

# Price, Quality, and Pesticide Related Health Risk Considerations in Fruit and Vegetable Purchases: An Hedonic Analysis of Tucson, Arizona Supermarkets

Edmund A. Estes and V. Kerry Smith

National opinion polls indicate that pesticide residues on fresh fruits and vegetables remain an important concern of American consumers, despite a decade-long increase in per capita consumption levels for fresh fruits and vegetables. Increased availability of organically grown fruits and vegetables may change consumer produce purchase behavior which is often dominated by appearance considerations. Domestic consumers likely consider and tradeoff price, visual appearance, and health risk when buying fresh produce. This paper uses an hedonic framework to examine price, appearance, and health risk considerations made by Tucson, Arizona shoppers in 1994.

Americans have increased their consumption of fresh fruits and vegetables nearly 16 percent during the past decade (The Food Institute, 1996). Several factors motivated shoppers to purchase more fruits and vegetables, including a greater variety of items available in grocery stores and recommendations from Food and Drug Administration scientists that individuals can improve their overall health by eating more fresh fruits and vegetables (*1996 Fresh Trends Report*, Vance Publishing, Inc). Paradoxically, however, produce consumption increased during a period when a increasing proportion of consumers were worried about the overall safety of fresh fruits and vegetables. Widespread publicity about harmful pesticide residues on produce alerted consumers to be cautious in purchase habits. Well-publicized incidents involving apples, grapes, and baby food heightened consumer fears. Random consumer surveys reported by trade association publications

(*The Food Institute, The Packer, and The Grower*) indicated that a majority of Americans were concerned about the presence of harmful pesticide residues on fruits and vegetables. The *1996 Fresh Trends Report* reported that while consumer concerns about pesticide residues had declined somewhat from its 1990 level, nearly two of every three shoppers remained worried about unseen health dangers lurking from pesticide residues. Thus, despite uncertainty about the impacts of residues, domestic production of fruits and vegetables expanded and consumers continued to buy increasing amounts of fresh fruits and vegetables.

The main focus of this article is to report research findings obtained from one portion of a much larger study designed to examine how people evaluate tradeoffs among price, health risk, and other dimensions of quality when they make fresh produce purchase decisions. The overall study examined interrelationships between price and a wide array of appearance-related attributes as well as one measure of long-term health risk concerns. In the overall study, greater understanding of the process by which consumers tradeoff price, appearance, and health was obtained using three distinct information collection procedures: 1) focus group sessions; 2) mall intercept surveys; and 3) analysis of hedonic data. Three focus group sessions provided us with basic insights about important produce quality features considered by shoppers when they purchased

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Edmund A. Estes is a Professor in the Department of Agricultural & Resource Economics at North Carolina State University in Raleigh, N.C. and V. Kerry Smith is Arts and Sciences Professor of Environmental Economics at Duke University in Durham, N.C. The authors appreciate the support and research provided by the Research & Technology Division of the U.S. Department of Agriculture to conduct this study under Cooperative Agreement #43-3AEK-1-80131 and Professor Young Sook Eom of Chonbuk National University, Chonju, Korea for her participation in the focus group component of this research. The authors also acknowledge the insightful comments and suggestions provided by Ron Schrimper, Charles Safley, and two anonymous reviewers.

produce. Focus groups also provided key information concerning how to frame meaningful choices often faced by consumers, particularly concerning tradeoffs involving price, quality, and health. Mall intercept interviews were conducted to elicit more precise quantitative measures of tradeoffs made by shoppers under simulated market conditions. The third phase of the project was to observe causal linkages between price and various indicators of quality such as cosmetic appearance, size, and firmness through collection of hedonic attribute and price information.

While personal observation, conversations with focus group participants, and past empirical findings suggested that consumers responded in unique ways to a range of fruit and vegetables quality attributes, it was difficult to quantify the importance of each quality attribute in assessing exactly why consumers had purchased a specific item. As is true with many consumer products, quality characteristics are subjectively evaluated and are usually bundled such that consumers cannot select or deselect a quality attribute. Isolating the importance of each attribute often requires a controlled or simulated circumstance in which incremental changes in the quality mix can be made while unimportant considerations are held constant. In controlled experiments, sufficient variation in prices, quality, variety, and selection is needed so as to measure the impact of each attribute on purchase behavior. That is, the relationship between price and each characteristic must be isolated so as to measure the buyer's willingness-to-pay for each separate attribute. Early research conducted by Waugh (1929) recognized the need to differentiate among important dimensions of quality when he examined the effect of stalk length and stalk color on the market price for asparagus. Following Waugh's research, quality characteristic models were employed to analyze the importance of a wide range of "quality" features embodied in a bundled product. Hedonic techniques were utilized to explain differences in market prices for houses purchased with seemingly similar features (lot size, square footage, construction materials, etc) but had variable selling prices. Agricultural analysts have used hedonic techniques to examine why soybean buyers preferred soybeans possess-

ing certain characteristics over soybeans with another set of characteristics.

Hedonic techniques can provide an estimate for the implied value of each quality-related characteristic in an item such as fruit or vegetable. The extensive scope of this overall project precludes a comprehensive discussion concerning all phases of this research. Instead, this article will report only the hedonic findings obtained as part of this overall project. When appropriate and useful, details from the other portions of the overall project (the focus group and mall intercept portions) will supplement discussion of the hedonic results. Detailed information concerning the focus group and mall intercept elements can be obtained directly from the authors. After a brief discussion about fruit and vegetable quality characteristics, a basic overview of hedonic models will be presented. Next, study findings will be presented and analyzed. Study findings and conclusions will be compared with results obtained by Conklin, Thompson, and Riggs (1991) who conducted a similar hedonic study in the same market location. Finally, conclusions and implications of the study are presented.

## **Background**

Consumers evaluate and tradeoff a number of factors when purchasing a fresh fruit or vegetable. Decision variables often include price, personal disposable income, absolute and relative quality, overall availability of the item, availability of a substitute item, the satisfaction obtained from consumption, perceived freshness, and personal tastes. While searching through supermarket display racks of produce, a consumer usually evaluates appearance features such as the amount and extent of visible defects, an item's relative size, firmness and/or soft spots, and the maturity of an item. For search attributes, quality evaluation is straightforward and apparent. However, other attributes such as health, safety, dietary considerations, and safety are less apparent through standard searching procedures but nonetheless are likely to be considered by the average American shopper when buying fruits and vegetables. For many of these type attributes, label information, experience, and the education

level of the consumer influence purchase decisions.

Beyond a fruit or vegetable's sensory features, concerns about pesticide residues might also influence a particular consumer's purchase decision. Greater availability of organically grown fruits and vegetables has provided consumers with additional information. Use or non-use of chemicals (particular or general) can be viewed as an additional "quality" attribute considered by buyers. Once relegated to natural food stores and specialty outlets, organic fruits and vegetables are commonly available in mainstream supermarkets. Increased availability of organic produce has complicated produce purchase decisions. Unlike many other quality features such as appearance and size, visual detection of residues is usually impossible and consumers must depend on signage and in-store information to determine if an item was grown organically or without application of synthetic chemicals. While the appearance of organically grown fruits and vegetables is often similar to or, at times, superior to the appearance of conventionally grown fruits and vegetables, many consumers still perceive that organically grown fruits and vegetables tends to vary more in visual appearance and believe they are usually more expensive to purchase. A number of studies (van Ravenswaay and Hoehn (1991), Weaver (1992), Weaver, Evans, and Luloff (1992), and Lynch (1992)) reported higher sale prices for organic produce and consumer willingness-to-pay price premiums for certified organic produce. For example, van Ravenswaay and Hoehn conducted a nationwide contingent valuation study and reported that sample shoppers were willing to pay nearly one-third more per pound for fresh apples, primarily to ensure the absence of pesticide residues. In another consumer study, Weaver (1991) reported that 57 percent of surveyed Pennsylvania consumers believed that pesticide-residue free tomatoes tended to have more cosmetic defects than did conventionally grown tomatoes. Finally, a 1989 nationwide poll conducted by Gallup reported that one-half of American consumers were willing to pay more money for certified organic produce. Our focus group discussions also indicated that shoppers were willing to pay a price premium for organic produce. However, a majority of our

focus group also seemed willing to accept a slightly lower appearance quality but only if the asking price were less. About one-fourth of our focus group participants expressed a desire for comparable or superior quality for similarly priced items, irrespective of its organic or conventional label.

Common sense suggests that consumers, as a rule, would seek out the ripest, largest, best-looking fruit or vegetable available at the lowest price. If the subjectively-determined "ideal" fruit or vegetable is not available for immediate purchase, then consumers make "tradeoffs" considering the overall balance of desirable and undesirable features in an item. In effect, consumers evaluate and compare price to incremental values for each characteristic. If the absence of visible defects is a very important feature, then perfect-looking would be purchased despite a shopper's desire for additional characteristics such as a larger size or riper fruit. Estimation of the average consumer's incremental willingness-to-pay for various quality features might be achieved through marginal changes in quality accomplished through a structured, tightly-controlled experiment conducted in a retail grocery store. In this study, this option would be difficult to utilize because of the extreme perishability and appearance variability of fresh fruits and vegetables. Alternatively, market-based observations of in-store shopper behavior could also provide insights about consumer tradeoffs between available types of produce. Finally, a third option would be to conduct a controlled food laboratory experiment in which randomly selected shoppers would select items in a mock-up of a produce department located in a grocery store. In this instance, purchase decisions would be observed and quality characteristics would be measured *ex post* by investigators. Of course, results obtained from simulated market conditions critically depend on the investigators ability to duplicate actual purchase conditions. While direct observation of consumer behavior and/or use of well-designed food lab experiments might provide higher quality results, their formats were too difficult and costly to replicate. Instead, the less costly hedonic approach was employed. Hedonic measurements of quality required use of multiple sources of information about how consumers

evaluate trade-offs concerning cosmetic appearance, price, and health risk. Use of composite strategies involving focus group sessions, mall intercept surveys, and hedonic assessments should provide, in general, consistent responses among consumers on how they consider tradeoffs in produce purchase decisions. Most focus groups and contingent valuation surveys, when conducted properly and carefully, can provide information about purchase intentions that describes how consumers would respond if confronted with specific market choices. It would be expected that hedonic measures would provide generally consistent information with contingent valuation, mall intercept, and focus group studies.

### Quality Attributes

For convenience, it is useful to think of an individual fruit or vegetable as a distinct bundle of characteristics. Shoppers decide to buy a particular item based on perceived amounts of desirable attributes contained in each product available at a given price level. Typically, specific monetary values are not associated with each characteristic since consumers purchase only the bundled commodity. However, hedonic estimation procedures can provide implicit value information for each characteristic. Quality characteristics are important determinants of consumer willingness-to-pay. The effect of quality variability on prices has been examined in a number research investigations. Strong theoretical underpinnings for using hedonic techniques were developed in seminal articles written by Lancaster in 1971 and Rosen in 1974. Both Lancaster and Rosen stressed the importance of properly identifying and measuring the appropriate consumer characteristics. Consumer surveys conducted by *The Packer* (a fruit and vegetable trade magazine) identified a comprehensive set of preferred attributes frequently desired by retail produce shoppers. Important features included an item's eye appeal, its color, its maturity, its relative size, expected taste and flavor, and the store's past reputation for stocking high quality produce. The *1996 Fresh Trends Report* also noted increased consumer interest in the nutritional content of produce since many consumers want to improve their diet.

Hedonic analysis must begin with some insights into the product attributes likely to be important in a consumers choice. In this study, important characteristics were identified from past research efforts and from the three focus group sessions. Focus group sessions indicated that important purchase decision variables included: 1) the retail sales price per item; 2) whether or not an item was labeled as conventionally grown or was organically grown; 3) the severity, extent, and scope of visual impairments such as surface defects, immaturity, or misshapen; and 4) relative size, packaging (bulk or single item), and if an item was on sale. A portion of the focus group participants also noted that part of their assessment included an ability to physically handle the item prior to a choice. In a broader perspective, consumers also more general demand considerations such as their disposable income, overall product supply availability, close substitute availability, and their personal tastes and preferences. However, for the purposes of estimating first-stage hedonic parameters, general demand and supply considerations are assumed to be constant in the very short-run since the hedonic framework is assumed to describe an equilibrium market condition.

### Hedonic Research and Theoretical Considerations

Hedonic approaches for exploring price-quality relationships have been used by a number of economic investigators including, Waugh (1929), Triplett (1990), Griliches (1961), Rosen (1974), Palmquist (1981, 1984), McConnell and Phipps (1984), and Bartik (1987). Agricultural applications of hedonic techniques included Ladd and Martin (farm inputs, 1976), Perrin (soybeans and milk, 1980), Ethridge and Davis (cotton, 1982), Estes (bell peppers, 1986), Huang and Misra (fruits and vegetables, 1991), Conklin, Thompson, and Riggs (fruits and vegetables, 1991), and Wahl, Shi, and Mittelhammer (beef cattle, 1995). Economic analysts argue that any differentiable product can be described by a vector of objectively measured characteristics embodied in that product. Hedonic modeling efforts rely on the fact that consumers and producers recognize these attributes in approximately the

same ways and that choices each group makes (to demand or to supply) lead to an equilibrium set of prices. The short-run equilibrium condition describes a situation in which consumers and suppliers have no incentive to change. Of course, this description is an ideal situation that presumes all other influences such as consumers' incomes or factors influencing producers' costs do not change over the time period examined. If these conditions prevailed, or existed at an approximate level, then prices could describe how each group responded (at the margin) to a change in a product attribute. As a result, implicit values (or more precisely, marginal values) can be estimated for each attribute at that particular point in time. In effect, the observed purchase price is linked with the amount of characteristic contained in the item purchased.

Underlying theoretical arguments used in the development of an hedonic model rely on the notion that oftentimes products can be distinguished simply and uniquely by their characteristics. Thus, demands for various desired characteristics can be derived from consumer willingness to pay for a product. Consumers selected an item because it possessed the greatest number of desired features for a specified price. As Palmquist noted, "the hedonic 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, 1984). In essence, consumers in competitive markets can influence the price paid by varying the quantity of a characteristic purchased, subject to their preferences and purchasing power. Investigators of hedonic price estimation procedures (Rosen; Palmquist; Estes) have noted that first-stage hedonic studies alone typically do not provide sufficient information to isolate demand or supply functions for characteristics, but instead reveal only point estimates for incremental values of attributes. Two-stage hedonic studies utilize first-stage hedonic findings to describe an equilibrium and the coefficient values (in linear form) then provide estimates of the marginal value of each important product attribute.

While hedonic models can provide analysts with useful insights about quality-price relationships, results must be interpreted carefully. In particular, hedonic procedures provide simply a

schedule of equilibrium points where consumers and sellers were mutually satisfied with the exchange price and the set of characteristics and services embodied in the product. For example, in most cases the best we can do is to recover a "marginal rate of substitution" schedule. Particular issues concerning the estimation process are discussed insightfully in McConnell and Phipps (1984) and Wahl, Shi, and Mittelhammer (1995).

The primary focus of our study was to describe existing market conditions and to test the effects of variable quality features on price at a time when a short-run market equilibrium existed. Therefore, first-stage hedonic relationships were of most interest. A limitation of the first-stage approach is that analysts obtain only equilibrium conditions that existed in one location at a uniquely defined time period rather than the preferred general demand or supply schedules. Thus, generalizations about attribute features and their marginal values are limited to the data set. Beyond this limitation, however, estimation of a first-stage, single equation, commodity-specific hedonic model would permit a comparison of our results with a 1991 hedonic model developed by Conklin, Thompson, and Riggs (CTR). CTR developed a fruit and vegetable hedonic model in order to analyze price and quality linkages for eight fruits and vegetables sold in Tucson, Arizona grocery markets.

For produce, quality differences (and thus differentiable products) can arise from changes in either the mix of inputs used, from changes in associated services, or from both. Similarly, the price paid for an item reflects an outcome of two exchanges: 1) the prevailing market price for item given constant spatial, temporal, and form considerations; and 2) any premium or discount adjustments made to price because of included or omitted quality attributes. For situations where characteristics have observable markets established (such as for transportation or precooling), price adjustments are straightforward and tractable through the distribution network. However, for many items such as fruits and vegetables, characteristics which contribute to quality or taste may not be easily measured, because they have subjective elements. Imputed values for characteristics may be concealed by short-run market

influences. In effect, hedonic price models are not "guaranteed" to work.

One way to conceptualize an hedonic framework is to consider that another based on the relative amount of characteristics contained, or embodied in it relative to another good. As a result, each characteristic contributes marginally to a commodity's overall value. Observed prices of the differentiable commodity and its associated set of characteristics can reveal an implicit price or value for each quality characteristic. Statistical measurement of the relationship between prices paid by consumers for a commodity and the quality mixes contained in that commodity can be used to interpret these marginal values in monetary terms. As shown by Lancaster and later extended by Ladd and Martin as well as Rosen, the set of production functions,  $g_y(\cdot)$ , that exist for  $m$  production characteristics  $Q_{kj}$  with  $K =$  characteristic,  $j =$  commodity, and  $Q_y =$  amount of good  $y$  can be described as:

$$(1) \quad Q_y = g_y(Q_{1y}, Q_{2y}, \dots, Q_{my})$$

$$(2) \quad \pi = \sum_{y=1}^Y P_y g_y(Q_{1y}, Q_{2y}, \dots, Q_{my}) - \sum_{y=1}^Y \sum_{i=1}^n P_{zi} Z_{iy}$$

where  $Z_{iy} =$   $i$ th input to output  $y$ ,  $Q_y$  is the quantity of output  $y$  produced, and  $Q_{jy}$  is the total quantity of characteristic  $j$  used to produce output  $Q_y$ . Producer profits result from the difference between total revenues and total costs, or equivalently stated, where  $P_y$  and  $P_{zi}$  are output and input prices respectively, and  $Z_{iy}$  is the quantity of input  $j$  used to produce output  $Q_y$ .

$$(3) \quad P_{zi} = P_y \sum_{j=1}^m (\partial g_y / \partial Q_{jy}) (\partial Q_{jy} / \partial Z_{iy})$$

To link equation (3) to the market equilibrium, assume firms perceive a vector of constant prices for each bundle of attributes (i.e., the  $P_y$ 's). Then, inverting equation (3) to solve for  $P_y$  we have an expression for the relationship between different firms' perceptions of  $P_y$  in equation (4).

$$(4) \quad P_y = \frac{P_{zi}}{\sum_j (\partial g_y / \partial Q_{jy}) \cdot (\partial Q_{jy} / \partial Z_{iy})}$$

To the extent we can gauge the cost requirements needed to add more inputs to produce the specific characteristics ( $Q_{jy}$ 's) associated with a  $Q_y$ , then it is possible to interpret the cost to acquire additional units in terms of the marginal price and value of the attributes. This process is one where the right side of equation (4) identifies important components of marginal implicit price. Of course, this requires prior knowledge about the role of  $Z$ 's in the production of attributes. More generally, Lancaster and later Rosen suggested that the market equilibrium reveals information for both sides of the market simultaneously. Replacing equation (4) by its equivalent expression in (5), we have a more general characterization that acknowledges hedonic price functions as simultaneously measuring both the cost and value side tradeoffs.

$$(5) \quad P_y = h(Q_{1y}, Q_{2y}, \dots, Q_{my})$$

This equilibrium relationship describes how prices must relate to characteristics in order for there to be no incentives for consumers or firms to want to change their decisions. From (5), the marginal cost ( $MC_{Q_{jy}}$ ) and incremental value or marginal willingness to pay ( $MWTP_{Q_{jy}}$ ) for additional characteristics (through the marginal prices) are obtained. As noted in equation (6), they are:

$$(6) \quad \frac{\partial P_y}{\partial Q_{jy}} = MC_{Q_{jy}} = MWTP_{Q_{jy}}$$

In general, theoretical considerations do not suggest an appropriate functional form for an hedonic price equation. The importance of determining the appropriate functional form in hedonic models is addressed extensively by Palmquist (1984) and Cropper, Deck, and McConnell (1988) as well as in Wahl, Shi and Mittelhammer [1995]. Intuitive reasoning concerning the impact of alternative quality characteristic effects on price suggests an intrinsically

linear relationship since many characteristics are separable and additive. While parameters of the hedonic model might be hypothesized to be linear, some variables may be nonlinear in their relationship with price. A systematic test to assist analysts in identifying the appropriate functional form can be conducted utilizing Box-Cox power transformation procedures. Box-Cox power transformation techniques allow the data to determine its most appropriate functional form. Box-Cox power transformation variables range in value between and 0 and 1, with a value of 1 indicating a strictly linear relationship. Standard Box-Cox procedures are well documented in the economics literature but an excellent discussion of using Box-Cox procedures within an hedonic model can be found in Wahl, Shi, and Mittelhammer (1995).

A potentially troublesome estimation issue involving hedonic functions is the existence of multicollinear relationships among identified characteristics. Multicollinearity poses serious analytical problems because it is difficult to isolate effects of each characteristic on the price. The most appropriate remedy for multicollinearity problems is to collect and incorporate new information into the model. However, sample size was limited because of cost considerations. As a result, it was necessary to combine selected product attributes. Of course, some correlation was expected because one attribute could be supplied without another (such as size and weight). Other correlations may be the result of deliberate responses of producers who recognize consumers link specific dimensions of the appearance of produce as simultaneous indicators of quality. The challenge for the analyst is to attempt to define transformations of the available measures of product characteristics so that they closely resemble ways in which consumers and producers evaluate distinctive characteristics.

### **Data Collection**

Tucson grocery stores were selected as the study location for three reasons. First, a wide variety of organically and conventionally grown fruits and vegetables are available year-round in Tucson due to abundant local production and the proximity of this market to supply areas in Mexico, California and Texas. Second, research noted

earlier by University of Arizona economists who collected hedonic fruit and vegetable purchase data in Tucson during 1991 could prove useful in analyzing findings and might provide some interpretative insights. And third, the overall project design dictated that we identify two study cities -- one city with little or no exposure to organic fruit and vegetables and a second city with a reasonably active organic market. Since this paper discusses only Tucson hedonic results, findings from the "no exposure to organic" city (Wichita, Kansas) will not be discussed. Tucson also met our population and demographic requirements (moderate size population with above average disposable income).

Data were collected from twenty-eight different grocery stores over a two-day period during the first week of June 1994. The twenty-eight stores were owned or managed by eleven different firms and/or individuals. Stores and locations were identified using a current local telephone book. Because of time and resource constraints, information was collected for only four commodities: celery (trimmed cello wrap and naked stalks), Valencia Oranges (individual and bulk pack), grapefruit (individual and bulk pack), and apples (individual and bulk pack). Apple data were collected for three varieties since consumers often shopped for apples on the basis of color (red, green, or yellow), tartness, and relative price. Apple varieties included in the Tucson survey were Red Delicious, Golden Delicious, and Granny Smith.

Store size, produce department square footage, and displayed quantities of produce varied greatly by store and location. Produce department space ranged from a modest 225 square feet to nearly 4,300 square feet. For the two major chain supermarkets operating in Tucson (Safeway and ABCO), data collection efforts were limited to a maximum of three locations since corporate affiliation resulted in a great deal of similarity in price and quality across stores. Two stores identified their facilities as primarily natural food stores. Managers at these two stores indicated that they preferred to carry organic produce exclusively but stocked conventionally grown local items when organic items were unavailable. In mainstream stores, organic produce was often available but the mix, variety, and quantities were

usually limited. For example, organic celery was available in only the two natural food stores.

Sample data were obtained via hour-long visits to each of the twenty-eight stores. Prices were recorded directly from posted price cards displayed near the item. Quality information was recorded on quality assessment sheets developed for this study. Quality assessments were made by randomly selecting 10 fruit from each display rack and first assessing the cosmetic appearance of each item. Three general ratings were possible: 1) no visible scars or surface defects; 2) a minor amount of decay, bruising, scarring, insect bites, and/or cuts; and 3) a serious amount of damage and defects. In this study, damage was defined to be minor if some damage was evident but 10 percent or less of the total surface area was occupied by the defect. Serious damage was noted if more than 10 percent of the total surface area had visible damage, defects, and/or scarring. If two of ten fruit inspected had serious defects, then the commodity received an appearance rating of 2.0. In general, minor and serious assessment rankings were additive and mutually exclusive. Thus, if an item had one minor defect and two serious defects, its overall appearance rating would be 3.0. Appearance ratings were collected for both organic and conventionally grown produce and the same appearance rating scheme and standards were applied to both. This rating scheme permitted quality comparisons between organically and conventionally grown commodities but would preclude ranking across commodities (such as between apples and oranges).

In the study, one observational unit consisted of the 10-unit sample which was chosen randomly from displayed fruit. Specific data recorded for each 10-unit sample included: the posted regular and/or promotional price per unit, sales or package unit (pound, 5 pound bag, etc), variety or brand name displayed (Red Ruby grapefruit, Washington State Red Delicious apples), fruit size (large, medium, small), average weight per fruit, the proportion of sampled items having serious defects, the proportion of sampled items having minor defects, the store location, its affiliation (if any), and whether in-store displays which identified an item as organically grown. If an item was not labeled or identified as organic, it

was assumed to be grown using conventional practices.

A maximum of 14 observations (organic and conventionally grown celery, grapefruit, oranges, plus organic and conventionally grown Red Delicious, Golden Delicious, and Granny Smith apples) could be obtained from each store. A full data set would consist of 392 observations (14 observations per store and twenty-eight stores). During the two-day study period in June, all commodities were not available in all store locations. For all commodities and all stores, a total of 269 observations were recorded. Unfortunately, the number of organic observations was limited, with only 31 organic observations obtained. Few mainstream grocery stores offered organic celery, grapefruit, and oranges for sale during the sampled time period but a greater proportion did stock organic apples. There were a total of 46 usable observations obtained for grapefruit (42 conventional and 4 organic), 41 usable observations obtained for Valencia Oranges (39 conventional and two organic), 42 observations obtained for celery (40 conventional and 2 organic), and 140 observations obtained for apples (117 conventional and 23 organic). The small data set combined with the few organic observations (except for apples) suggested that it might be difficult to identify causal relationships between price and attributes for three of the commodities. This process implies our sample for each type of produce is composed of a type of panel with the potential for multiple observations from each store.

### **Estimated Hedonic Model**

Excluding the influence of overall demand and supply conditions which should influence market price levels for all the stores in the market area, an equilibrium first-stage hedonic function can be estimated by regressing the observed equilibrium market price for commodity  $j$  on the set of commodity characteristics a double subscript is used to indicate that within a produce type there are varieties (identified by  $j$ ) and different stores (identified by  $k$ ). Separate functional relationships can be specified for each commodity possessing a different set of attributes. The estimated hedonic price equation for each commodity  $j$  follows a

similar format. For example in the case of apples as commodity  $j$  with our semi-log specification, it would be given as equation (7):

$$(7) \quad \log(P_{jk}) = a_1 + b_1 \text{Large}_{jk} + b_2 \text{Small}_{jk} + b_3 \text{Bulk}_{jk} \\ + b_4 \text{Defects}_{jk} + b_5 \text{Organic}_{jk} + b_6 \text{Sale}_{jk} \\ + b_7 \text{Loc1}_{jk} + b_8 \text{Loc2}_{jk} + b_9 \text{RedDel}_{jk} \\ + b_{10} \text{Granny Smith}_{jk} \\ + c_1 \text{Safeway}_{jk} + c_2 \text{ABCO}_{jk} + e_{jk}$$

where:

$P_{jk}$	= retail sales unit price for apples of type $j$ ;
$\text{Large}_{jk}$	= dummy variable equal to one if commodity $j$ was large;
$\text{Small}_{jk}$	= dummy variable equal to one if commodity $j$ was small;
$\text{Bulk}_{jk}$	= dummy variable equal to one if commodity $j$ was sold in bulk packs;
$\text{Defects}_{jk}$	= proportion of commodity $j$ with surface defects;
$\text{Organic}_{jk}$	= dummy variable equal to one if commodity $j$ labeled organic;
$\text{Sale}_{jk}$	= dummy variable equal to one if commodity $j$ was featured sale item;
$\text{Loc1}_{jk}$	= dummy variable equal to one if store $k$ located in West quadrant;
$\text{Loc2}_{jk}$	= dummy variable equal to one if store $k$ located in East quadrant;
$\text{RedDel}_{jk}$	= dummy variable equal to one if commodity $j$ was Red Delicious apple;
$\text{Golden}_{jk}$	= dummy variable equal to one if commodity $j$ was Golden Delicious apple;
$\text{Granny Smith}$	= dummy variable equal to one if commodity $j$ was Granny Smith apple;
$\text{Safeway}_{jk}$	= dummy variable equal to one if commodity $j$ sold in Safeway store;
$\text{ABCO}_{jk}$	= dummy variable equal to one if commodity $j$ sold in ABCO store;
$e_{jk}$	= stochastic error term for $jk$ observation.

The parameters  $a$ ,  $b$ , and  $c$  are estimated using ordinary least squares (OLS) methods. There are seven dummy variables specified in each estimated commodity equation. Dummy

variables offer a simple way to reflect qualitative distinctions. For example, they can designate qualitative characteristics of an observation, a type of produce, or a specific food chain. They allow the analyst to provide for shifts in the level (up or down) of the price function, provided variables are classified into mutually exclusive categories. In this study, for example, mutually exclusive categories included Red Delicious, Golden Delicious, or Granny Smith apple varieties. Dummy variables are assumed to have binary values of either 1.0 or zero. If the binary characteristic is found in an observation, then the values of the variable defined for this characteristic will be 1.0; otherwise, its value is assumed to be zero. When three options are possible, one variable is chosen as the omitted or control variable and the equation is then evaluated including the remaining two variables. The coefficients for the included variables measure the effects of each attribute relative to the omitted feature. Thus, in the example for types of apples with Granny Smith specified to be the omitted dummy variable, the coefficient for Red Delicious measured the differential effect of Red Delicious over Granny Smith on price.

In the case of a semi-log function (i.e., log of the dependent variable, with independent variables in linear form) the interpretation of the coefficients for dummy variables needs some specific clarification. Ordinarily, for a continuous variable, such as weight or a count of the defects, the coefficient is interpreted as the proportionate increase in price with a change in the variable (scaled by 100, it would be simply the percentage change). To interpret dummy variables we must reformulate the model and transform the coefficients. The semi-log for a simple case with one continuous independent,  $x$ , and one dummy variable,  $D$ , can be written equivalently as (8a) and (8b).

$$(8a) \quad \log(P) = a_0 + a_1x + a_2D$$

$$(8b) \quad P = e^{a_0 + a_1x + a_2D}$$

Because  $D$  is not continuous, a percentage change can be developed from  $a_2$  by recognizing that an

equivalent expression (in terms of its estimating form) would yield (8c):

$$(8c) \quad P = (1 + \alpha)^D e^{a_0 + a_1 x}$$

Simplifying by taking the log of both sides, we result in equation (9).

$$(9) \quad \log P = a_0 + \log(1 + \alpha) \cdot D + a_1 x$$

This interpretation was first suggested by Halvorsen and Palmquist (1980). The expression measures the percentage change in the price needed to estimate  $\alpha$ . This can be accomplished by setting the estimated coefficient for D, say  $\hat{\alpha}_2$  equal to  $\log(1 + \alpha)$  and then solving the expression as in (10).

$$(10) \quad \hat{\alpha} = e^{\hat{\alpha}_2} - 1$$

One further refinement, as proposed by Kennedy (1981), recognized that the estimate will be biased because of properties inherent in the transformation. Kennedy suggested that an estimator found to be successful in adjusting for the expected bias was:

$$(11) \quad \tilde{\alpha} = e^{\hat{\alpha}_2 - \frac{1}{2} \text{Var}(\hat{\alpha}_2)} - 1$$

where  $\text{Var}(\hat{\alpha}_2)$  = the estimated variance in the coefficient estimated for the dummy variable.

In the following discussion, table information presented represents the estimated coefficients for each dummy variable and we then transform them using equation (11) before discussing their implications in the text.

As other studies have noted, it is difficult to determine *a priori* the exact functional form for the relationship between explanatory variables and the dependent variable. Wahl, Shi, and Mittelhammer (1995) as well as Estes (1986) suggested utilization of a standard Box-Cox power transformation variables approach to allow the data to identify its most appropriate functional form. In this procedure, estimation of the set of power transformation parameters  $\lambda$  is equivalent to choosing the functional form which best fits

the data. A nonlinear grid search algorithm (SAS, PROCNLIN) was used to evaluate alternative sets of parameter estimates using maximum likelihood and minimum mean square error fit criteria. Preliminary testing of survey data revealed that mean square errors were lowest when a semi-log functional form was specified. Cropper, Deck, and McConnell's (1988) evaluation of hedonic functions in the context of housing applications also provided some support for use of the semi-log functional form in first-stage hedonic models. Since the semi-log form provided slightly better results than other forms, semi-log hedonic price equations were employed to analyze all commodity data.

Effects of quality characteristics can have a positive or negative influence on price. *A priori* expectations concerning regression coefficient signs can be formulated. The organic coefficient is expected to have a positive sign because both organic shoppers and suppliers indicate consumer willingness to pay premiums food safety and lower health risks due to the absence of pesticide residues that might be present in conventional growing practices. A positive relationship between price paid and size or weight is hypothesized since larger fruit are typically more desirable for shoppers. Since produce is sometimes sold on an item rather than per pound basis (3 for \$1.00), consumers often perceive larger is a better value. Variables to standardize for the effects of price promotions need to be interpreted carefully. They may reflect the supplier's use of the item to attract consumers. Thus, the store is deliberately departing from the "known" equilibrium patterns for the item in order to meet another objective (increased sales). By including this factor in the model we attempted to standardize (or control) for short-term departures from equilibrium pricing strategies via promotional sales that might be initiated to attract additional consumers. In general, we would expect a negative effect of this designation. Conversely, increased defects would result in less consumer inclination to buy an item so a negative relationship is hypothesized between defects and price. Finally, the expected relationship between price and store or location is unknown *a priori*. If higher prices were charged for a commodity by a store (or a group of stores), then a positive relationship

between price and store is expected. If prices were below the average of competitor prices for either an individual store location or a chain of stores, then a negative value would be expected.

Hedonic price equations were estimated for apples, grapefruit, oranges, and celery. As noted previously, the data set was limited except for apples (which had 140 total observations). It was therefore not surprising to find that the grapefruit, orange, and celery estimation results indicated few links between price and most quality attributes. Since hedonic equation results were more robust and interesting for apples in comparison to the other three commodities, the bulk of the discussion will focus on the model for apples. However, grapefruit, orange, and celery hedonic equation results will be discussed briefly after results for the apples are presented.

### Hedonic Apple Equation Results

The largest data set obtained in the study was for apples (140 observations) since all stores generally stocked ample supplies of apples as well all three apple varieties. In addition, nearly all stores offered for sale both bulk pack (bagged) and individual apples. Table 1 contains hedonic estimation results for apples. In analyzing results

listed in Table 1, it is useful to note that four dummy variables, store affiliation, store geographic location, size, and variety, involved three rather than the usual two 0-1 value choices. The omitted variable for store affiliation was for all stores other than Safeway and ABCO, the omitted variable for geographic location was the northern Tucson quadrant, the omitted variable for size was medium, and the omitted variable for variety was Granny Smith apples.

Retail prices for organic apples were, on average, 118 percent higher per pound than the selling price for conventional apples. Statistical analysis of characteristic data suggested that consumers evaluated size, weight, defects, organic labeling, variety, and package size in their purchase decision. Shoppers at ABCO stores tended, on average, to pay slightly more for apples than did shoppers at other Tucson stores. Overall, Golden Delicious apples sold for 20 percent more per pound than Granny Smith apples.

Bagged apple prices (all varieties) were lower than individually priced apples by about 30 percent per pound. ABCO stores tended to price their apples about 24 percent more than did all other Tucson grocery stores. Safeway, a major

**Table 1. Hedonic Regression Results for Apples, Tucson, AZ, June 1994.**

Variable	Parameter Estimate	Standard Error	t-statistic	p-value
Intercept	-0.4814	0.1147	-4.196	0.0001***
organic	0.7809	0.0582	13.401	0.0001***
defects	-0.0218	0.0111	-1.973	0.0507*
sale	-0.1385	0.0574	-2.409	0.0175**
large	0.2314	0.0716	3.232	0.0016**
small	0.1327	0.0694	1.911	0.0582*
loc1	-0.0381	0.0381	-0.999	0.3198
loc2	0.0288	0.0456	0.632	0.5283
ABCO	0.2169	0.0365	5.931	0.0001***
SAFEGWAY	0.0238	0.0549	0.435	0.6643
RedDel	-0.0328	0.0487	-0.803	0.4234
Golden	0.1811	0.0422	4.283	0.0001***
bagged	-0.2671	0.0424	-6.298	0.0001***
weight	0.5511	0.2087	2.641	0.0093***

R-squared (adjusted) = .71

dependent variable = log of price per pound

F value = 27.33

\*\*\*, \*\*, \* = Significant at 1%, 5%, and 10% level respectively.

competitor to ABCO stores in the Tucson area, priced apples about 22 percent lower per pound than did ABCO. In part, ABCO's higher average price for apples reflected the fact that a greater proportion of inventory consisted of the higher-priced individual apples. In addition, ABCO weight for an individual apple tended to vary among stores, with the average weight noted to be one-half pound per apple. Visible defects on apples tended to reduce average price somewhat but, on average, the discount was rather modest, amounting to about two cents per pound.

Hedonic equation results identified several important features desired by Tucson apple shoppers. Important considerations seemed to include information about whether the apple was grown using organic methods, if apples were sale priced, information about size and weight, if an apple could be purchased in bulk or as a single item, and the number or amount of visible surface defects. Since quality features are bundled, consumers simply select the apple with the greatest amount of desirable features while also minimizing less desirable attributes for a given price. In the competitive grocery business, if a store stocks a high proportion of fruit that has less desirable attributes, then fewer apples will be sold. Among the attribute set, purchase decisions seemed to rely on labeling information (organic or conventional), relative size and weight, and bulk availability. While the number of visible defects was a consideration, its relatively minor role in apple purchase decisions (as indicated by the apple equation), might be explained by two possible causes: 1) the constant sorting and culling of apples by packers, handlers, and retail clerks tended to minimize the number of damaged apples displayed at a point in time; or 2) consumers perceive appearance attributes to be proxies for a number of other desirable quality characteristics (color, flavor, taste, maturity, etc) but are aware of the possibility that appearance is not always a reliable indicator of quality.

### **Grapefruit Hedonic Results**

A total of 46 observation points were collected for grapefruit. Table 2 contains selected regression results obtained from the hedonic grapefruit equation. Most variables were insignificant

and were omitted from Table 2. Analysis of variance information indicated the equation had an adjusted R-squared value of 0.74 and an F-value of 12.76. Overall, regression results were poor and indicated that there was little causal relationship between most explanatory variables and the price per pound. Only the intercept term, the chain store affiliation for ABCO, and the bagged (bulk) terms were meaningful variables at 1 percent level. In part, these poor results were likely associated with the small size of the grapefruit sample. On average, however, prices charged by Tucson grocery stores varied considerably.

ABCO stores charged 61 percent more per pound for grapefruit than did the average Tucson store sampled. Safeway, the other principal chain operated store in Tucson, tended to price grapefruit, on average, about 62 percent less per pound than did ABCO-affiliated stores. At stores sampled, bulk (3 or 5 pound bags) grapefruit prices were 83 percent less per pound than prices charged for single grapefruit. As was true in the apple analysis, there did not appear to be meaningful linkages between the price paid (selling price) and the number of defects. Unlike the apple regression results, however, differences in prices were not meaningfully associated with the organic factor. While the average quality of the organic and conventionally grown grapefruit were not significantly different, cursory examination of the data sheets did suggest that minor cosmetic defects for organic grapefruit were slightly more numerous than were the defects observed on the conventionally grown grapefruit. Thus, price differences appeared to be most directly associated with package size (bulk packed was priced lower than individual grapefruit) and the retailer rather than appearance and/or production methods.

### **Orange Hedonic Results**

A total of 41 observations were collected for Valencia Oranges. Table 3 contains selected hedonic equation estimation results for oranges. Insignificant variables were excluded from the model reported in Table 3. The adjusted R<sup>2</sup> statistics suggest that results for oranges were marginally better than grapefruit results in terms of

**Table 2. Hedonic Price Regression Results for Grapefruit, Tucson, AZ, June 1994.**

Variable	Parameter Estimate	Standard Error	t-statistic	p-value
Intercept	-0.9252	0.1866	-4.958	0.0001***
Organic	0.1400	0.1684	0.831	0.4119
Defects	0.0074	0.0201	0.367	0.7162
ABCO	0.4788	0.0873	5.485	0.0001***
Safeway	-0.0173	0.1299	-0.133	0.8948
Bulk (bagged)	-0.6105	0.0958	-6.373	0.0001***

R-squared (adjusted) = .74

Dependent variable = log of price per pound

F value = 12.76

\*\*\* = Significant at 1% level.

the ability to associate differences in the attributes of Valencia Oranges with price differences. Nonetheless, a number of independent variables were not significant factors in explaining price differences. As before, package size (bulk packs) tended to reduce the average price of Valencia Oranges significantly and the ABCO stores priced oranges about 33 percent more per pound than other Tucson grocery stores. Bagged oranges, on average, were priced 59 percent less per pound than individual oranges. Regression results also supported the notion that organically grown oranges were higher priced than conventionally grown oranges. Among sampled stores, organic Valencia Oranges were sold nearly 51 percent higher per pound than conventionally grown Valencia Oranges. A weak but still significant relationship was noted between defects and prices for Valencia Oranges. As the number of defects tended to increase, the average price for Valencia Oranges declined. On average, defects reduced price by about 2.6 percent per pound.

### Celery Hedonic Results

Selected hedonic celery results are reported in Table 4. A total of 42 usable observations were used for the celery price equation. As observed in the grapefruit and orange analysis, celery price seemed unrelated to most quality features. However, the analysis indicated that organic celery, on average, was priced about 154 percent more per pound than conventionally grown celery. Since buyers of organic celery were paying about 154 percent more per pound than buyers of conventional celery and there were significant appearance differences between the two types of celery, the price equation estimates do confirm that some consumers are willing to pay higher prices for reduced health risk by eliminating the prospects for encountering the pesticide residues present with commercially grown celery. Unlike other commodities tested in this study, prices for bulk (bagged) celery were higher than celery stalks. In this case the bulk packages contained trimmed, cello pack celery in which the top portion of the

**Table 3. Hedonic Price Regression Results for Valencia Oranges, Tucson, AZ, June 1994.**

Variable	Parameter Estimate	Standard Error	t-statistic	p-value
Intercept	-0.6246	0.1165	-5.363	0.0001***
Organic	0.4195	0.1426	2.942	0.0064**
Defects	-0.0257	0.0101	-2.495	0.0185**
Small	0.0906	0.0489	1.852	0.0742*
ABCO	0.2863	0.0446	6.161	0.0001***
Bulk	-0.4628	0.0477	-9.669	0.0001***

R-squared (adjusted) = .81

Dependent variable = log of price per pound

F value = 16.46

\*\*\*, \*\*, \* = Significant at 1%, 5%, and 10% level respectively.

**Table 4. Hedonic Regression Results for Celery, Tucson, AZ, June 1994.**

Variable	Parameter Estimate	Standard Error	t-statistic	p-value
Intercept	-0.7769	0.2633	-2.951	0.0061***
Organic	1.0106	0.3939	2.565	0.0156**
Bagged	0.3858	0.1966	1.962	0.0591*

R-squared (adjusted) = .17

Dependent variable = log price per pound

F value = 1.821

\*\*\*, \*\*, \* = Significant at 1%, 5%, and 10% level respectively

stalk was cut off (therefore eliminating celery leaves). It is believed that stalk trimming reduces waste for many consumers and thus provides added value. Therefore, trimmed celery commanded a price premium, on average, of about 44 percent more per pound than did unwrapped, untrimmed stalks of celery. During store visits, conversations with employees indicated that nearly all Tucson stores obtained their conventional celery from one of two major suppliers in the Southwest region and quality was comparable between the suppliers. Similarly, there was only one source for organic celery in Tucson. With a limited number of suppliers, it is reasonable to assume that quality features would be quite similar among retailers and it would be difficult to detect price and quality differences on retail shelves. Since major price differences existed between organic and conventional celery but there was little evidence that the price difference was based on appearance considerations, it is plausible to conclude that consumers purchase organic celery to reduce possible pesticide residue exposure with the potential for increased long-term health risks.

### 1991 Conklin, Thompson, & Riggs Study

As noted previously, Conklin, Thompson, and Riggs (CTR) developed hedonic price models for eight fruits and vegetables offered for sale in Tucson grocery stores in 1991. CTR considered apples, carrots, potatoes, leaf lettuce, iceberg lettuce, grapes, tomatoes, and bell pepper during the February 1991-June 1991 period. While there is little overlap among commodities in the CTR and current study, an hedonic equation for apples was estimated in both studies. Although data

collection procedures and the length of time used to collect data differed significantly in the two studies, several factors suggest that a comparison of findings might be appropriate. First, both studies identified and measured a large number of visual quality attributes such as defects, bruising, shape, and size. Second, price and quality data were collected for both organic and conventionally grown apples. Third, price and quality data collection procedures and methods were similar, with hedonic data obtained from grocery stores operating in the same city (Tucson) and were collected less than three years apart. Finally, for apples, the only commodity common to both studies, the total number of observations were similar (125 in CTR and 140 in this study). Table 5 summarizes important similarities between the 1991 and 1994 studies, including the commodities and number of observations obtained in each study.

### Apple Result Comparisons

Table 6 contains regression estimates obtained for apples in this study as well as the CTR study. The results in Table 6 reveal a general level of consistency in study findings. Adjusted  $R^2$  values and the number of usable observations were similar in each study. Both studies found that the average price of organic apples was significantly greater than the average price charged for conventionally grown apples. Both studies also found that bulk packaging tended to reduce sales price. Finally, both studies found little evidence to support the belief that price differences were based primarily on differences in cosmetic appearance considerations. Consumers, of course,

**Table 5. Number of Total Observations and Organic Observations Obtained in Conklin, Thompson, & Riggs (CTR) Hedonic Study and the Present Study (ES).**

Item	CTR 1991 Study	ES 1994 Study
Data collection period	February 1991- June 1991	June 11-12, 1994
apples	125* (53)**	140 (23)**
carrots	144 (54)**	not collected
leaf lettuce	144 (54)**	not collected
iceberg lettuce	107 (11)**	not collected
tomatoes	110 (20)**	not collected
grapes	76 (7)**	not collected
bell peppers	88 (3)**	not collected
grapefruit	not collected	46 (4)
oranges	not collected	41 (2)**
celery	not collected	42 (2)**

Number in parenthesis indicates number of organic observations contained within the total observation set; 1991 study results obtained from Conklin, Thompson, and Riggs (CTR).

**Table 6. Hedonic Price Regression Coefficient Values for Apples, 1991 and 1994 Studies, Tucson, AZ.**

Variable	CTR 1991 study	ES 1994 study
intercept	0.671 (11.147)	-0.481 (-4.196)
organic	0.163 (5.634)	0.781 (13.410)
defects	-0.015 (-1.642)	-0.021 (-1.973)
sale	-0.138 (-2.138)	-0.138 (-2.409)
large size	0.053 (1.749)	0.231 (3.232)
small size	not estimated	0.132 (1.911)
USDA grade	-0.056 (-0.934)	not estimated
bagged	-0.110 (-1.738)	-0.267 (-6.298)
weight	not estimated	0.551 (2.641)
type - Red Delicious	not estimated	-0.032 (-0.803)
type - Golden Delicious	not estimated	0.181 (4.283)
loc1 (West Tucson)	not estimated	-0.038 (-0.999)
loc2 (East Tucson)	not estimated	0.028 (0.632)
store (ABCO)	not estimated	0.0216 (5.931)
store (Safeway)	not estimated	0.023 (0.435)
Store 2	0.072 (1.992)	not estimated
Store 3	0.150 (3.618)	not estimated
Store 4	0.338 (8.578)	not estimated
Store 5	0.182 (3.991)	not estimated

Note: Values in parenthesis are t-statistics.

preferred larger, fresher, perfect-looking apples over less attractive apples but the influence of defects on price seemed negligible. Of particular interest in both studies was a comparison of the number of defects obtained from organic apple samples with conventional apple samples. *A priori*, it might seem reasonable to hypothesize

that organic apples possessed a greater number of visible defects than did conventionally grown apples. CTR noted that they detected little visual difference between organically and conventionally grown apples and concluded that "sensory defects seemed to have no significant effect on retail prices for organic or conventionally grown

produce". Our results tend to support CTR's observation that few, if any, cosmetic differences existed between organic and conventional apples. Moreover the simple correlation analysis indicated that the frequency and magnitude of visible defects observed on organic apples were similar to those obtained for conventionally grown apples (data not shown). Thus, when a consumer is trying to decide whether to purchase an organic or conventional apple, it would seem difficult to base the purchase decision primarily on appearance considerations. Both studies observed significantly higher prices for organic apples (irrespective of variety and color) and few if any, appearance differences between organic and conventional apples in Tucson markets. Given these similarities, it would seem reasonable to conclude that the primary reason for higher organic prices is unrelated to appearance features. Rather this higher price for organic apples would appear to be more related to a perception that purchasing organic conveys a lower risk of exposure to pesticide residues and with it potentially lower risks of the associated health effects due to these pesticides.

### **Study Conclusions and Implications**

Domestic produce consumption continues to expand. Likely reasons for increased consumption of fresh produce include consumer's attention to health, diet, and nutritional needs. Study results suggested that Tucson consumers considered labeling information about production and handling practices (that is, the possible existence of pesticide residues) as an important purchase decision factor for some types of fresh produce. Our findings also suggested that there were few direct links between price and appearance, with more attractive produce items priced significantly higher than less attractive items. Anecdotal evidence and study results supported the hypothesis that consumers, when faced with a constant price, sought to maximize the number of desirable quality features such as appearance, shape, ripeness, and freshness when hand-selecting individual fruits and vegetables. Concomitantly, retailer pricing strategies (and indirectly consumer purchase intentions) seemed to be influenced by several other quality dimensions such as packag-

ing, comparative size, and organic label information. These general observations, particularly with regard to the spurious link between price and cosmetic appearance, were also observed by CTR in their 1991 study of Tucson supermarkets.

There were few, if any, notable appearance differences noted between the supply of conventionally grown fruits and vegetables and the organically grown fruits and vegetables. While there were few appearance factors, there were, however, notable differences in retail prices. Per unit prices for organically grown items ranged between 30 percent and 90 percent higher than conventionally grown items. For example, organic apples were, on average, priced \$.70 per pound higher than were comparable quality conventional apples (average price for conventional apples was \$.92 per pound while organic apple price was \$1.78 per pound). Since buyers of organic apples were, on average, willing to pay substantially more money for apples which were similar in appearance and quality to conventionally grown apples, it seems reasonable to conclude that these buyers were purchasing additional food safety by eliminating uncertainty about pesticide residues. The magnitude of the price premium for apples also suggested that there was a high marginal implicit value for the organic feature when the surface of an item was likely to be consumed (except when apples were purchased for home processing).

If we consider only the results for apples, our findings suggested a much larger price premium for organic produce. CTR's estimates implied an 18 percent price premium paid for organic apples (holding other factors constant). By contrast, our results suggested a significantly higher price premium, approximately 118 percent for organically grown apples. Differences in price premiums might be attributed to yearly and seasonal differences between in the two studies, changes in attitudes and preferences about organic apples between 1991 and 1994, perceived value of organic apples relative to conventionally grown apples, and differences in supply availability of both organic and conventional apples. Recall first-stage hedonic value estimates represent short-run market equilibrium observations and it is inappropriate to deduce more general demand

and supply conditions using first-stage hedonic estimates.

In general, rapid expansion of organic sales into mainstream grocery stores suggests that increasing numbers of consumers are willing to pay premium prices for organic fresh fruits and vegetables in order to minimize concerns about exposure to pesticide residues. Our analysis of hedonic price and attribute data indicated that organic and conventional produce possessed similar visual quality characteristics but prices for organic produce were significantly higher than comparable conventionally grown fruits and vegetables. Consumption of high-volume, frequently purchased items such as apples may cause consumers to monitor purchases carefully and modify their purchasing habits. That is, consumers may differentiate otherwise similar appearing items in an effort to minimize exposure to undesired residues. The availability of organic produce in mainstream grocery stores indicated that an increasing portion of consumers were willing to pay higher prices for certain types of risk reductions. Since regression results indicated only a casual linkage between price and cosmetic appearance, it seemed reasonable to conclude that consumers were purchasing increased health and safety when buying organic products rather than other quality attributes.

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