'Donovan and McCarthy indicated that about 70% of Irish consumers were not willing to pay more than a 10% price premium for organic meat.

Empirical analysis of demand for organic produce has been limited and has focused mainly on specific market areas. To our knowledge, there is no systematic study, using national data, of price premiums across produce type, season, market area, and consumer characteristics. Most previous studies of organic produce have surveyed attitudes regarding the purchase of organic produce rather than actual purchases (Byrne et al.; Huang 1996; Loureiro and Hine; Roddy, Cowan, and Hutchinson; Williams and Hammitt). Although consumer attitudes toward organic products are generally positive, Buzby and Skees found that only 25% of the respondents who indicated a preference for organic fresh fruit and vegetables actually purchased them regularly to reduce the health risk associated with pesticides. Similarly, among respondents who said that they would pay more to lower their risk, less than 18% purchased fresh produce certified as "pesticide residue-free" on a regular basis.

What consumers are actually buying and paying in the marketplace when they have a choice between organic and conventional produce needs to be examined. Few studies have investigated the potential impact of socioeconomic and demographic factors, in addition to product attributes and characteristics, on the retail prices paid by consumers. The recent addition of organic food sales to scanner data, by ACNielsen and Information Resources, Inc., has enabled researchers to quantify consumer demand for organic foods in response to changes in price, income, and other socioeconomic characteristics throughout the United States. The objectives of this study were to analyze household purchases of fresh tomatoes and to determine the magnitude of the price premium paid for organic tomatoes by estimating a hedonic price model with Homescan panel data from ACNielsen.

Theoretical Framework and Model Specification

Recognizing some of the shortcomings and limitations of the neoclassical demand model, Lancaster developed an alternative theory of consumer demand; he suggested that utility is derived from the properties or characteristics of goods.

According to Lancaster, consumption is an activity for which goods and services, singly or in combination, are inputs and a collection of characteristics is the output. Lancaster's theory of the demand for characteristics plays a crucial role and lays the necessary conceptual framework in the development of modern hedonic demand analysis.

Expanding on the idea that consumers purchase goods because of the utility derived from their characteristics or attributes, economists have applied Lancaster's theory to agricultural products and developed hedonic approaches for exploring price–quality relationships to estimate the implicit values of product characteristics (Ladd and Martin; Ladd and Suvannunt; Rosen; Wilson). Hedonic modeling efforts rely on the fact that consumers and producers recognize these product attributes in approximately the same ways and that the choices each group makes lead to an equilibrium condition that neither the consumers nor the suppliers have any incentive to change.

The underlying assumption in the development of a hedonic model is that products can be distinguished simply and uniquely by their characteristics. Thus, demand for various desired characteristics can be derived from consumer willingness to pay for a product. As a result, marginal or implicit values can be estimated for each attribute at the observed purchase price, which is linked to the number of characteristics contained in the goods purchased. In essence, the hedonic approach is the disaggregation of commodities into characteristics and the estimation of implicit prices for units of the characteristics. Statistical measurement of the relationship between prices paid by consumers for a product and the quality mixes contained in that product can be used to interpret these marginal values in monetary terms.

As shown elsewhere in the literature (Ladd and Martin; Ladd and Suvannunt; Rosen), the hedonic model supposes a bundle of n products where each of the first m product characteristics is provided by several products. In addition, each product provides a unique characteristic provided by no other product. Following Ladd and Suvannunt, the total amount of product characteristics consumed by the consumer, Q, is then expressed as a function of the quantity of products consumed, q, and the quantity of characteristics provided by each product, Z:

$$Q_i = f_j(q_1, q_2, \ldots, q_n, Z_{1j}, Z_{2j}, \ldots, Z_{nj}), \quad \text{for } i = 1, 2, \ldots, n, \text{ and } j = 1, 2, \ldots, m, \tag{1}$$

and

$$Q_{m+i} = f_{m+i}(q_i,\ Z_{im+i}), \tag{2}$$

where Q_i is the total amount of the ith product characteristic provided by all products, q_i is the quantity of the ith product consumed, and Z_{ij} is the quantity of the jth characteristic provided by one unit of product i. The Z_{ij}s are buyer parameters whose magnitudes are determined by the sellers or producers. Q_{m+i} in equation (2) represents the number of unique characteristics available only from the consumption of the ith product. For example, Q_{m+i} might measure the particular vintage year for a wine or the presence or absence of a particular sensory property of a fresh fruit.

The consumer's utility function in terms of the total number of product characteristics provided by all products consumed is expressed as

$$U = U(Q_1,\ Q_2, \ldots,\ Q_m,\ Q_{m+1}, \ldots,\ Q_{m+n}), \tag{3}$$

or more specifically,

$$U = U(q_1, \ldots,\ q_n,\ Z_{11}, \ldots\ Z_{1m},\ Z_{21}, \ldots,\ Z_{nm}, \ldots,\ Z_{nm+n}). \tag{4}$$

The consumer is assumed to choose a bundle of products that optimizes the combination of total product characteristics or attributes to maximize utility. Mathematically, utility maximization is obtained by maximizing equation (4) subject to a budget constraint, $\sum p_i q_i = y$, where p_i is the price of the ith product and y represents the total expenditure or income available to the consumer. For the sake of brevity, solving the first-order conditions from the constrained utility maximization for p_i produces the standard hedonic price function, where the price of the product can be written as

$$p_i = f_i(z), \tag{5}$$

where z represents a vector of all product attributes associated with the ith product. Implicit in equation (5) is the assumption that the price paid by the consumer for each product consumed equals the sum of the marginal monetary values of the product's characteristics (Ladd and Suvannunt). It describes a competitive equilibrium price reached simultaneously by both sides of the market in terms of the amount of product characteristics supplied by producers and demanded by consumers (Rosen). In other words, the hedonic price equation is determined by the bids that consumers are willing to make for different bundles of characteristics and the offers of those bundles by suppliers (Palmquist).

For empirical analysis, Rosen suggested that the marginal consumer bid and producer offer functions must be estimated simultaneously to avoid simultaneous equation bias. However, many economists have contended that the supply of characteristics may be considered perfectly inelastic and have used the single equation approach to estimate the hedonic price equation (Estes and Smith; Maguire, Owens, and Simon; Steiner; Wilson). In this case, the analysts only obtain equilibrium conditions that existed at a specific point in time rather than the preferred general demand or supply schedules (Palmquist). The primary focus of this study was to determine the effects of organic features and other market factors on fresh tomato prices at different market locations. Therefore, the ordinary least squares procedure was used to obtain the "first-stage" estimation of the hedonic price relationships.

Data Source and Estimation

This study used the 2004 ACNielsen Homescan panel data that include purchases of both random-weight and Uniform Product Code (UPC) food items. According to ACNielsen, the panel consists of representative U.S. households that provide food purchase data for at-home consumption. Each week, a panel household scanned either the UPC or a designated code for random-weight (unpackaged) products of all their purchases from grocery stores or other retail outlets. The data include quantity, expenditures, some product characteristics, and promotion information as well as detailed household income and demographic data. For 2004, more than 8,500 households reported their purchases of both UPC-coded and random-weight foods. For packaged or UPC-coded food products, organic produce can be identified by the presence of the USDA organic seal or with organic-claim codes created by ACNielsen.[1] For random-weight items, the descriptions of designated codes can be used to identify organic produce.[2] Although there are many product attributes such as color, size and shape, quality levels, production, and origin that may be important determinants of tomato prices, these product attributes were excluded from this study because they are not included in the Homescan data.

For the purpose of this study, the weekly purchase data were sorted by the circumstances under which fresh tomatoes were purchased. Specifically, each purchase was identified by the presence of UPC (packaged or not), type (organic or not), store (discount store or not), and sale (on sale or not). The price was computed as a unit value by dividing total expenditure (promotional and sale discounts incorporated) by the total quantity purchased. Table 1 provides detailed descriptions of relevant variables specified for empirical estimation.

We expected that buyers of organic tomatoes might differ across market areas or regions in the United States. Using cluster analysis, Larson found that a new market grouping explained the regional variation in food consumption better than the standard set of census-region markets based on geographic boundaries. In this study, we followed Larson's scheme and grouped the 11 SCANTRACK major markets into four-region markets.[3] Table 2 presents descriptive statistics for each regional market.

As shown in table 2, the average price that consumers paid for fresh tomatoes varied from \$1.69/lb in the ATL-SA (Atlanta–San Antonio) market to \$1.86/lb in the NY-PHI (New York–Philadelphia) market to \$1.93/lb in the CHI-B/W (Chicago–Baltimore/Washington) and LA-SFR (Los Angeles–San Francisco) markets. Furthermore, the average regional prices paid for fresh organic tomatoes were \$1.93/lb (ATL-SA), \$2.22/lb (NY-PHI), \$2.24/lb (CHI-B/W), and \$2.31/lb (LA-SFR), all above the prices of conventional tomatoes. About 8.9% of the sample of fresh tomato purchases in the LA-SFR market was organic, compared with 2.9% in the ATL-SA market. There are four major brand names of fresh tomatoes. To protect proprietary information, these brand names have been termed A–D in this study. The distribution pattern of these four brands appears quite similar between the NY-PHI and CHI-B/W markets and between the ATL-SA and LA-SFR markets. Ratios of UPC purchase frequency to total purchase frequency varied from 17.6% (LA-SFR) to less than 30% (NY-PHI), suggesting that a vast majority of fresh tomatoes were purchased as random-weight products.

For empirical analysis, this study used a panel data model with random individual effects (Wooldridge). Thus, the price of fresh tomatoes, P_i, in the hedonic model was specified as

$$P_{it} = \alpha_0 + \alpha_1 ORG_{it} + \sum_{n=1}^{4} \beta_n BND_{nit} + \sum_{r=1}^{14} \gamma_r MKT_{rit} + \sum_{s=1}^{8} \delta_s SOC_{sit} + e_{it} \tag{6}$$
$$e_{it} = u_i + v_{it},$$

Table 1. Definition of variables used in the hedonic model

Variable	Definition	Mean[a] (Std. Dev.)
Dependent Variable		
P	Unit price of fresh tomatoes purchased, dollars per pound[b]	1.85 (0.956)
Product Attributes		
Organic	= 1 if organic produce, = 0 otherwise	4.92
Brand A	= 1 if the produce is sold under brand name A, = 0 otherwise	N/A[c]
Brand B	= 1 if the produce is sold under brand name B, = 0 otherwise	N/A
Brand C	= 1 if the produce is sold under brand name C, = 0 otherwise	N/A
Brand D	= 1 if the produce is sold under brand name D, = 0 otherwise	N/A
Market Factors		
Packaged	= 1 if the produce purchased is packaged with UPC code, = 0 otherwise	24.04
Discount store	= 1 if the produce is purchased from supercenters or club warehouses, = 0 otherwise	7.70
Sale	= 1 if the produce is on sale, = 0 otherwise	25.77
January	= 1 if the produce is purchased in January, = 0 otherwise	8.73
February	= 1 if the produce is purchased in February, = 0 otherwise	8.63
March	= 1 if the produce is purchased in March, = 0 otherwise	9.63
April	= 1 if the produce is purchased in April, = 0 otherwise	9.96
May	= 1 if the produce is purchased in May, = 0 otherwise	10.87
June	= 1 if the produce is purchased in June, = 0 otherwise	10.14
July	= 1 if the produce is purchased in July, = 0 otherwise	9.28
September	= 1 if the produce is purchased in September, = 0 otherwise	7.50
October	= 1 if the produce is purchased in October, = 0 otherwise	6.84
November	= 1 if the produce is purchased in November, = 0 otherwise	5.33
December	= 1 if the produce is purchased in December, = 0 otherwise	4.99
Household Characteristics		
Income	The ratio of household income over the federal poverty level;[d] where household income is the midpoint of the income class	4.408 (2.224)

(continued)

Table 1. Continued

Variable	Definition	Mean[a] (Std. Dev.)
Married	= 1 if the marital status is married, = 0 otherwise	63.05
Female head unemployed	= 1 if the female head of the household is not employed for pay, = 0 otherwise	38.52
High school	= 1 if the highest education level of the male or female household head is high school or lower, = 0 otherwise	16.66
Age < 40	= 1 if the oldest age of the male or female household head is less than 40 years, = 0 otherwise	10.46
Age 65 or older	= 1 if the oldest age of the male or female household head is 65 years old or older, = 0 otherwise	29.36
Black	= 1 if the race of household head is black, = 0 otherwise	11.19
Hispanic	= 1 if the race of household head is Hispanic, = 0 otherwise	10.96
	Total number of observations	33,449

[a]For all binary variables, the mean is reported as a percentage of sample observations that have assigned value of 1 and the standard deviation is omitted.
[b]The price was computed as a unit value by dividing total expenditure (promotional and sale discounts incorporated) over the total quantity purchased. It represents an average price paid for conventional and organic fresh tomatoes.
[c]The market share information of individual brands has been withheld to protect confidentiality.
[d]The poverty guideline for households of different sizes was developed by the U.S. Department of Health and Human Services for the implementation of federal food aid programs, such as the Food Stamp Program. We expressed household income as a percentage of the poverty income threshold so that household size is incorporated into the income measure.

where P_{it} is the price of tomatoes paid by the ith household in time t; ORG_{it} represents the organic attribute of the tomatoes purchased; BND_{it} represents the four major brands[4] under which tomatoes are marketed; MKT_{it} represents a set of market factors and characteristics such as packaging, type of store, on-sale occasion, and month of purchase; and SOC_{it} is a set of sociodemographic factors that characterize the household making the purchase.[5] The error term, e_{it}, has two components: an unobserved random individual or household-specific effect, denoted by u_i, and a random error, denoted by v_{it}.

The hedonic price model of equation (6) represents essentially a reduced-form equation reflecting both supply and demand influences. Little theoretical guidance with respect to the appropriate functional form can be applied *a priori* in the regression analysis. Previous studies have used various functional forms, including the linear function (Boland and Schroeder; Maguire, Owens, Simon; Palmquist; Taylor and Brester; Wilson), the semi-log function (Estes and Smith; Palmquist; Steiner), and the more flexible functional form of a Box–Cox

Table 2. Summary statistics by regional market, 2004

Variable	NY-PHI[a] Mean[e] (Std. Dev.)	CHI-B/W[b] Mean (Std. Dev.)	ATL-SA[c] Mean (Std. Dev.)	LA-SFR[d] Mean (Std. Dev.)
Conventional tomatoes ($/lb)[f]	1.85	1.92	1.68	1.89
	(0.893)	(1.012)	(0.854)	(1.022)
Organic tomatoes ($/lb)[f]	2.22	2.24	1.93	2.31
	(1.011)	(0.979)	(1.030)	(1.057)
Dependent variable				
P ($/lb)[f]	1.86	1.93	1.69	1.93
	(0.900)	(1.013)	(0.860)	(1.032)
Product attributes				
Organic	3.45	4.69	2.91	8.88
Brands A–D	N/A[g]	N/A	N/A	N/A
Market Factors				
Packaged	29.74	26.60	22.57	17.64
Discount store	3.18	6.72	14.47	5.47
Sale	26.13	33.55	16.92	28.02
January	8.00	9.46	8.83	8.65
February	9.03	8.59	8.55	8.36
March	9.32	9.73	9.57	9.89
April	9.23	10.32	10.36	9.86
May	11.54	11.17	10.27	10.59
June	10.99	10.93	9.02	9.80
July	10.17	10.17	8.10	8.89
September	7.28	6.46	8.51	7.59
October	6.27	6.17	7.71	7.07
November	4.82	4.88	5.62	5.95
December	4.98	4.88	5.07	5.02
Household Characteristics				
Income	4.278	4.603	4.094	4.708
	(2.222)	(2.268)	(2.037)	(2.328)
Married	60.54	60.89	69.34	60.50
Female head unemployed	39.09	35.37	42.24	36.74
High school	21.32	19.56	16.46	9.52
Age < 40	10.77	9.06	9.61	12.43
Age 65 or older	29.96	30.68	26.91	30.30
Black	10.27	15.06	10.81	8.87
Hispanic	6.89	5.06	16.56	14.25
No. of observations	8,151	7,801	9,275	8,222

[a]Includes SCANTRACK major markets identified as Suburban New York, Urban New York, Exurban New York, and Philadelphia.
[b]Includes SCANTRACK major markets identified as Chicago, Baltimore, and Washington, DC.
[c]Includes SCANTRACK major markets identified as Atlanta and San Antonio.
[d]Includes SCANTRACK major markets identified as Los Angeles and San Francisco.
[e]For all binary variables, the mean is reported as a percentage of sample observations that have assigned value of 1, and the standard deviation is omitted.
[f]All price was computed as a unit price paid by dividing total expenditure net of any promotional and sale discounts by the total quantity purchased.
[g]The market share information of individual brands has been withheld to protect confidentiality.

transformation model (Jordan et al.; Loureiro and McCluskey). Consequently, the choice of the functional form for the hedonic price equation remains an empirical issue. In this study, we chose the log-linear form because it has the advantage of transforming the dependent variable to approximate a normal distribution.

Finally, we also conducted preliminary analyses to test differences in the estimated coefficients across regional markets. Results of our analyses rejected the hypothesis that behavior is the same among regional markets. Thus, it is appropriate that a separate hedonic price model be estimated for each region to examine to what extent the price premiums and discounts might vary according to product attributes, market factors, and consumers' sociodemographic characteristics within each region.

Empirical Results

The regression coefficients reported in table 3 were obtained by estimating the log-linear functional form of equation (6). The estimated coefficients could not be interpreted as marginal effects as readily as those coefficients obtained from the linear form. Thus, the marginal implicit price (MIP) or marginal willingness to pay, computed (as the estimated coefficient multiplied by the average price) for each significant variable, is also presented in table 3 for ease of interpretation and discussion. As shown in table 3, most of the parameter estimates for the regional hedonic models are highly significant and consistent with *a priori* expectations in signs.

For the organic attribute, the results show that organic tomatoes command a premium above conventional tomatoes, ranging from $0.14/lb in the CHI-B/W and LA-SFR markets to $0.25/lb in NY-PHI and to $0.29/lb in the ATL-SA market. The organic premiums are 13.5%, 7.3%, 17.3%, and 7.4% over the prices of conventional tomatoes in the NY-PHI, CHI-B/W, ATL-SA, and LA-SFR market areas, respectively. In a 1994 survey of two retail outlets in Tucson, Arizona, Thompson and Kidwell reported that the price premium for organic tomatoes averaged about $0.62/lb, 45%, above the price of conventional tomatoes. Estes and Smith also estimated that prices for organic produce ranged between 30% and 90% higher than conventional produce. The price premiums reported in previous studies were typically collected from small samples of local specialty stores. Substantial price differences between supermarkets/supercenters/discount or warehouse clubs and local specialty stores are to be expected. The relatively lower price premium obtained from the Homescan data is consistent with the fact that organic food is no longer considered a niche product due to its increasing popularity and availability over the past decade. The competition brought about by mass marketing among mainstream supermarkets is expected to effectively reduce the price premium consumers pay for organic tomatoes.

Except for brand C in the ATL-SA market, all the estimated coefficients for the four major brands are statistically significant, at least at the 5% probability level. It is interesting to note that there appears to be a difference in consumer preferences reflected in the prices paid for different brands. Consumers in the NY-PHI and CHI-B/W markets paid a higher price for brands A and B, while all four major brands of fresh tomatoes were sold at a lower price relative to the reference tomatoes (no brand or smaller brands) in the ATL-SA and LA-SFR

Table 3. Estimation results of the hedonic model by regional market, 2004

	NY-PHI		CHI-B/W		ATL-SA		LA-SFR	
Variable	**Coef.**	**MIP**[b]	**Coef.**	**MIP**	**Coef.**	**MIP**	**Coef.**	**MIP**
Constant	0.381		0.346		0.317		0.448	
Product attributes								
Organic	0.132***	0.25	0.070***	0.14	0.173***	0.29	0.071***	0.14
	(0.024)[a]		(0.025)		(0.022)		(0.020)	
Brand A	0.161***	0.30	0.056***	0.11	−0.084***	−0.14	−0.092***	−0.18
	(0.017)		(0.022)		(0.017)		(0.035)	
Brand B	0.073***	0.14	0.080***	0.16	−0.240***	−0.41	−0.194***	−0.38
	(0.025)		(0.024)		(0.018)		(0.026)	
Brand C	−0.174***	−0.32	−0.070**	−0.14	0.003		−0.077***	−0.15
	(0.038)		(0.036)		(0.019)		(0.024)	
Brand D	−0.258***	−0.48	−0.211***	−0.41	−0.110***	−0.19	−0.226***	−0.44
	(0.037)		(0.035)		(0.017)		(0.024)	
Market factors								
Packaged	0.142***	0.26	0.269***	0.52	0.606***	1.02	0.470***	0.91
	(0.039)		(0.038)		(0.019)		(0.029)	
Discount store	−0.181***	−0.34	−0.254***	−0.49	−0.112***	−0.19	−0.296***	−0.57
	(0.026)		(0.022)		(0.011)		(0.026)	
Sale	−0.169***	−0.31	−0.165***	−0.32	−0.203***	−0.34	−0.159***	−0.31
	(0.010)		(0.011)		(0.010)		(0.011)	
January	0.181***	0.34	0.158***	0.30	0.051***	0.09	0.101***	0.20
	(0.192)		(0.021)		(0.15)		(0.022)	
February	0.159***	0.30	0.167***	0.32	0.004		0.116***	0.22
	(0.019)		(0.022)		(0.015)		(0.022)	
March	0.215***	0.40	0.156***	0.30	0.014		0.136***	0.26
	(0.019)		(0.021)		(0.014)		(0.021)	
April	0.204***	0.38	0.184***	0.36	0.011		0.111***	0.21
	(0.019)		(0.021)		(0.015)		(0.021)	
May	0.187***	0.35	0.173***	0.33	0.000		0.125***	0.24
	(0.018)		(0.021)		(0.015)		(0.021)	
June	0.127***	0.24	0.115***	0.22	−0.047***	−0.08	0.030	
	(0.018)		(0.021)		(0.015)		(0.021)	
July	0.066***	0.12	0.002		−0.068***	−0.11	−0.002	
	(0.018)		(0.021)		(0.015)		(0.021)	
September	0.102***	0.19	0.046**	0.09	0.001		0.018	
	(0.020)		(0.023)		(0.015)		(0.022)	
October	0.325***	0.60	0.273***	0.53	0.217***	0.37	0.210***	0.41
	(0.020)		(0.024)		(0.016)		(0.023)	
November	0.580***	1.08	0.520***	1.01	0.531***	0.90	0.472***	0.91
	(0.022)		(0.025)		(0.017)		(0.024)	
December	0.494***	0.92	0.446***	0.86	0.422***	0.71	0.443***	0.86
	(0.021)		(0.025)		(0.018)		(0.025)	
Household characteristics								
Income	0.024***	0.05	0.030***	0.06	0.016***	0.03	0.026***	0.05
	(0.004)		(0.005)		(0.004)		(0.005)	
Married	−0.012		0.002		0.001		0.014	
	(0.018)		(0.023)		(0.015)		(0.022)	
Female head unemployed	−0.014		−0.032		0.001		−0.003	
	(0.021)		(0.026)		(0.016)		(0.026)	
High school	−0.031		−0.010		0.000		−0.059	
	(0.022)		(0.028)		(0.019)		(0.038)	
Age < 40	0.059**	0.11	0.112***	0.22	0.070***	0.12	0.005	
	(0.028)		(0.036)		(0.022)		(0.032)	
Age 65 and older	−0.014		−0.037		−0.106***	−0.18	−0.123***	−0.24
	(0.023)		(0.027)		(0.017)		(0.028)	
Black	−0.096***	−0.18	−0.062**	−0.12	−0.096***	−0.16	−0.152***	−0.29
	(0.028)		(0.028)		(0.020)		(0.036)	
Hispanic	−0.090***	−0.17	−0.158***	−0.30	−0.164***	−0.28	−0.161***	−0.31
	(0.034)		(0.051)		(0.020)		(0.031)	
Wald $\chi^2_{(27)}$	3,825.97		3,237.46		8, 517.21		3, 214.15	
R^2	0.322		0.306		0.510		0.306	

[a]Numbers in parentheses are standard errors. ***,**, and * indicate the estimated coefficients are significantly different from zero, at least at the 1%, 5%, and 10% significance level, respectively.
[b]The marginal implicit price (MIP) for the log-linear model is computed as MIP = $c \times \bar{p}$, where c is the estimated coefficient and $\bar{p}$ is the average price paid or the mean value of the dependent variable. The MIP is computed only for the estimated coefficients that are statistically significant at least at less than the 10% significance level. The significance level of MIP, however, is not derived here.

markets. Among the major brands, brand D tomatoes were sold consistently at a lower price than the reference tomatoes or other major brands, except in the ATL-SA market, where brand B was sold at a lower price than brand D.

With respect to market factors, fresh tomatoes packaged in a container are usually of more consistent quality or less ordinary varieties (such as grape or on-vine tomatoes) than random-weight tomatoes and, therefore, may be priced higher. The estimated MIPs or marginal willingness to pay for packaged tomatoes varied considerably from \$0.26/lb in the NY-PHI market to \$1.02/lb in the ATL-SA market. Consumers in the LA-SFR market paid higher prices (\$0.91/lb) for packaged tomatoes than those living in the CHI-B/W (\$0.52/lb) market area. The estimated MIPs for packaged tomatoes again show a pattern of similarity between the ATL-SA and LA-SFR markets versus the NY-PHI and CHI-B/W markets.

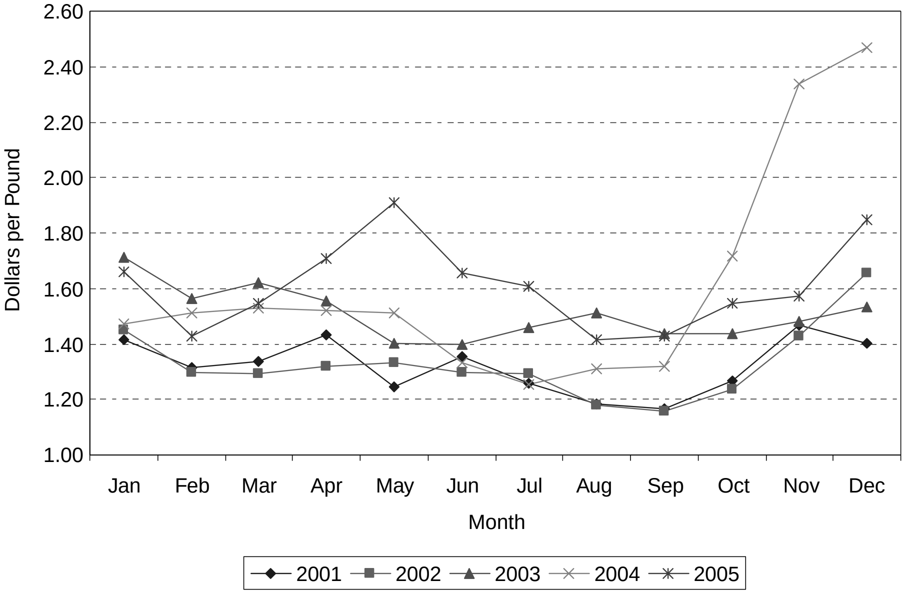
The results indicate that consumers consistently paid a lower price for fresh tomatoes at discount stores such as supercenters and warehouse clubs than at traditional supermarkets or specialty food stores. The discounts at discount stores are expected and are significant at the 0.01% probability level. The estimated discounts varied from about \$0.19/lb in the ATL-SA market to \$0.57/lb in the LA-SFR market. Similarly, when on sale, fresh tomatoes were discounted by \$0.31 to \$0.34/lb. The promotional discounts on tomato prices were fairly consistent across regions. The estimated MIPs at discount stores were larger than the MIPs for on-sale occasions for all the regional markets except the ATL-SA market, where the opposite was true.

Seasonal variations in tomato prices were evident across regional markets. The majority of the estimated coefficients on monthly binary variables were positive and significantly different from the base month of August at less than the 0.01% probability level. The results indicate that retail tomato prices tend to be lower in the summer months (June–August) than in other seasons. There were no significant differences found between prices in August and September in the ATL-SA and LA-SFR markets, where consumers appeared to pay the lowest price in July. The results are consistent with the patterns of seasonal price variations that we observed in the historical time-series data. Figure 1 presents the U.S. monthly average of fresh tomato prices at the retail level for 2001–2005. As shown in figure 1, tomato prices typically fall to the lowest level in August and September, while reaching their peak toward the end of the year. In particular, the abnormally high tomato price in October–December 2004, reflects the fact that the fall supply was affected by hurricanes in Florida and heavy October rain in California.

The results indicate that consumers paid a higher price for fresh tomatoes in October through December than in the summer. However, there was little difference in fresh tomato prices from January to May within each regional market. Compared to August, the results show that the estimated marginal willingness to pay varied from \$0.35 to \$0.40/lb (NY-PHI), \$0.30 to \$0.36/lb (CHI-B/W), and \$0.21 to \$0.26/lb (LA-SFR) during the spring months (March–May). In the ATL-SA market, none of the estimated coefficients from February to May were significantly different from August, indicating little or no variation in tomato prices during those months.

With respect to household characteristics, the effect of household income on prices paid for fresh tomatoes was positive and highly significant in all markets. This positive and significant association between tomato prices and income is to

Figure 1. U.S. monthly retail price, 2001–2005: Fresh tomatoes



Source: Lucier and Jerardo.

be expected, for higher income households are more likely to purchase higher priced/quality food products or shop at retail outlets that offer more customer service and/or are located in high rent areas. Thompson and Kidwell found that higher household income increases the probability that a household will choose to shop at specialty grocery stores, which tend to maintain higher prices on average, not only for fresh produce but also for other products. The income effects are about the same across the regional markets. Given that the income variable was measured as a ratio of household income to the federal poverty level (defined in part by household size), the results suggest that each percentage point increase of household income over the poverty level contributes about \$0.03/lb (ATL-SA), \$0.05/lb (NY-PHI and LA-SFR), and \$0.06/lb (CHI-B/W) to the prices consumers paid for fresh tomatoes.

We would expect a negative association between the price paid and the household characteristics of married and unemployed female head because married couples with an unemployed female head may have more time to search and bargain for lower-price items. With respect to the effects of educational attainment on organic purchase behavior, past findings are mixed. Roddy, Cowan, and Hutchinson found that "organic purists" are more likely to be highly educated and in a high-income category, while others reported that willingness to pay for reductions in pesticide exposure levels (Buzby and Skees) and willingness to pay a premium for organic produce (Govindasamy and Italia) decreased as education increased. In this study, none of these three household characteristics were found to have any significant effects on prices paid for fresh tomatoes among the regional markets. These results are plausible because organic produce has gained wider acceptance over the past decade and the profile of organic consumers has changed as the market has evolved.

The age of the household head was found to affect the prices paid for fresh tomatoes. The results suggest that younger households (age 40 or younger) in general pay higher prices than households headed by individuals who are between 40 and 64 years old. It is plausible that younger adults prefer more expensive tomatoes such as organic, on-vine, or greenhouse tomatoes. The result is consistent with previous studies suggesting that younger respondents were more willing to pay a premium for organic produce (Govindasamy and Italia), organic potatoes (Loureiro and Hine), or certified pesticide residue-free produce (Buzby and Skees) than were older respondents. However, consumers aged 65 and older were found to pay a significantly lower price for fresh tomatoes than younger consumers in the ATL-SA and LA-SFR markets. For heads of household 65 years and older, the marginal willingness to pay was estimated to be \$0.18/lb and \$0.24/lb lower than their counterparts in the ATL-SA and LA-SFR markets, respectively.

In general, prices paid for fresh tomatoes varied significantly with consumers' race and ethnicity. This finding implies that white households generally pay higher prices for fresh tomatoes than their counterparts. Black households were found to pay \$0.29/lb less than white households in the LA-SFR market. Hispanic households, except those in the NY-PHI market area, appeared to pay lower prices for fresh tomatoes than both white and black households, while blacks in the NY-PHI market paid lower prices than white and Hispanic households.

Summary and Conclusions

Organic demand and markets have received considerable research interest. Many studies have examined how high a price premium consumers are willing to pay for organic products and how socioeconomic and demographic factors affect their willingness to pay using a contingent valuation approach. These studies have measured attitudes toward the purchase of organic produce rather than actual purchases. Empirical analysis of demand for organic produce has been limited and has focused mainly on specific market areas. To our knowledge, there is no systematic study, using national data, of variations in price premiums across produce type, season, market area, and consumer characteristics.

This study estimated a hedonic price model based on data from the 2004 AC-Nielsen Homescan panel, a nationally representative panel, to assess consumer valuation of various attributes of fresh tomatoes, including organic production. The hedonic methodology proved useful as a tool for analyzing price variation in fresh tomatoes and as a mechanism for examining consumer preferences for particular product attributes. Marginal implicit prices were estimated for (*a*) selected product and market attributes and (*b*) household economic and demographic characteristics that affected the retail price of fresh tomatoes.

This study used Homescan panel data to identify important attributes that affect the prices consumers paid for fresh tomatoes among regional markets. The use of data from major markets throughout the United States distinguishes this study from previous research that has utilized only localized data. Though fresh tomatoes were the focus of this applied research, the data can be used to conduct similar analyses of other organic produce, to profile organic buyers, and to estimate demand for organic food. Furthermore, Homescan data are available for several years before and after the implementation of the USDA Organic Standards; consequently, the data are suitable for monitoring the organic food market.

Overall, the signs and magnitudes of the marginal implicit prices obtained in this study appear to be reasonable and plausible. Although substantial differences among regional markets are evident, the results also show that the ATL-SA and LA-SFR markets share some similarities, as do the NY-PHI and CHI-B/W markets. The availability of organic produce in mainstream grocery stores indicated that an increasing portion of consumers were willing to pay higher prices for organic and packaged tomatoes.

Our results suggest that consumers are paying a price premium for organic fresh tomatoes from as low as 7% above the price of conventional tomatoes in the CHI-B/W and LA-SFR markets to as high as 17% in the ATL-SA market. This finding is consistent with the general belief that consumers are not willing to pay a price premium above 10–30% (Hutchins and Greenhalgh; O'Donovan and McCarthy) and with the observed penetration of organic foods into mainstream markets. The fact that organic foods are widely available from mainstream supermarkets and grocery stores will tend to make organic foods more competitive and reduce the magnitude of organic price premiums.

With expanded production and increased volumes, the cost of producing and marketing organic foods may decline further and hence perpetuate the growth momentum. Organic food will continue to command a price premium over its conventional counterpart as long as the demand for it outpaces supply. Given that current domestic organic production is lagging, imports of organic foods will begin to play a more important role in satisfying consumer demand. In 2002, the estimated value of U.S. organic imports was between $1.0 billion and $1.5 billion (U.S. Department of Agriculture 2005), or less than 0.03% of total food sales. It is noted that U.S. customs does not differentiate between organic and non-organic trade, so there are no official statistics for U.S. organic food imports and exports.

Our analysis is limited to the at-home market. The most important food-related lifestyle change of the past two decades is probably the increase in consumption of food prepared away from home. Data from USDA's Continuing Survey of Food Intakes by Individuals, collected in 1994–1996, indicate that Americans consume about a third of their calories from food prepared away from home, up from less than a fifth in 1977–1978 (U.S. Department of Agriculture 2004). But when Americans order their food away from home, fruits and most vegetables seldom make the list. Tomatoes are a noticeable exception, with about 30% of the fresh market being handled away from home. The rising popularity in eating out could potentially present an additional growth of demand to the organic produce industry. However, there is little to no information available about consumer demand for organic foods when they eat out. Further research to study the demand for organic produce in the food away from home markets is needed to provide a more complete picture of the overall demand for organic produce.

Acknowledgments

Research for this study was supported by USDA-ERS Cooperative Agreement No. 43-3AEM-5-80043. ACNielsen's proprietary and confidential Homescan data were accessed through an agreement between ACNielsen and the Economic Research Service. The views expressed in this study are those of the authors, and do not necessarily reflect those of the U.S. Department of Agriculture.

Endnotes

[1]The National Organic Program establishes regulations and requirements for the use of the word *organic* on food and other agricultural products labeling. All farms and agricultural products with organic claims must be certified by a USDA-approved independent agency as meeting or exceeding USDA standards. The USDA approved four categories of organic labels to be used on food and other agricultural products on October 21, 2002. However, only the first two categories, 100 Percent Organic and Organic (at least 95% of content is organic by weight), may carry the label that displays the "USDA Organic" seal. The other two categories include Made with Organic (at least 70% of content is organic) and Some Organic (less than 70% of content is organic). Farmers who gross less than $5,000 from organic products and sell direct to consumers or retailers are exempt from the certification requirement. Those farmers may call their products organic, but they cannot use the USDA organic seal. Aside from the presence or absence of the USDA organic seal, there are a variety of organic claims or statements that are used to describe organic products with UPC codes in the Homescan data. Those organic claims include the following descriptions: certified 100% organic, 100% organic, 100% certified organic, certified organic, certified organic produce, organically grown, organically produced, certified organically grown, organic, or premium organic.

[2]For random-weight products that are purchased in loose form and that do not carry a UPC, lists of designated codes were provided by the ACNielsen to the panelists. To record the purchase, the panelists can look up the product from the codebook and scan in the product code. In the Homescan random-weight data, there is a product description for each designated code. When an organic product is available, separate codes are created for organic and conventional products.

[3]Larson identified 11-market clusters based on food purchases in 126 categories from 54 U.S. markets. The grouping of markets formed in this study is consistent with Larson's cluster 11 (NY-PHI), cluster 3 (CHI-B/W), and cluster 2 (LA-SFR), except for the Atlanta (ATL) and San Antonio (SA) markets, which belong to cluster 6 and cluster 8, respectively. We combined the Atlanta and San Antonio markets based on geographical consideration that they share a similar southern culture and lifestyle.

[4]Four major brands were identified based on the supplier information available in the Homescan data. Together, the top four brands represented about 86% of fresh tomatoes purchased by ACNielsen Homescan panelists. The different brands may represent a particular variety or certain product attributes, but they represent primarily the company/label of the suppliers.

[5]Strictly speaking, the hedonic model as derived in equation (5) traditionally includes only variables that are pertinent to product attributes and marketing characteristics. However, sociodemographic variables are typically included in studies related to consumer willingness to pay for a certain product. In the former case, sociodemographic characteristics are normally unavailable, while using the contingent valuation approach to study willingness to pay lacks the actual pricing information. In this study, we bridge the gap by extending the hedonic analysis to examine to what extent sociodemographic characteristics are related to the price paid for the product in addition to the product attributes. In essence, one may consider equation (6) a hybrid of the hedonic model and willingness to pay analysis.

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