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The Price Premium for Organic Babyfood: A Hedonic Analysis

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The price premium associated with organic babyfood is estimated by applying a hedonic model to price and characteristic data for babyfood products collected in two cities: Raleigh, North Carolina, and San Jose, California. The price per ounce of babyfood is modeled as a function of a number of babyfood and store characteristics. The estimated organic price premium is generally equal to 3¢ to 4¢ per ounce. To the extent this premium reflects consumer willingness to pay to reduce pesticide exposures, it could be used to infer values for reduced dietary exposures to pesticide residues for babies.

Key words: babyfood, hedonic analysis, organic foods

Introduction

Understanding how parents value risk reductions for their children has become an important issue in policy analysis. The need for this information stems from advances in risk assessment which allow for age-specific analyses in some cases, as well as the issuance of Executive Order 13045 requiring all federal agencies to pay particular attention to environmental health and safety risks to children (*Federal Register*, 1997). One way to gauge how parents value these risk reductions is to examine products available for purchase that reduce risks to children. Recent expansion of the organic babyfood market makes jarred babyfood an ideal candidate for such an analysis, as babyfood is purchased for a specific member of the family and requires little to no additional effort on the part of the parent to utilize.

In recent years, the public has expressed concern for healthier eating in general, and safer foods in particular (Huang, Misra, and Ott, 1990; Weaver, Evans, and Luloff, 1992). Organic foods, which are generally perceived as pesticide free and therefore safer than conventionally grown foods, are a way to introduce safer foods into a diet.[1] In October 2002, new U.S. Department of Agriculture (USDA) guidelines went into effect requiring producers and handlers be certified by a USDA-accredited agent to sell, label, or represent their products as organic (*Federal Register*, 2000). However, even before the new guidelines were binding, a wide and growing variety of organic foods, both processed

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[1]Consumption of organic foods may not eliminate consumption of pesticide residues for a variety of reasons. For example, residues from persistent chemicals may be present or spray may "drift" onto an organic field. Parker et al. (2002) analyzed data from three produce sources and found that organic produce does contain fewer residues than conventional produce, but is not residue-free. Consumers, however, may believe consumption of organic food will eliminate dietary exposure.

and fresh, were available—with babyfood being one notable choice in the organic market. Industry sources cite a 20% increase in organic food sales between 1999 and 2000 (Meyers and Rorie, 2000), and the USDA cites a rise in sales in the organic babyfood market as well (Harris, 1997). Additionally, sales of organic babyfood are expected to more than double between 2001 and 2006 (Fetto, 2003). These trends may signal a desire on the part of parents to reduce certain pesticide-related health risks for their children.[2]

Taking advantage of the increased availability of organic varieties and the unique properties of jarred babyfood, the price premium paid for the organic component is estimated in this study using hedonic methods. This premium is calculated using retail price data in two U.S. cities, and then compared to the premium obtained in studies of other markets to gain insights into the relative value consumers place on organic babyfood. A subject of future research is to use this information to estimate values for reduced lifetime cancer risks to babies, a topic discussed briefly below.

Previous Studies

The organic market has been studied extensively, with several researchers estimating the price premiums for different organic products. Earlier studies have reported on consumer willingness to pay for organic produce in hypothetical settings (e.g., Hammitt, 1990; Fu, Liu, and Hammitt, 1999), and others have reported price differences based on actual market prices for organic produce (Estes and Smith, 1996) or other products, such as clothing made from organic cotton (Nimon and Beghin, 1999). These studies provide useful information regarding the organic market, and they confirm intuition that the organic price premium is positive. However, because of the heterogeneity of products, they provide little information on the magnitude of the price differential one might expect to find in the babyfood market.

Several studies have focused exclusively on the babyfood market. For example, Thompson and Glaser (2001) analyzed two sets of scanner data from the late 1980s and the 1990s to investigate own- and cross-price elasticities for conventional and organic babyfood. Based on their findings, the own-price elasticity for organic babyfood is large, suggesting small changes in prices could lead to large changes in consumption. Thompson and Glaser's analysis also shows a clear downward trend in the organic price premium for four types of babyfood. A 1997 hedonic study by Harris, also using scanner data from large grocery stores only, reports a premium associated with organic babyfood of 21¢ per jar.

While the above results are useful, both studies pre-date recent expansions in the babyfood market. Furthermore, because scanner data are only available for large grocery store chains, both studies necessarily exclude a portion of the market. The data used here, in addition to being more recent, encompass all store types, not just the large grocery store chains, and allow any changes that may have occurred in the market to be captured. There are, however, disadvantages to these data. They depict a single

[2] Advertising may have played a role in increasing demand. For example, an analysis by Mathios and Ippolito (1999) found consumer diets improved after policy changes allowing manufacturers to link diet and disease went into effect. Babyfood manufacturers have not explicitly linked consumption of organic babyfood to reduced health risk on their labels, although the Earth's Best website does note their product is produced "without potentially harmful pesticides and fertilizers" (Earth's Best, 2002).

cross-section from two cities representing less than 1% of the U.S. population of children less than one year of age. Furthermore, data on the quantity of babyfood purchases are not included. Nonetheless, this investigation complements analyses using scanner data by providing a more complete picture of retail venues in the babyfood market. In addition, the hedonic method employed is an inexpensive and straightforward technique for estimating implicit prices. While the data do not allow for an estimation of demand functions and welfare estimates resulting from policy changes, as do the scanner data, the data do provide a unique perspective in that all establishments selling babyfood are represented.

The Hedonic Model

Babyfood is available in many brands and flavors, and is sold by developmental stage of the child in a variety of venues. As such, it is difficult to determine the organic premium from observations of prices alone. For example, two jars of babyfood may differ across many dimensions, such as organic versus conventional, flavor, and brand. The hedonic framework allows the estimation of the price for the organic characteristic (or any characteristic), distinct from the other characteristics of babyfood.[3]

Rosen (1974) contributed the seminal paper on the formal derivation of the hedonic method. His model is briefly described to demonstrate how observations on babyfood prices can be used to infer the price of the organic characteristic, which represents both consumer and producer optimal behavior.

Consumers purchase one unit of a differentiated good, **y**, which is a jar of babyfood in this study. Babyfood consists of n component characteristics: $y_1, y_2, ..., y_n$. These characteristics include the organic characteristic (i.e., organic or conventional), brand, and venues where sold. Consumers maximize utility, u, subject to a budget constraint, where utility is a function of a composite good, x, and the purchase of one unit of the differentiated good, **y**, which is a $\{1 \times n\}$ vector of characteristics. That is, consumers maximize $u(x, \mathbf{y})$ subject to a budget constraint, $m = x + p(\mathbf{y})$, where m is income and $p(\mathbf{y})$ is the price of babyfood. The price of the composite good, x, is normalized to one, and the market is assumed to be competitive so consumers take prices as given. The maximization problem yields first-order conditions as follows:

$$(1) \qquad \frac{\partial u/\partial y_i}{\partial u/\partial x} = \frac{\partial p}{\partial y_i}, \quad \forall\, i = 1, \ldots, n.$$

Utility is maximized when the marginal rate of substitution between a characteristic of babyfood, y_i, and the composite good is equal to the marginal price of y_i. Individuals will consume a component characteristic (as revealed through their purchase of **y**) to the point where the relative value of that characteristic, or the marginal willingness to pay, is equal to its marginal price. Specifically, for a given level of income, individuals will choose a jar of babyfood with a set of characteristics (e.g., Gerber, organic, multi-pack) and price which maximize their utility.

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[3] An alternative model would be to estimate decisions over time in a discrete choice framework, as suggested by a reviewer. Presently, the data to conduct such an analysis for all establishments are not available.

On the supply side of the market, producers maximize their profits, π, by choosing an amount (T) to produce of good **y**, babyfood, which consists of component characteristics, $y_1, \ldots, y_n$. Total revenues are equal to $Tp(\mathbf{y})$. Again, markets are assumed to be competitive and firms take prices as given. Costs of production are $c(T, \mathbf{y}; \beta)$, where β is a parameter describing variables in the cost-minimization problem, such as factor prices.[4] Hence, the profit function is $\pi = Tp(\mathbf{y}) - c(T, \mathbf{y}; \beta)$. Firms maximize profits by choosing the amount of **y** to produce, such that the following condition holds:

$$\frac{\partial p}{\partial y_i} = \frac{\partial C/\partial y_i}{T}, \quad \forall i = 1, \ldots, n, \tag{2}$$

where $\partial C/\partial y_i$ is the marginal cost of producing y_i.[5] In (2), the profit-maximizing level of production occurs where the per unit marginal cost of producing a characteristic, y_i, is equal to the marginal price of that component.

From (1) and (2), the following relationship holds:

$$\frac{\partial p}{\partial y_i} = \frac{\partial u/\partial y_i}{\partial u/\partial x} = \frac{\partial C/\partial y_i}{T}. \tag{3}$$

The price of a component characteristic, y_i, represents both the relative value consumers place on the characteristic, as well as the per unit marginal cost of production of the characteristic. In other words, the price of y_i represents optimal behavior by both sides of the market. This relationship allows one to analyze the price premium for organic babyfood based on prices observed in the market (i.e., posted prices), as opposed to actual transactions.

Rosen (1974) further specifies a bid function, $\theta(y_i; u, m)$, and an offer curve, $\phi(y_i; \pi, \beta)$, showing the amount consumers are willing to pay and producers are willing to produce, respectively, of a particular y_i, for given levels of utility and income for consumers and profit and production costs for producers. The tangency between these two curves traces the hedonic price function relating the price of a good to its characteristics, $p(y_1, \ldots, y_n)$. In this way, data on prices and characteristics can be used to estimate the marginal value of one characteristic, holding all others constant.

The relationship between prices and characteristics of babyfood is estimated as follows:

$$p_j = h(\mathbf{S}_j, \mathbf{F}_j, O_j), \quad \forall j = 1, \ldots, J, \tag{4}$$

where p_j is the price of the jth jar of babyfood, $\mathbf{S}_j$ represents a vector of store characteristics for each jar, $\mathbf{F}_j$ represents a vector of characteristics of the babyfood other than organic for each jar, and O_j denotes the organic component of the babyfood. This analysis is also referred to as a first-stage hedonic price function. The derivative of this function with respect to a component price represents a second-stage hedonic price function and can be used to estimate the demand for a component. Such estimation would require data on individual consumer characteristics, which is beyond the scope of this paper.

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[4] Because no assumptions are made regarding returns to scale, T is an argument in the cost function.

[5] Firms also choose the amount, T, to produce. This decision is tangential to our analysis.

The Structure of the Babyfood Market

In the United States, there are five major brands of jarred babyfood available at retail outlets: Beechnut, Gerber, Earth's Best, Heinz, and Organic Baby.[6] Beechnut and Heinz offer conventional babyfood only, Earth's Best and Organic Baby are exclusively organic babyfood, while Gerber offers both conventional and organic varieties. In 2000, Gerber enjoyed a 70% market share, Beechnut had a 13% market share, and Heinz had an 11% market share of the total babyfood market (*U.S. Business Reporter*, 2001).[7]

Introduced in 1988 in Vermont, Earth's Best was, for many years, the only nationally available organic babyfood, and initially could be purchased only in health food stores. By 1996, Earth's Best was sold in approximately 45% of supermarkets in the United States (Harris, 1997). In the late 1990s, Gerber introduced Tender Harvest, an organic line of babyfood. While initially produced only in limited varieties, Tender Harvest has recently expanded to offer more choices. Relatively little information is available on the origins of the Organic Baby brand of babyfood. Jarred babyfood is sold in major grocery stores in the United States, as well as smaller convenience stores, drug stores, and other specialty markets. Both organic and conventional babyfood are sold in most of the larger venues.

Most parents purchase jarred babyfood for their child as a convenient method for introducing solid, table food. Jarred babyfood is offered by "stage" which is directly related to the developmental stage or age of the baby. Generally, there are three stages within each brand. Stage 1 babyfood consists of simple, single-flavor foods, such as peas or peaches, serving as a baby's first introduction to "solid" food. Stages 2 and 3 often combine flavors (e.g., blueberries and pears) and offer increasingly complex flavors by combining food groups (e.g., beef and pasta). As stage increases, so does the texture of the food.

Within a stage, babyfood can be categorized according to seven types: cereal, fruit, vegetable, fruit-vegetable combination, meat, dinner, and dessert. Not all types are offered in each stage. The meat category consists of jars with single ingredients (e.g., beef), whereas the dinner category consists of more traditional dinner-like flavors (e.g., beef noodle dinner). There are a variety of flavors available within each stage and type. For example, common stage 2 fruits include pears, plums with apples, and apple-blueberry.

Data Collection and Descriptive Statistics

Conventional and organic babyfood are sold in a number of retail outlets in the United States. These outlets vary from large, regional grocery stores to small specialty shops and convenience stores. No one store in either of this study's sample cities was expected to be representative of all brands, types, and flavors of babyfood, so different types of venues were included in the sample. Babyfood price and characteristic data were

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[6] In 1996, Heinz USA acquired Earth's Best. Since 1998, under various agreements, Earth's Best products were sold to natural food stores and retail outlets by Hain Celestial Foods under a license from Heinz. In September 1999, Hain Celestial Foods purchased the trademarks of Earth's Best from Heinz. Additionally, after the data used in this study were collected, a new brand of organic babyfood, Healthy Times, became available in some retail outlets.

[7] These percentages incorporate all babyfood products, including cereals and juices, and therefore do not represent the market shares for jarred foods exclusively. It is likely the market shares for jarred foods differ only slightly since the smaller babyfood manufacturers offer fewer non-jarred choices. Therefore, the market shares for Gerber, Heinz, and Beechnut are expected to be slightly lower for jarred foods only.

Table 1. Distribution of Venues for Jarred Babyfood Products by City

	Distribution by City (%)	
Venue Type	San Jose	Raleigh
Grocery Stores	74	89
Upscale Markets	4	1
Ethnic Markets	7	n/a
Discount Stores	3	6
Small Grocery Stores	5	n/a
Convenience Stores	2	1
Other Stores [a]	5	3
Number of observations	759	930
Date of data collection	August 20–21, 2001	February 5–6, 2001

[a] "Other Stores" consist of venues such as Babies R' Us, which do not neatly fall into the other categories.

collected from 38 establishments in Raleigh, North Carolina, in February 2001, and from 45 establishments in San Jose, California, in August 2001.[8] Stores in each city were randomly selected from a list of all retail food establishments generated from current local online consumer yellow pages.[9] The samples were stratified across establishment types based on the distribution of food purchased by location for consumers in the United States [USDA/Economic Research Service (ERS), 2000]. Although specific information is not available on the distribution of jarred babyfood sales by location, the USDA/ERS data were used as a basis for the stratification, and the sample was reallocated to reflect likely babyfood retail venues.

Table 1 summarizes the distribution of visited establishments in the two-city sample. Although Raleigh has more large grocery stores than San Jose, none of the ethnic or small grocery stores in the Raleigh sample sold babyfood. Unlike previous analyses using scanner data (e.g., Harris, 1997; Thompson and Glaser, 2001), all venue types within each city were sampled, thus providing a more complete representation of the market for babyfood.

In each of the stores in the sample, data were recorded on all jarred babyfood offered for sale. Because price varies only rarely across flavors within a stage and type, babyfood type (e.g., fruit, vegetables, dinner) within stage and brand was selected as the unit of observation.[10] For example, Beechnut stage 1 fruits are an observation, as are Heinz stage 2 dinners. Specifically, information on the following characteristics was collected: the price of each observation, the number of flavors offered for sale, the shelf space allocated to the observation, and other relevant store characteristics.

[8] The decision to collect data from Raleigh and San Jose was based on several factors. The desire was to have two cities of similar sizes, but with variation in characteristics in order to achieve a more representative picture of the national market. The percentage of the population under one year of age is similar in Raleigh and San Jose—1.4% and 1.5%, respectively. Yet, the composition of the entire population of the two cities is quite different. For example, the population of San Jose is approximately 30% Hispanic or Latino, while in Raleigh less than 10% of the population is Hispanic or Latino (U.S. Census Bureau, 2003). No claims are made, however, that these results are applicable to the entire United States.

[9] The consumer yellow pages can be found online at http://yp.yahoo.com. These pages were accessed on January 29, 2001, and again on July 31, 2001.

[10] When price did vary within an observation, a weighted average of the prices of all flavors was calculated to derive an observation price.

Information on within-brand variations in product labeling that had potential for influencing price was also obtained. For example, Beechnut offers a "Simple Recipes" line, which has fewer additives than its regular line. Jarred babyfood is sometimes provided in type-specific "multi-packs" (e.g., four jars of stage 2 fruits packaged together); recognizing that multi-packs could be priced differently than single jars, multi-packs are considered separate observations, noting the number of jars packaged together and the babyfood type and stage. Several detailed categories for the type of grocery store were developed, including ethnic, small, and upscale grocery stores.

As noted earlier, while babyfood is widely available in a myriad of stores, no single store is representative of all available brands, particularly with regard to the organic brands. In Raleigh, Earth's Best and Organic Baby were rarely available in the traditional grocery stores, and some stores carried only Gerber brands. In San Jose, there was more variety in each store, but still Organic Baby was rarely available in the traditional outlets. Hence, within each city, it was necessary to canvass a variety of stores in order to obtain a representative sample of babyfood available for sale.

Data collection resulted in 1,689 usable observations, with 930 observations from Raleigh, and 759 observations from San Jose. Detailed descriptions of relevant variables are provided in table 2; summary statistics are reported in table 3. The data consist of prices and organic designation, other product characteristics, and store characteristics, corresponding to the categories in (4). Several variables describe the products in each category. For example, product characteristics consist of label, stage, and brand.

Descriptive statistics are provided for the full data set, as well as by store type within location. Grocery stores are large retail brand-name outlets, such as Safeway or Winn Dixie. These stores are more likely to be similar in size, layout, and familiarity to the consumer, as compared to other store types. Approximately 21% of the observations are organic; there are more organic observations in San Jose grocery stores than in all other categories. In Raleigh, there are more organic observations in other store types than in grocery stores. Consequently, in Raleigh, organic babyfood is less likely to be a part of the mainstream market, as represented by the traditional grocery store venue.

Estimation Results and Discussion

Turning to the empirical estimation, the theoretical foundation for the hedonic model provides little guidance on the functional form to use. Babyfood is assumed to be separable and additive in the various characteristics (stage, organic, type, and flavor), suggesting a linear relationship for estimation purposes. This implies babyfood characteristics can be unbundled, repackaged, and purchased in any combination. For example, one can purchase stage 1 organic peas or stage 1 conventional peas at different stores.[11]

Palmquist (1991, p. 79) states that when characteristics can vary independently of each other, the linear hedonic price function is appropriate. With some products this is an unreasonable assumption. For example, two two-bedroom homes are unlikely to be equivalent to one four-bedroom home. However, in this study, costless repackaging is in fact a reasonable assumption because most of the characteristics are only available by purchasing an additional unit. In order to purchase additional "units" of organic,

[11] This is not strictly the case at all venues, but applies in general, and therefore the model is appropriate for analysis. For example, not all flavors are available in every stage and brand at every store.

Table 2. Description of Variables

Variable	Description
PRICES AND ORGANIC VARIABLE:	
PRICE	Price per ounce
PRICE_CONV	Price per ounce of conventional babyfood
PRICE_ORG	Price per ounce of organic babyfood
ORGANIC	= 1 if an organic product, = 0 otherwise
PRODUCT CHARACTERISTICS:	
MEAT	= 1 if a meat product, = 0 otherwise
LABEL	= 1 if a special label within brand, = 0 otherwise
STAGE1	= 1 if a stage 1 product, = 0 otherwise
STAGE2	= 1 if a stage 2 product, = 0 otherwise
STAGE3	= 1 if a stage 3 product, = 0 otherwise
GERBER	= 1 if a Gerber product, = 0 otherwise
BEECHNUT	= 1 if a Beechnut product, = 0 otherwise
EARTHS_BEST	= 1 if an Earth's Best product, = 0 otherwise
HEINZ	= 1 if a Heinz product, = 0 otherwise
ORG_BABY	= 1 if an Organic Baby product, = 0 otherwise
MULTI	= 1 if sold in a multi-pack, = 0 otherwise
STORE CHARACTERISTICS:	
GROCERY	= 1 if sold in a grocery store, = 0 otherwise
UPSCALE	= 1 if sold in a specialty grocery store, = 0 otherwise
ETHNIC	= 1 if sold in an ethnic grocery store, = 0 otherwise
DISCOUNT	= 1 if sold in a discount store (e.g., Target, K-Mart), = 0 otherwise
SMALL_GROC	= 1 if sold in a small neighborhood market, = 0 otherwise
CONVENIENCE	= 1 if sold in a convenience store, = 0 otherwise
OTHER_STORE	= 1 if sold in other store type (e.g., drug store), = 0 otherwise
SQFT	Square feet of shelf space devoted to observation
RALEIGH	= 1 if sold in Raleigh, NC, = 0 if sold in San Jose, CA

individuals must purchase additional jars, which in this framework are available to the consumer at a constant marginal price per unit during each shopping excursion.[12]

Further justification for a linear model can be found in Feenstra (1995), who argues if firms are able to exert price-setting behavior such that marginal prices are set above marginal costs, then a log-linear model will overstate the marginal value of characteristics but a linear model will not. To the extent the babyfood market is dominated by one large producer, namely Gerber, price-setting behavior is a possibility; however, we have no evidence to support or refute this contention.

Based on (4), several variables are used to measure the store and babyfood characteristics; the organic characteristic is measured directly. Babyfood characteristics are measured using indicator variables for the following: meat products, special labels, stage, brand, and multi-packs. Store characteristics are measured by the type of store,

[12] Although this framework implies the marginal price of the organic characteristic is constant, this is not necessarily problematic. In the babyfood market, consumers are unlikely to experience diminishing marginal utility over the course of time jarred babyfood products are used or over the total quantity of babyfood consumed. Furthermore, a constant marginal price is necessary under certain assumptions regarding health risk (e.g., threshold risks).

Table 3. Descriptive Summary Statistics: Means / (Standard Deviations)

		San Jose		Raleigh	
Variable	All Data	Grocery	Other Stores	Grocery	Other Stores
PRICES AND ORGANIC VARIABLE:					
PRICE	0.15	0.17	0.15	0.14	0.15
	(0.14)	(0.04)	(0.04)	(0.04)	(0.04)
PRICE_CONV	0.14	0.16	0.14	0.13	0.15
	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)
	[n = 1,341] [a]	[n = 386]	[n = 164]	[n = 711]	[n = 80]
PRICE_ORG	0.18	0.19	0.18	0.16	0.17
	(0.03)	(0.03)	(0.03)	(0.01)	(0.02)
	[n = 348]	[n = 177]	[n = 32]	[n = 120]	[n = 19]
ORGANIC	0.21	0.31	0.16	0.14	0.19
	(0.40)	(0.46)	(0.37)	(0.35)	(0.40)
PRODUCT CHARACTERISTICS:					
MEAT	0.05	0.05	0.03	0.05	0.02
	(0.21)	(0.22)	(0.16)	(0.22)	(0.14)
LABEL	0.22	0.28	0.17	0.20	0.17
	(0.41)	(0.45)	(0.38)	(0.40)	(0.38)
STAGE1	0.19	0.17	0.14	0.22	0.17
	(0.39)	(0.37)	(0.35)	(0.41)	(0.38)
STAGE2	0.56	0.57	0.70	0.52	0.61
	(0.50)	(0.50)	(0.46)	(0.50)	(0.49)
STAGE3	0.25	0.26	0.16	0.26	0.22
	(0.43)	(0.44)	(0.37)	(0.44)	(0.42)
GERBER	0.61	0.61	0.89	0.53	0.63
	(0.49)	(0.49)	(0.31)	(0.50)	(0.49)
BEECHNUT	0.26	0.17	0.02	0.42	n/a
	(0.44)	(0.37)	(0.14)	(0.49)	
EARTHS_BEST	0.04	0.07	0.04	0.08	0.11
	(0.20)	(0.26)	(0.20)	(0.09)	(0.32)
HEINZ	0.09	0.14	0.03	0.04	0.23
	(0.28)	(0.35)	(0.17)	(0.20)	(0.42)
ORG_BABY	0.004	n/a	0.02	n/a	0.03
	(0.06)		(0.12)		(0.17)
MULTI	0.08	0.02	0.19	0.06	0.32
	(0.27)	(0.14)	(0.39)	(0.24)	(0.47)
STORE CHARACTERISTICS:					
GROCERY	0.83	1.00	n/a	1.00	n/a
	(0.38)				
UPSCALE	0.03	n/a	0.17	n/a	0.13
	(0.16)		(0.38)		(0.34)
ETHNIC	0.03	n/a	0.26	n/a	n/a
	(0.17)		(0.44)		
DISCOUNT	0.05	n/a	0.12	n/a	0.58
	(0.21)		(0.33)		(0.50)
SMALL_GROC	0.02	n/a	0.19	n/a	n/a
	(0.15)		(0.39)		
CONVENIENCE	0.01	n/a	0.07	n/a	0.11
	(0.12)		(0.26)		(0.32)

(continued . . .)

Table 3. Continued

		San Jose		Raleigh	
Variable	All Data	Grocery	Other Stores	Grocery	Other Stores
STORE CHARACTERISTICS (cont'd.):					
OTHER_STORE	0.04	n/a	0.19	n/a	0.31
	(0.25)		(0.39)		(0.47)
SQFT	1.16	1.09	1.04	1.20	1.53
	(0.93)	(0.81)	(0.98)	(0.88)	(1.61)
RALEIGH	0.55	0.00	0.00	1.00	1.00
	(0.50)				
No. of Observations	1,689	563	196	831	99

[a] The number of observations, n, is displayed for select variables in brackets.

square feet, and location where the observation is collected. A linear model is estimated using ordinary least squares (OLS) as follows:

$$(5)\quad PRICE_{jkl} = \alpha + \beta_1(ORGANIC) + \beta_2(MEAT) + \beta_3(LABEL) + \beta_4(STAGE1) + \beta_5(STAGE2) + \beta_m(BRAND_m) + \beta_6(MULTI) + \beta_n(STORE_n) + \beta_7(SQFT) + \beta_8(CITY) + v_{jkl},$$

where $PRICE_{jkl}$ is the price per ounce of the jth jar in city k (i.e., San Jose or Raleigh) in store type l (i.e., grocery stores or all other types), $BRAND_m$ indicates the mth brand of babyfood (e.g., Gerber, Beechnut, etc.), $STORE_n$ indicates the nth store type within all other stores (e.g., upscale market, convenience store, etc.), and v_{jkl} is the random error component.[13] All other variables are as defined in table 2. In this model, the dependent variable is the price per ounce of the observation. The price per ounce, as opposed to price per jar, is used as the dependent variable because jars vary in size according to stage.

The estimation process began with the pooling of the data across cities, venues, and the stage of the babyfood. However, concerns that heterogeneity in these subsamples might preclude such pooling caused us to consider various subsamples separately. For example, unobserved differences between San Jose and Raleigh or changes in preferences for babyfood as the baby ages may result in different coefficient estimates by city and stage, respectively. Therefore, the location where the data were collected (i.e., Raleigh and San Jose), the venue in which the babyfood was sold (i.e., grocery stores and non-grocery stores), and the stage of the babyfood (i.e., stage 1, stage 2, and stage 3) were considered separately. Non-grocery stores consist of upscale markets, ethnic markets (in San Jose only), discount stores (e.g., Target, Wal-Mart), small grocery stores (in San Jose only), and convenience stores (e.g., 7-11).

[13] A log-linear model was also estimated. It is difficult to compare the linear and log-linear models directly because of the differences in the dependent variable. Greene (1993, p. 154) provides an analog to the R^2 measure that can be used to compare the two models. The analog R^2 was calculated as follows: $R^2 = 1 - (\Sigma e_i^2/\Sigma(y_i - \bar{y})^2)$, where e_i denotes the error terms, y_i is the dependent variable, and $\bar{y}$ is the mean of the dependent variable. The log-linear model performs slightly better in the San Jose models; however, the significance of the results does not differ between the two models. The linear results were selected for presentation here.

Table 4. Results of Tests for Pooling the Data

Null Hypothesis	Test Statistic	Degrees of Freedom[a]	Critical Value	Result
RALEIGH = SAN JOSE	7.24	15, 1,655	1.67	Reject Null
GROCERY = NON-GROCERY	2.70	9, 1,661	1.88	Reject Null
RALEIGH_GROCERY = RALEIGH_NON-GROCERY = SAN JOSE_GROCERY = SAN JOSE_NON-GROCERY	6.96	34, 1,636	1.46	Reject Null
STAGE1 = STAGE2 = STAGE3	98.67	29, 1,641	1.46	Reject Null

Notes: The null hypothesis is that the data for each subsample arise from the same distribution (i.e., the coefficients are the same in each subsample). An F-test is used to test the null hypothesis. The test is distributed as a ratio of chi-squares, with J degrees of freedom in the numerator and $n-K$ degrees of freedom in the denominator, where J is the number of restrictions in the pooled model, n is the sample size, and K is the number of free parameters in the unrestricted (i.e., disaggregated) models (Greene, 1993, p. 206).
[a] The first value represents the numerator degrees of freedom in the F-test, and the second value represents the denominator degrees of freedom.

Table 5. Results of Tests for Heteroskedasticity

Model	Test Statistic	Degrees of Freedom	Critical Value	Result
RALEIGH	729.89	15	25.00	Reject Null
SAN JOSE	767.43	17	27.59	Reject Null
GROCERY	1,035.77	10	18.31	Reject Null
NON-GROCERY	350.80	16	26.30	Reject Null
RALEIGH_GROCERY	713.11	10	18.31	Reject Null
RALEIGH_NON-GROCERY	150.07	13	22.36	Reject Null
SAN JOSE_GROCERY	560.30	10	18.31	Reject Null
SAN JOSE_NON-GROCERY	234.67	16	26.30	Reject Null
STAGE1	411.53	15	25.00	Reject Null
STAGE2	806.83	16	26.30	Reject Null
STAGE3	171.27	14	23.69	Reject Null

Notes: The null hypothesis in each model is homoskedasticity in the error term. A Breusch-Pagan Lagrange multiplier test is used to test the null hypothesis. The test is distributed as chi-squared with K degrees of freedom, where K is the number of parameters in the model (Greene, 1993, p. 395).

Table 4 shows the results of the F-tests for pooling the data across these various subsamples. The null hypothesis is that the data could be pooled across the particular subsample. For example, in the test according to city, the null hypothesis is that the Raleigh and San Jose data arise from the same distribution. As shown in table 4, the null hypothesis is rejected for each of the tests considered. Hence, the results are reported by location and venue, as well as by stage. The data are not robust enough to report further levels of disaggregation, such as location and venue by stage.

In order to address any remaining heteroskedasticity, a Breusch-Pagan Lagrange multiplier test is used to test the null hypothesis of homoskedastic errors. As observed from table 5, the null hypothesis is rejected for each of the models. Hence, all results are reported using Huber-White consistent standard errors.

Table 6 reports the results of four models according to the city and venue in which the observations were collected. Each of the models performs well, with overall adjusted R^2

Table 6. Estimation Results Using Ordinary Least Squares (dependent variable = *Price per Ounce*)

	San Jose		Raleigh	
Variable	Grocery	Other Stores	Grocery	Other Stores
Intercept	0.133***	0.127***	0.103***	0.030***
	(0.003)	(0.008)	(0.001)	(0.009)
Organic Variable:				
ORGANIC	0.026***	0.038***	0.033***	0.030***
	(0.004)	(0.009)	(0.002)	(0.004)
Product Characteristics:				
MEAT	0.078***	0.054***	0.095***	0.078***
	(0.008)	(0.005)	(0.008)	(0.009)
LABEL	0.015***	-0.002	-0.0001	0.008**
	(0.004)	(0.004)	(0.003)	(0.004)
STAGE1	0.019***	0.065***	0.057***	0.070***
	(0.005)	(0.009)	(0.002)	(0.004)
STAGE2	-0.003	0.0096**	0.019***	0.004
	(0.003)	(0.005)	(0.002)	(0.003)
GERBER	0.007**	0.014*	0.014***	0.094***
	(0.003)	(0.007)	(0.002)	(0.009)
HEINZ	-0.005	-0.023**	-0.003	0.079***
	(0.003)	(0.011)	(0.003)	(0.009)
EARTHS_BEST	0.022***	0.012	0.006	0.024***
	(0.005)	(0.018)	(0.008)	(0.003)
ORG_BABY	n/a	0.014	n/a	n/a
		(0.014)		
MULTI	0.011***	-0.008	-0.025***	0.005**
	(0.003)	(0.005)	(0.004)	(0.002)
Store Characteristics:				
UPSCALE	n/a	0.002	n/a	0.087***
		(0.008)		(0.010)
ETHNIC	n/a	-0.011*	n/a	n/a
		(0.006)		
DISCOUNT	n/a	-0.002	n/a	-0.004
		(0.003)		(0.003)
SMALL_GROC	n/a	0.036***	n/a	n/a
		(0.008)		
CONVENIENCE	n/a	0.060***	n/a	0.098***
		(0.007)		(0.010)
SQFT	-0.004***	-0.002	-0.002**	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Adjusted R^2	0.52	0.64	0.71	0.91
No. of observations	563	196	831	99

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are Huber-White consistent standard errors.

values ranging from 0.52 to 0.91. Among the product characteristics, the price of meat observations (i.e., jars with single meat ingredients, such as turkey or beef) is found to be consistently higher than other jars, ranging from 5¢ to 10¢ per ounce. The price of stage 1 babyfood is also consistently higher—from 2¢ to 7¢ per ounce—than stage 3 jars (the omitted category). Stage 2 jars are only priced significantly higher in non-grocery stores in San Jose and grocery stores in Raleigh, with a range of only 1¢ to 2¢ per ounce. In general, stage 1 jars are 2.5 ounces, stage 2 jars are 4 ounces, and stage 3 jars are 6 ounces. Therefore, these results translate into prices which are 5¢ to 18¢ per jar higher for stage 1, and 4¢ to 8¢ per jar higher for stage 2. Stage 3 foods are likely to have the most substitutes (i.e., table food).

Other characteristics were also found to be significant factors in determining price. Relative to Beechnut (the omitted category), Gerber prices are consistently higher, ranging from 1¢ to 10¢ more than Beechnut. Heinz jars are priced fairly inconsistently across the samples. In San Jose non-grocery stores, Heinz jars are 2¢ *less* per ounce, while in Raleigh non-grocery stores, Heinz jars are 8¢ *more* per ounce. These results likely reflect regional differences in the products bought and sold.

Jars sold in multi-packs are also priced differently depending on the venue and location. In San Jose, multi-pack jars sold in grocery stores are approximately 1¢ *more* per ounce than single jars, whereas multi-pack jars sold in grocery stores in Raleigh are almost 3¢ *less* per ounce than single jars. However, multi-pack jars sold in non-grocery stores in Raleigh were priced higher than single jars. These results are contrary to the expectation that multi-pack jars would be consistently priced lower than single jars to reflect volume discounts.

To account for the venue in which the babyfood is sold, dummy variables are used for store type (e.g., ethnic grocery store, upscale grocery store, etc.) in the models focusing on stores other than standard grocery stores. Features of the store types may result in variation in prices. For example, upscale grocery stores tend to have wider aisles, fewer items of each product, and elaborate displays as compared to convenience stores. The "other" store type (representing uncategorized stores, such as drug stores and supercenters) is the omitted category. Results show prices are higher in small grocery stores and convenience markets, as expected, given that these venues tend to have fewer varieties, and likely do not enjoy economies of scale. Prices are also higher in upscale markets in Raleigh, reflecting the cost of more elaborate displays and other luxury features of such venues. Prices are lower in ethnic markets in San Jose, where these types of markets tend to be large stores catering to a particular ethnic population, perhaps affording them the economies of scale needed to offer more competitive prices.

Turning to the variable of ultimate interest, *ORGANIC*, the price of organic babyfood is found to be significantly higher in all venues and locations, ranging from 2.6¢ per ounce in San Jose grocery stores to 3.8¢ per ounce in San Jose non-grocery stores. In Raleigh, the price is about 3¢ per ounce higher in both types of stores. These values translate into a 10¢ to 15¢ per jar price differential between organic and conventional babyfood, assuming an average jar size of 4 ounces (the size of stage 2 jars).

Because of possible differences in consumer preferences according to the age of the baby, the model was also estimated by stage of babyfood. Again, as reported in table 4, the test for pooling shows data on the stages of babyfood are not drawn from the same distribution. Tests for heteroskedasticity were also conducted, with the results reported in table 5. Table 5 shows the null hypothesis of homoskedasticity can be rejected in each model. Hence, the results are reported by stage and corrected for heteroskedasticity using a Huber-White consistent variance-covariance matrix.

Table 7 reports the estimation results by stage. In the stage 1 model, the organic premium is not significant. It could be the case that at the age when babies are

Table 7. Estimation Results by Stage Using Ordinary Least Squares (dependent variable = *Price per Ounce*)

	Model		
Variable	Stage 1	Stage 2	Stage 3
Intercept	0.153***	0.139***	0.114***
	(0.007)	(0.003)	(0.003)
Organic Variable:			
ORGANIC	-0.043	0.031***	0.104***
	(0.027)	(0.002)	(0.003)
Product Characteristics:			
MEAT	0.156***	0.055***	n/a
	(0.008)	(0.002)	
LABEL	-0.184	0.002	0.004*
	(0.026)	(0.002)	(0.003)
GERBER	0.056***	0.009***	0.005***
	(0.003)	(0.002)	(0.001)
HEINZ	0.021***	-0.008***	-0.002***
	(0.006)	(0.002)	(0.001)
EARTHS_BEST	0.115**	0.015***	-0.078***
	(0.028)	(0.002)	(0.006)
ORG_BABY	n/a	-0.002	n/a
		(0.008)	
MULTI	-0.016***	-0.002	0.008***
	(0.004)	(0.002)	(0.003)
Store Characteristics:			
GROCERY	-0.011**	-0.005*	-0.001
	(0.006)	(0.003)	(0.003)
UPSCALE	0.007	0.007*	0.022***
	(0.007)	(0.004)	(0.004)
ETHNIC	0.004	-0.007**	-0.001
	(0.010)	(0.004)	(0.003)
DISCOUNT	0.002	-0.009**	0.004**
	(0.006)	(0.003)	(0.002)
SMALL_GROC	0.068	0.037***	0.046***
	(0.057)	(0.005)	(0.003)
CONVENIENCE	0.149***	0.068***	0.050***
	(0.006)	(0.005)	(0.006)
RALEIGH	-0.002	-0.007***	-0.007***
	(0.003)	(0.001)	(0.006)
SQFT	-0.003	-0.003***	-0.0001
	(0.003)	(0.001)	(0.0003)
Adjusted R^2	0.86	0.73	0.97
No. of observations	320	949	420

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses are Huber-White consistent standard errors.

consuming stage 1 foods there are a number of substitutes, including breast milk, formula, and cereals—none of which are represented in this model. The availability of these substitute goods may result in a negligible organic premium, if any, for stage 1 foods.

The organic premium for stages 2 and 3 is 3¢ and 10¢ per ounce, respectively. During stage 2, babyfood is likely to comprise a larger proportion of the baby's diet than in stage 1. While the stage 2 baby's diet may be supplemented by formula and/or breast milk, the child will consume an increasing amount of babyfood. The lack of substitutes may make demand for stage 2 babyfoods more inelastic, thereby driving the premium higher. This argument, however, does not extend easily to stage 3, where a multitude of substitute foods exist—including most table foods.

Finally, because Gerber is the only brand available in both conventional and organic varieties, the model was estimated using only Gerber observations (not reported here). The estimated premium using the Gerber observations is similar. The premium for Gerber organic babyfood (i.e., the Tender Harvest label) is 3¢ per ounce. This is not necessarily surprising, given that Gerber organic observations represent 79% of the total organic observations. While it is not clear if Gerber can drive price above marginal cost, it does seem reasonable to assume the company has significant market power. Gerber is sold in over 90% of supermarkets in the United States, and very often Heinz and Beechnut pay slotting fees to obtain desired shelf space while Gerber does not pay such fees (U.S. Court of Appeals, 2001). Nevertheless, the fact that the magnitude of the price premium is similar to the premium in the other models provides some comfort.

As discussed earlier, this premium represents both individual willingness to pay for the organic characteristic, as well as the higher marginal production costs which may be associated with organic babyfood. Organic babyfood is likely more costly to produce than conventional babyfood; however, assuming the hedonic framework applies, this premium represents willingness to pay for a characteristic, regardless of the additional production costs. If individuals value organic babyfood at less than the market price, then one would likely see changes in the market, such as producers exiting and fewer lines of organic babyfood available for sale. In fact, just the opposite has occurred. The number of producers of organic babyfood has increased over the last few years, and large, well-known producers, such as Gerber, have joined the ranks of smaller, lesser known companies in offering this product. Although the data offer only a snapshot of the babyfood market, it seems appropriate to interpret the premium as the value the individual is willing to pay for the characteristic.

Of interest is how this organic premium compares to results found in other research. As noted earlier, one study (Harris, 1997) cites a premium of 21¢ per jar for organic babyfood in 1993. This result is based on national scanner data from grocery stores, exclusively. The study did not control for brand of babyfood, but rather aggregated the brand and organic variables. The differences in results between this study and the Harris study are not surprising. Ten years ago there was less competition in the organic babyfood market, costs of production may have been higher in the early 1990s, and brand loyalty may have been more prominent in the Harris results.[14] Earth's Best itself acknowledges its babyfood costs approximately 50% more than conventional babyfood (Earth's Best, 2002). Applying this figure to the price data used here suggests organic babyfood would be almost 28¢ more per jar than conventional babyfood, as opposed to 10¢ to 15¢ more per jar found in this study. It is unclear how Earth's Best arrived at this value. If in fact the Earth's Best analysis is based on older data, then these differences are not surprising.

[14] These assertions were confirmed by personal conversation with Harris on July 14, 2003.

Thompson and Glaser (2001) analyzed scanner data from 1988 to 1999, finding a clear downward trend in the price premium associated with four types of babyfood—dinners, fruits, vegetables, and juices. For example, the price premium associated with dinners in 1988, the first year of their analysis, was 123%. This premium decreased rather steadily to 51% in 1999. Their results for the other three types of babyfood are similar. The findings from our study indicate the price of organic babyfood is 16% to 27% more than its conventional counterparts, all else equal, and may signal a continued decrease in the premium associated with organic babyfood.

Conclusion

This study combines a unique data set with the hedonic framework to estimate how consumers (specifically, parents of babies) value reductions in pesticide exposure, as evidenced through the organic babyfood market. Results indicate individuals are willing to pay 3¢ to 4¢ per ounce more, or 10¢ to 15¢ per jar (approximately 16–27%) for organic babyfood as opposed to conventional varieties. These results provide interesting insights into the prices consumers are paying for organic babyfood. Even though babyfood is only purchased for a short period of time in a child's life (typically ages 3–12 months), some consumers pay a premium to feed their baby organic rather than conventional babyfood.

While this information is interesting in its own right, it could be combined with information, once available, on the perceived cancer risk reduction conferred by organic babyfood and consumption data to estimate a value of reduced lifetime cancer risks associated with childhood dietary exposures, a subject of future research. Such information could be gleaned from interviews with parents regarding risk perceptions and feeding patterns.

Economists use information on health and safety products to infer values of risk reductions. The majority of the risk-reduction studies apply to adult populations (e.g., seat belts) or households (e.g., smoke detectors). Two studies have investigated safety products used exclusively by children. Carlin and Sandy (1991) examined mothers' purchase and use of car seats, and Jenkins, Owens, and Wiggins (2001) examined child (and adult) bicycle helmets use. Because babyfood is targeted to a very specific age group, examining this market presents a unique opportunity to further estimate parental willingness to pay to reduce risks to their children—specifically, willingness to pay to reduce dietary pesticide exposures in infants.

It is important to note that the premium for organic babyfood may not only reflect the value associated with reducing dietary exposure to pesticide residues as suggested here. While reduced pesticide residues is likely the primary reason behind organic purchases, it could be the case that individuals value organic babyfood for other reasons as well. For example, individuals may purchase organic foods because of a preference for environmentally friendly farming practices or a concern for farm worker exposure to pesticides. Using retail data, these competing effects cannot be distinguished, nor can value be apportioned to them. Instead, one can merely assert that the premium reflects a desire to avoid pesticide residues.

Even if we assume negligible competing effects, the organic premium provides limited information regarding willingness to pay for reduced dietary exposures to pesticide residues. Specifically, it provides a lower-bound estimate for purchasers of organic babyfood. By construction, the organic premium estimated here does not account for values for reduced exposures held by non-purchasers. Simply because non-purchasers do not buy organic babyfood does not mean they have no value for the reduced dietary exposure. Rather, this choice may suggest either that their values are lower than the price premium or they are pursuing other means (e.g., making their own babyfoods using organic produce), perhaps at a greater price than the premium, to reduce exposure. Likewise, without information on these other means of reducing dietary exposure, the premium clearly cannot be interpreted as their maximum willingness to pay. Instead, it can only be asserted that the organic premium represents a lower-bound value for this group.

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