Demand for Organic and Conventional Beverage Milk

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Abstract: Sales of organic milk in mainstream supermarkets have grown over the last 8 years, reaching $75.7 million in 1999, as more organic milk processors enter the market and more mainstream supermarkets sell organic products. National-level scanner data for mainstream supermarkets are employed to assess market shares and price premiums, as well as to estimate key demand elasticities. Container size is important in analyzing market shares for organics. Half-gallon containers are the principle organic market with volume shares ranging from 1.6% to 2.8% in 1999. Market shares for quarts and gallons of organic milk are considerably below 0.5%. Price premiums for organic milk averaged 60% of branded prices and 75% of private-label prices during the study period (November 1996-December 1999). Own-price elasticities suggest considerable response to lower organic prices, although the magnitude of this response declines as expenditure shares increase in later months. Cross-price elasticities indicate that organic and branded milks are usually substitutes but with considerable asymmetry in responses; branded prices affect organic purchases much more than the converse. Expenditure elasticities for organic milk imply that as milk expenditures decline, quantities purchased of organic milk will increase. Jointly, the elasticities suggest considerable response to changing retail prices.

Keywords: organic foods, beverage milk, almost ideal demand system.

The availability of organic foods expanded in the 1990's, partially spurred by the growth of natural-product supermarkets such as Whole Foods and Wild Oats. Mainstream supermarkets also introduced or increased organic product lines in response to retail competition and consumer demand. It is no longer unusual for large-scale supermarkets in metropolitan areas to carry fresh and processed organic products.[3]

Industry sources have estimated that sales of organic products in natural-product stores, which include health food stores and natural-product supermarkets, grew from $847 million in 1991 to $1.95 billion in 1996 (Arnold, Scott). The *Natural Food Merchandiser* and Nutrition Business International surveyed managers of natural-product stores and report that sales of all organic products totaled $3.28 billion in 1998 and $4.0 billion in 1999 (May and *Natural Foods Merchandiser*). Organic foods accounted for a majority of the sales, amounting to $2.6 billion in 1998 and $3.2 billion in 1999. Organic produce was the leading food category in both years, accounting for $708 million in sales in

[3] Organic products are grown and processed using environmentally friendly practices. Organic farming systems rely on ecologically based practices, such as cultural and biological pest management, and virtually exclude the use of synthetic chemicals in crop production and prohibit the use of antibiotics and hormones in livestock production (Greene).

1998 and $833 million in 1999. Sales of organic dairy products in natural-product stores totaled $167 million in 1998 and $171 million in 1999.

In the last few years, SPINS (Spence Information Services), a market research firm, and AC Nielsen have begun tracking sales of selected categories of organic packaged foods (excluding fresh meat, fresh produce, and bulk products) at mainstream supermarkets, natural-product supermarkets, drug stores, and mass merchandise stores. Sales of this subset of organic foods totaled $1.0 billion in 1999, up from $853 million in 1998 (May). Organic non-dairy beverages, such as soy- and rice-based drinks, and organic milk products (milk, half and half, and cream) were the top two categories in 1999, accounting for $138 million and $114 million in sales, respectively. Of the four organic food categories with more than 50% of their sales in mainstream supermarkets in 1999, milk products topped the list at 64.6%, followed by cold cereals (54.3%), non-dairy beverages (55.5%), and cookies and snack bars (52.8%).

In this paper, we examine retail sales of organic and conventional beverage milk, excluding buttermilk and flavored milk, using national-level supermarket scanner data. Descriptive analysis includes comparisons of sales volume, prices, and market shares. Price and expenditure elasticities are estimated using the almost ideal demand system (AIDS).

Previous Studies

Most previous studies of the demand for organic foods have measured attitudes rather than actual purchases. As an indication of such attitudes, these studies often elicit willingness to pay for organic or pesticide-free products relative to conventional counterparts. Moreover, these studies have mainly focused on fresh produce. Only in the last few years have researchers broadened their scope of analysis to include other organic foods. Thompson (1998) recently reviewed this highly disparate group of academic and industry studies.

The lack of readily accessible retail sales data probably accounts for the emphasis in previous studies on self reporting by consumers. Time series of supermarket scanner data long enough to permit econometric analysis do exist for packaged products, but the data are expensive. Data on variable-weight products, such as fresh fruit and vegetables, are limited.[4] Only in the last few years have firms

[4] See Eastman for an explanation of product coding for packaged items and variable-weight fresh produce and the types of scanner data available for each.

begun to collect and sell scanner data on variable-weight products and only for selected metropolitan areas.

Commercial and Supermarket Sales of Beverage Milk

For our analysis of retail milk sales, we utilized two sources of national-level supermarket scanner data for packaged grocery items.[5] Monthly data from AC Nielsen Marketing Research span the period from April 1988 to December 1996. These data were collected from approximately 3,000 supermarkets and represent about 83% of the U.S. retail food market, excluding fresh meat and produce. Data from Information Resources, Inc. (IRI) were available for 13-week periods from January 1993 to December 1999 and 4-week periods roughly from November 1996 to December 1999. These data were collected from 13,000 supermarkets, which either belong to a national supermarket chains or operate independently in one of 64 selected metropolitan markets around the country. Data collected were used by IRI to estimate sales for eight U.S. regions, which were summed to a national total.

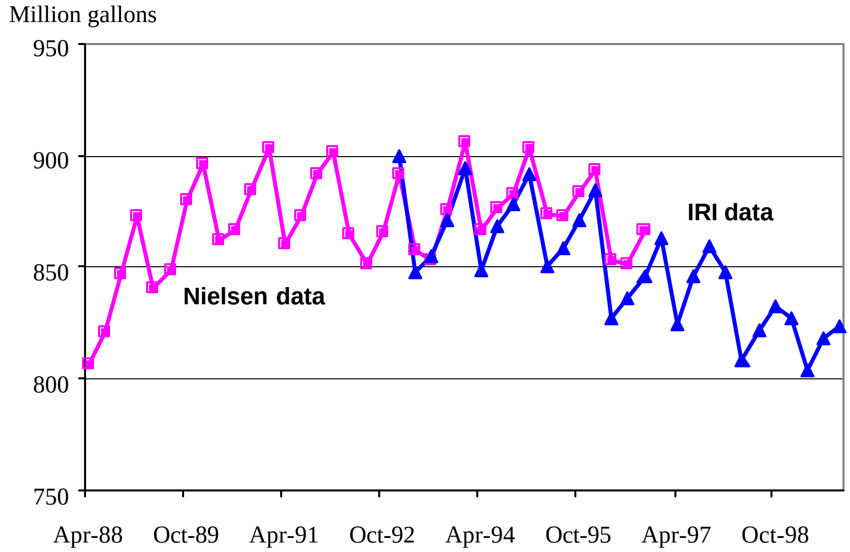
Both Nielsen and IRI use the food industry's definition of a supermarket: a grocery store with dairy, produce, fresh meat, package food, and nonfood departments and annual sales of $2 million or more. Sales from health food stores, food cooperatives, and natural-product supermarkets are not included in the data.

From 1988 to 1998 (the latest year for which data are available), commercial sales of beverage milk averaged 54.9 billion pounds (USDA/ERS). Using a conversion rate of 8.6 pounds per gallon, that equates to 6.4 billion gallons of whole, lowfat, skim, and flavored milk and buttermilk. Sales of whole, lowfat, and skim milk over the period averaged 51.5 billion pounds or 6.0 billion gallons.

This analysis focuses on beverage milk, excluding buttermilk and flavored milk. According to the Nielsen and IRI data, sales of refrigerated beverage milk in mainstream supermarkets ranged roughly between 800 and 900 million gallons per quarter from April 1988 to December 1999 (Figure 1). On an annual basis, sales ranged from a high of 3.5 billion gallons in 1995 (Nielsen) to a low of 3.3 billion gallons in 1999 (IRI) and averaged 3.4 billion gallons for 1989-99. When converted to pounds,

[5] Although scanner data may contain some errors, these data are one the most accurate measures of prices paid at retail (Federal Trade Commission). However, the data do not include price discounts due to couponing and use of frequent purchaser cards. Of course, data errors also may be introduced by scanner data companies in the process of aggregating across supermarket chains and universal product codes.

Figure 1. Quarterly Supermarket Sales of Beverage Milk[1]



[1] Excluding buttermilk and flavored milk.
Sources: AC Nielsen Marketing Research and Information Resources, Inc.

these numbers range from 30.4 billion pounds to 28.1 billion pounds and averaged 29.6 billion. These poundage totals account for an average 58% of commercial sales of beverage milk (whole, lowfat, and skim). On an annual basis, the numbers are all within a few percentage points of the percent of fluid milk provided by handlers regulated under federal milk marketing orders and distributed through supermarkets (Table 1).

To analyze supermarket sales of organic and conventional milk, a list of milk processors and brands from the Nielsen and IRI data were compared to a list of organic food processing firms and the types of organic products they produce (including brand names when available), which was developed by the authors as part of a larger project examining the production and marketing of U.S. organic foods. Processors offering both conventional and organic products were contacted to identify which items were organic. Not all of the known organic milk processors appear in the Nielsen and IRI data, possibly because of their limited size and/or local scope of operation.

Based on the characteristics of the organic milk products in the Nielsen and IRI data, we organized the data into categories based on fat content—whole, 2%, 1%, and nonfat/skim—and

Table 1. Supermarket Milk Sales as a Percent of Commercial Milk Sales[1]

Year	Nielsen data	IRI data	Supermarket share of fluid milk sold in federal milk order markets[2]
1989	57%		54%
1990	59%		
1991	58%		55%
1992	58%		
1993	58%	58%	57%
1994	59%	58%	
1995	59%	58%	57%
1996	57%	56%	
1997		57%	58%
1998		55%	

[1]Million pounds of whole, lowfat, and nonfat/skim milk sold in supermarkets as a percent of commercial sales.

[2]Source: USDA/AMS.

container size—quarts, half gallons, and gallons. The purpose of forming these categories was to compare market share and retail prices of homogeneous products.

Supermarket Sales of Organic Milk

Organic milk brands first appear in the Nielsen data in October 1993 and in the IRI data in the third quarter of 1993. The initial products offered by one firm were 2% and nonfat/skim milk sold in half-gallon containers. Another firm entered the market in June 1994 with whole and nonfat/skim milk in quart containers. By December 1996, the Nielsen data contain eight firms selling organic whole, 2%, 1%, and nonfat/skim milk in quarts and half gallons. Due to the limited number of observations of organic sales in the Nielsen data, the rest of the analysis was confined to the IRI data.

The annual average volumes sold and market shares for the four milk types as reported in the IRI data are presented in Table 2. An additional four firms that process organic milk are in the IRI data, starting in January 1997 (one firm), April 1998 (two firms), and March 1999 (one firm). According to IRI, 46.1 million 16-oz. units[6] of organic milk were sold in mainstream supermarkets in 1997, 68.8 million in 1998, and 106.3 million in 1999. In dollar terms, sales of organic milk totaled $30.1 million in 1997, $46.0 million in 1998, and $75.7 million in 1999.

[6] Both Nielsen and IRI report equivalent volumes in 16-oz. units.

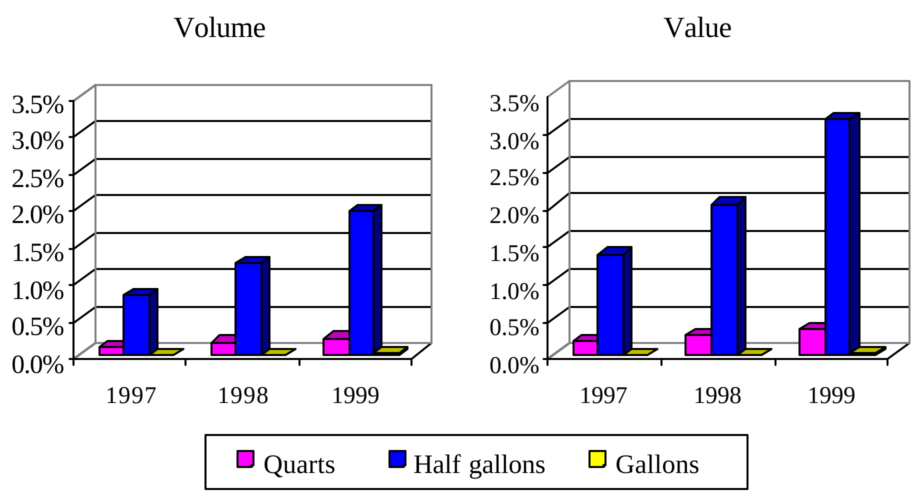
Table 2. Supermarket Milk Volume Sales and Market Shares (16-oz. Units)[1]

	Quarts			
Average Volumes[2]	Whole	2%	1%	Nonfat/Skim
Organic	20,890	28,131	4,288	41,013
Branded	9,837,633	9,059,373	4,384,368	11,335,602
Private Label	8,238,466	6,436,053	3,186,057	6,635,786
Organic Market Share				
1997	0.09%	0.11%	0.02%	0.18%
1998	0.12%	0.21%	0.04%	0.25%
1999	0.16%	0.27%	0.13%	0.29%
	Half Gallons			
Average Volumes[2]	Whole	2%	1%	Nonfat/Skim
Organic	1,235,095	1,364,579	1,059,550	1,674,033
Branded	43,106,260	51,280,523	27,469,705	50,366,294
Private Label	72,458,692	73,453,511	31,963,435	59,303,888
Organic Market Share				
1997	0.64%	0.70%	1.07%	1.00%
1998	1.02%	1.07%	1.60%	1.49%
1999	1.63%	1.60%	2.79%	2.20%
	Gallons			
Average Volumes[2]	Whole	2%	1%	Nonfat/Skim
Organic	16,603	34,425	11,337	26,112
Branded	123,167,202	138,290,331	51,951,035	81,011,652
Private Label	311,707,767	368,001,241	138,500,746	188,040,000
Organic Market Share				
1997	0.000%	0.000%	0.000%	0.000%
1998	0.001%	0.004%	0.000%	0.005%
1999	0.011%	0.018%	0.019%	0.026%

[1] Sales of beverage milk in mainstream supermarkets, excluding buttermilk and flavored milk.
[2] Annual average volumes were calculated over the entire sample period of 41 four-week periods ending from 12/8/96 to 1/2/00; sales in 1996 are included with those for 1997. For organic milks, averages were calculated over the subsample periods when they were available.

Container size is important for assessing market shares of organic milk. In gallon containers, organic milk did not appear in the IRI data until April 1998 for whole, 2%, and nonfat/skim milk, while organic 1% milk did not appear until April 1999. With such recent product introduction in mainstream supermarkets, the share of organic milk in gallon containers is barely detectable. Even though organic milk was available in quart containers for the full sample (the 4 weeks ending 12/8/96 to the 4 weeks ending 1/2/00), the volume share of organic milk sold in quarts was under 0.5%. Organic milk has registered impressive market shares, however, in half-gallon containers, reaching 3.1% on a value basis and 1.9% of volume in 1999 (Figure 2). Sales of all four organic milk types in half gallons have grown substantially but 1% is the category that has garnered the largest market share (Figure 3).

Figure 2. Organic Market Share of Supermarket Milk Sales[1]



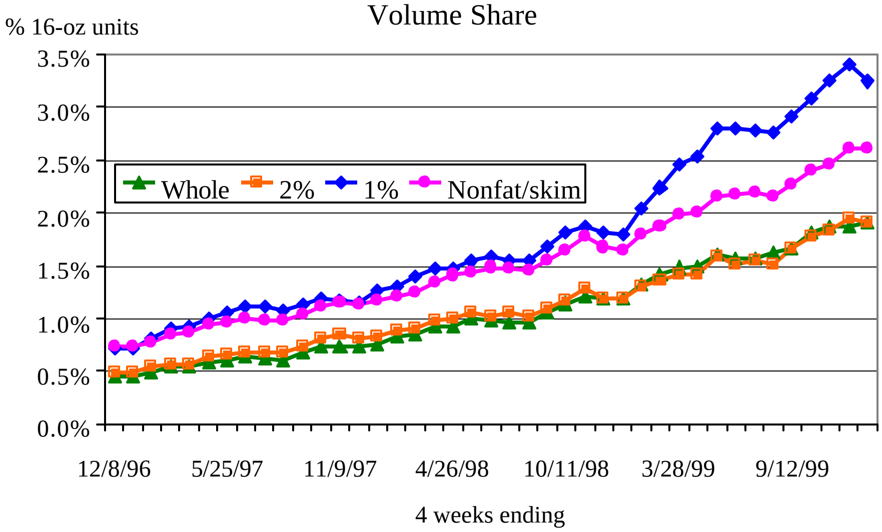
[1]Whole, 2%, 1%, and nonfat/skim milk in quart, half gallon, and gallon containers.
Source: Information Resources, Inc.

The absolute magnitudes of organic milk sold in half gallons also deserve emphasis. Among all four types of milk, average volumes exceed 1 million 16-oz. units. In contrast, the volumes sold in quarts or gallons do not exceed 50,000 16-oz. units. Both market shares and absolute sales volumes suggest that econometric analysis should focus on the half-gallon "market" because quart and gallon volumes of organic milk are inconsequential.

Organic Price Premiums

Average supermarket prices and price premiums for all four types of milk are displayed in Table 3. Some regularities appear in the nominal price figures: organic prices exceed branded prices, and

Figure 3. Organic Market Share of Supermarket Half Gallon Sales[1]



[1]Whole, 2%, 1%, and nonfat/skim milk in half gallon containers.
Source: Information Resources, Inc.

branded prices, in turn, exceed private-label prices for each fat content and container size. Average organic prices also are statistically significantly different from average branded and private-label prices.[7] Another regularity is that 16-oz.-unit prices are lowest for gallons and highest for quarts regardless of fat content or whether the milk is organic, branded, or private label.

Price premiums, however, do not display regular patterns. In quart containers, for example, the organic-private label premium for whole milk is quite large (103%) whereas the organic-branded premium for 1% milk is small (25%). One consistency regarding price premiums does emerge: the range of premiums for organic vs. branded or private label is smallest for half gallons (50% to 72%). The tighter range of price premiums for half gallons is due largely to the fact that organic prices for all fat contents in half gallons fluctuated less than organic prices of quarts or gallons. Coefficients of variation for half-gallon prices were consistently lower than those for quart or gallon prices.

Average price premiums do not indicate how premiums have evolved over the sample period. For most fat-content types in half-gallon containers, organic premiums appear to be declining although

[7] One tailed tests using t-statistics for differences in means of price series indicated that all organic prices were statistically significantly higher than the average prices of either branded or private-label milk.

Table 3. Milk Prices and Price Premiums (Nominal $ /16-oz. Unit)[1]

	Quarts			
Average Prices[2]	Whole	2%	1%	Nonfat/Skim
Organic	0.90	0.82	0.74	0.86
Branded	0.52	0.59	0.59	0.63
Private Label	0.44	0.47	0.49	0.53
Premiums[3]				
Organic vs. Branded	74%	40%	25%	37%
Organic vs. Private Label	103%	73%	52%	61%
Branded vs. Private Label	16%	24%	22%	18%
	Half Gallons			
Average Prices[2]	Whole	2%	1%	Nonfat/Skim
Organic	0.675	0.669	0.674	0.671
Branded	0.43	0.42	0.413	0.45
Private Label	0.39	0.39	0.407	0.40
Premiums[3]				
Organic vs. Branded	58%	60%	63%	50%
Organic vs. Private Label	71%	72%	66%	69%
Branded vs. Private Label	8%	8%	2%	13%
	Gallons			
Average Prices[2]	Whole	2%	1%	Nonfat/Skim
Organic	0.55	0.57	0.66	0.58
Branded	0.35	0.32	0.34	0.325
Private Label	0.32	0.31	0.33	0.321
Premiums[3]				
Organic vs. Branded	58%	76%	96%	78%
Organic vs. Private Label	70%	81%	99%	80%
Branded vs. Private Label	8%	4%	0%	1%

[1] Prices of beverage milk in mainstream supermarkets, excluding buttermilk and flavored milk.
[2] Branded and organic prices are weighted average prices. Private label is reported as a single series. For gallon containers, private label includes both private label and generic. Generic accounts for less than 1% of the generic-private label total.
[3] The branded-private label premium was calculated for the entire sample, whereas the organic premiums were calculated for the subsamples in which organic milk was available.

not all decreases are statistically significant.[8] Perhaps not coincidentally, the number of firms supplying organic milk in half-gallon containers was much larger (7 to 10 firms) than the number of firms supplying organic milk in quart (2 to 7 firms) or gallon containers (2 to 3 firms). The larger number of firms supplying half gallons of organic milk throughout the sample period apparently caused less fluctuation in retail supermarket prices.

The foregoing description reveals some interesting trends concerning organic milk: a small but growing market share, most likely due to more mainstream supermarkets selling organic milk, and sizable price premiums. The trends are similar to those found for organic frozen vegetables in a previous analysis (Glaser and Thompson). The market shares for organic frozen broccoli, green beans, green peas, and sweet corn in 1996 were each under 0.5% of volume and 1.2% of value, and price premiums ranged from 100% to 250% in several years of the 1991-96 study period. Anecdotal evidence from a supermarket chain in Oklahoma indicates price premiums for dairy and frozen foods tend to be higher than those for other organic products, with an overall estimate of premiums averaging between 20% and 30% (Richman). How the trends for organic milk affect price and expenditure elasticities has not been previously analyzed. We now turn to the estimation of these elasticities.

Econometric Estimation and Inference

As is evident from the descriptive statistics for the IRI scanner data, the market for organic milk is almost exclusively in half-gallon containers. Accordingly, demand systems were estimated considering the half-gallon market as separable from that of other container sizes. Within the half-gallon category, there are three types of milk—branded, private label, and organic—as well as four fat contents—whole, 2%, 1%, and nonfat/skim. In principle, a demand system with 12 “goods” could be estimated considering each combination of milk type and fat content as a single good. If all 12 combinations of types and fat contents were included in single system, a number of cross-price relationships would be estimated that are likely irrelevant. The cross-price relationship between organic whole milk and private-label nonfat/skim milk, for example, is likely non-existent. Plausibly, there may be potential substitution between similar fat contents, such as between whole and 2% or nonfat/skim and 1%, but

[8] Due to space limitations, graphs of price premiums and detailed regression results of time trends cannot be reproduced here. Price premiums were regressed on a time trend resulting in statistically significant coefficients on the time trend only for organic vs. branded premiums in 2% and nonfat/skim milk.

substitution between nonfat/skim and whole seems unlikely, and substitution between private-label nonfat/skim and whole organic milk seems even less likely.[9]

As a starting point, we considered each type of milk of a given fat content as constituting a single demand system of three goods. For example, branded, private-label, and organic whole milks were grouped into a demand system. This grouping resulted in four demand systems, one for each fat content.

The nonlinear almost-ideal demand system, AIDS, (Deaton and Muellbauer) was used as the specific parametric specification of the demand systems. Typical share equations in the AIDS model are

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln(x_t / P_t) \qquad t = 1, 2, ..., T$$

where w_{it} denotes the expenditure share of the i^{th} type of milk in the t^{th} time period ($w_{it} \equiv p_{it}q_{it}/x_t$), p_{jt} and q_{jt} represent the price and quantity of the j^{th} type of milk, x_t represents total expenditure on milk ($x_t \equiv \Sigma_j p_{it} q_{it}$), and P_t is defined as $\ln P_t = \alpha_0 + \Sigma_k \gamma_{kj} \ln p_{kt} + \Sigma_k \Sigma_j \gamma_{kj} \ln p_{kt} \ln p_{jt}$.

There are several specification issues worth mentioning. Because beverage milk is perishable, prices could be conditioned by quantities. Formula and pool pricing,[10] however, suggest that prices at retail may be predetermined so that an ordinary, rather than an inverse, demand system would be appropriate. Seasonality of retail sales was suspected but was not uniform across types of milk and not always clearly evident. Parameter estimates appeared stable without adding seasonal dummies or other seasonal variables. A linear trend was added to the organic share equation because organic shares have grown sizably.

The standard parametric conditions for adding up, homogeneity, and symmetry were imposed in estimating the nonlinear AIDS. Hypothesis tests for each of the parametric restrictions are not reported because the unrestricted nonlinear AIDS models experienced convergence problems. After imposing either homogeneity or symmetry, however, all models converged without problems. Negativity at the sample means was verified by checking the eigenvalues of $k_{ij} = p_i p_j s_{ij}/x$ (Deaton and Muellbauer).

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[9] Gould has reported that many households consume more than one fat content of milk, presumably because different family members prefer different fat contents in their milk. Simultaneous consumption of various fat contents of does not indicate, however, that households find these different fat-content milks to be complements or substitutes.

Hypothesis tests for non-normal residuals and system-wide serial correlation fail to indicate rejections of the null hypotheses.

Uncompensated price and expenditure elasticities are presented in Table 4. Standard errors were calculated using the method proposed by Krinsky and Robb. Nearly all elasticities display small standard errors with the exception of some price elasticities for organic whole milk. Some patterns in the own-price elasticity estimates are evident: private-label milk is usually the most price inelastic, branded milk is slightly more elastic, and organic milk is highly price elastic. The relative magnitudes of own-price elasticities seem reasonable. Consumers who habitually buy private label because its unit price is usually the lowest will respond less to small changes in its price. Branded milk is also own-price inelastic, with the exception of 2% milk, but slightly less so than the corresponding private-label milk. That organic milk volume is highly responsive to own-price changes is perhaps not surprising given the substantial price premiums noted over the sample period.

Some recent empirical evidence suggests that the perishable products in supermarkets are placed on advertised sales more often than non-perishable items (Hoskin and Reiffen). It is also well known that milk is often reduced in price as a loss leader to entice more customers into a supermarket (Green and Park). These advertised sales could very likely account for the elastic response to own-price changes. Given the level of temporal and spatial aggregation in our data, we are not able to observe consumer responses to advertised sales. Yet the own-price elasticities do suggest that, in the aggregate, consumers usually respond more to price reductions in types of milk which have higher average prices.

The magnitudes of own-price elasticities estimated here for branded and private-label milk sold in half gallons do not differ markedly from those of other studies, even though the present study is apparently the first to estimate elasticities by container size. Using household panel data for 1991-92, Gould estimated own-price elasticities ranging from -0.512 for 2% milk to -0.803 for whole milk.

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[10] Milk prices are regulated by federal and state milk marketing programs that involve these types of price-setting mechanisms.

Table 4. Uncompensated Elasticities Evaluated at Sample Means

	Whole Milk				2% Milk		
	Branded	Private Label	Organic		Branded	Private Label	Organic
Branded	-0.726 ***	-0.598 ***	0.162	Branded	-1.302 ***	-0.154 ***	0.318 ***
	(0.211)	(0.042)	(0.100)		(0.213)	(0.049)	(0.051)
Private Label	-0.282 ***	-0.659 ***	-0.062	Private Label	-0.041 *	-0.832 ***	-0.102 ***
	(0.017)	(0.072)	(0.050)		(0.025)	(0.150)	(0.035)
Organic	8.152 **	1.215	-3.637	Organic	13.520 ***	-3.264 ***	-7.374 ***
	(3.680)	(0.905)	(2.380)		(1.674)	(0.748)	(1.158)
Expenditure	1.162 ***	1.003 ***	-5.730 ***	Expenditure	1.138 ***	0.975 ***	-2.836 **
	(0.067)	(0.046)	(1.459)		(0.085)	(0.061)	(1.283)
	1% Milk				**Nonfat/Skim Milk**		
	Branded	Private Label	Organic		Branded	Private Label	Organic
Branded	-0.884 ***	0.655 ***	-0.379 ***	Branded	-0.808 ***	-0.297 ***	0.182 ***
	(0.159)	(0.065)	(0.134)		(0.124)	(0.038)	(0.035)
Private Label	-0.033	-2.106 ***	0.543 ***	Private Label	-0.366 ***	-0.728 ***	-0.080 ***
	(0.051)	(0.385)	(0.137)		(0.027)	(0.128)	(0.030)
Organic	-5.546 *	23.957 ***	-9.733 ***	Organic	7.106 ***	-0.632 ***	-3.668 ***
	(3.065)	(0.681)	(1.983)		(0.935)	(0.245)	(0.478)
Expenditure	0.609 ***	1.596 ***	-8.678 ***	Expenditure	0.922 ***	1.173 ***	-2.807 ***
	(0.123)	(0.113)	(1.288)		(0.071)	(0.060)	(0.461)

Note: Standard errors of elasticities are in parentheses. Also, *, **, and *** denote elasticities that are statistically significantly different from zero at 10%, 5%, and 1% level, respectively.

Other studies have found own-price elasticities that exceed unity in absolute value: -1.89 for skim milk (Reynolds); -1.66 for whole milk, -1.33 for 2% milk, and -1.82 for skim milk (Boehm and Babb).

Although the own-price elasticities of organic milk appear quite large at their sample means, their absolute values were declining rapidly over the sample period[11] (Figure 4a). By contrast, own-price elasticities for branded and private-label milk were quite stable throughout the sample period (Figures 4b and 4c). The clear tendency is that as organic milk of various fat content attains larger market shares, consumer response to own-price changes diminishes. Glaser and Thompson found similar results for changes in the own-price elasticities of organic frozen vegetables as market shares increase.

The majority of the cross-price elasticities are statistically different from zero. Only in the case of whole milk are half of the cross-price elasticities not statistically significant. Cross-price elasticities between branded and private-label milk are generally small—from -0.033 to -0.598—indicating some complementarity between the two types of milk for all fat contents but one. For 1% milk, the branded/private-label cross-price elasticity is positive indicating substitution between the two. The finding of complementarity between branded and private-label milk sold in half gallons appears counterintuitive but may have a reasonable explanation. Green and Park note that when milk is placed on advertised special, milk of all fat contents is usually placed on sale. If similar simultaneous price movements occur for branded and private-label milks, then increases in quantities of branded milk would be observed contemporaneously with decreases in private-label prices. In such a situation, a complementary cross-price relationship might be plausible.

Cross-price relationships indicate that organic and branded milks are substitutes in every fat content category except for 1% milk. Substitution between the two most expensive milk types, organic and branded, appears plausible because organic price premiums tend to be smaller between the two than the premiums between organic and private-label milks. From an individual shopper's perspective,

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[11] Using weekly scanner data for individual supermarkets Green and Park estimated own-price elasticities ranging from –0.329 for 1% milk to –2.714 for 2% milk. Although the nature of their data is different than the IRI data used here, estimation of own-price elasticities larger than -2 in absolute value does have precedent.

Figure 4a. Organic Own-Price Elasticities

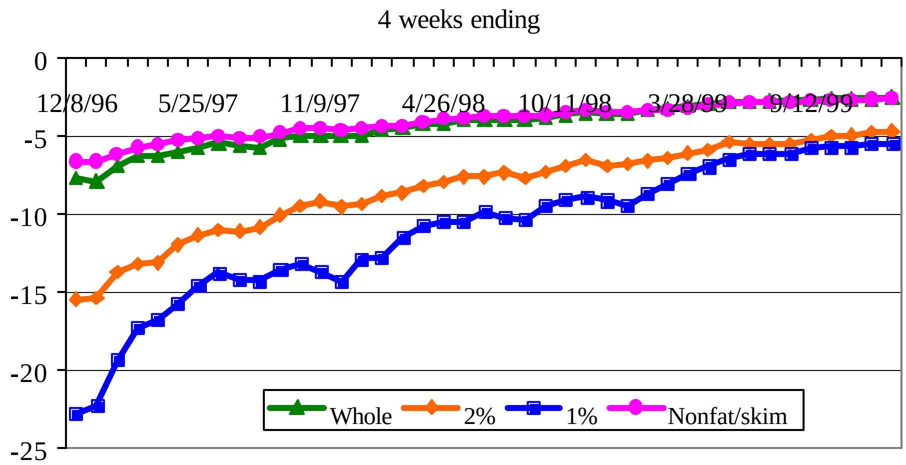


Figure 4b. Branded Own-Price Elasticities

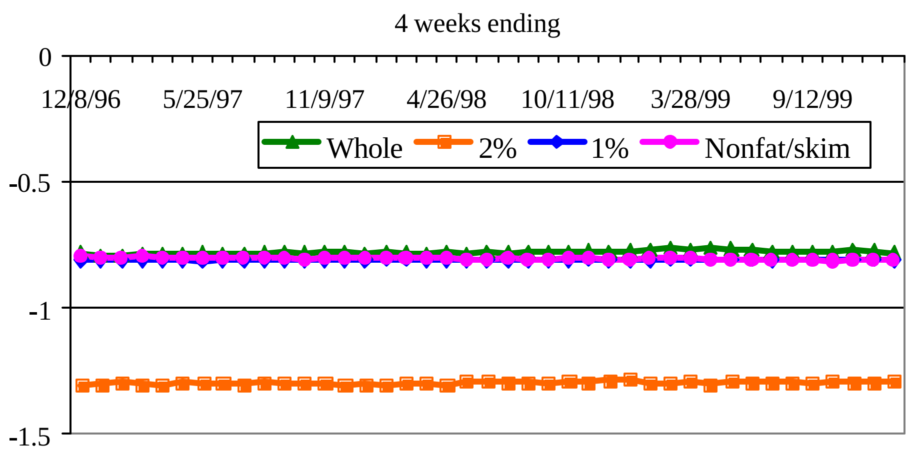
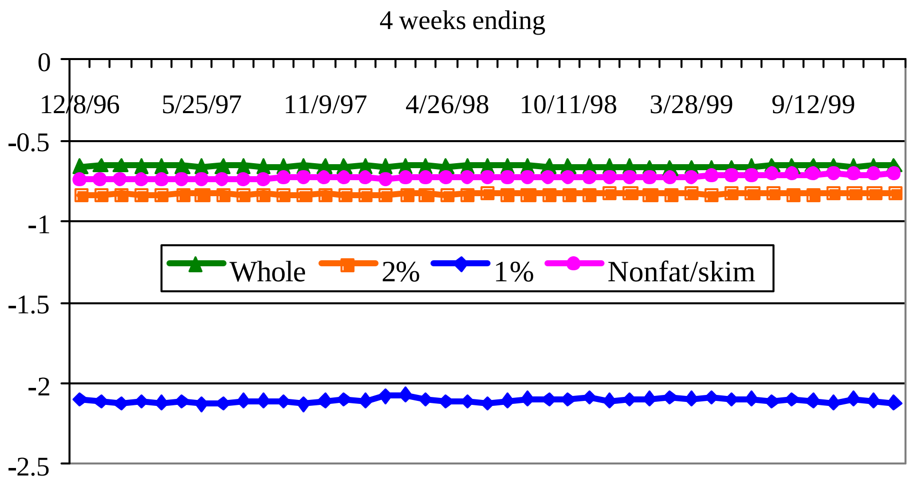


Figure 4c. Private-Label Own-Price Elasticities



willingness to pay for higher priced branded milk suggests that the shopper will be willing to consider paying even higher prices for organic milk. In the 1% milk category, the substitution relationship indicated between organic and private-label rather than branded is plausible because the average price premium of branded over private label is only 2% (see Table 3). Put differently, from a price perspective, branded and private-label 1% milks are virtually indistinguishable.

A notable pattern in the organic cross-price elasticities is that changes in organic milk prices elicit small changes in branded or private-label milk purchases whereas changes in private-label or branded prices elicit very large changes in organic purchases. This asymmetry in cross-price response is due in part to the structure of cross-price elasticities in the AIDS model. Suppressing time subscripts, a typical cross-price elasticity is calculated as $e_{ij} = \frac{\gamma_{ij}}{w_i} - \left(\frac{\beta_i}{w_i}\right) w_j$ where the ratio of the j^{th} to i^{th} expenditure share weights the second term. When expenditure shares differ greatly, as they do in the case of organic versus other types of milk, if the ratio of expenditure shares is small in calculating e_{ij}, the reciprocal of the ratio will be large in the calculation of e_{ji}. From an intuitive standpoint, if the price level of organic milk is very high to begin with, changes in those high prices may have little effect on purchases of private-label or branded milk. Conversely, if branded or private-label prices are relatively low compared to organic prices, changing those low prices may affect organic purchases more noticeably.

All expenditure elasticities are statistically significant and most expenditure elasticities for branded and private-label milk hover around unity. Expenditure elasticities for organic milk, however, are quite large negative numbers. Part of the large negative values are an artifact of the expenditure elasticities in the AIDS model which are calculated as $\eta_{it} = 1 + \frac{\beta_i}{w_{it}}$. Other things equal, a very small expenditure share will result in a large second term in the elasticity calculation. When the β_i estimate is negative, as is the case for organic milk, a small expenditure share results in a large negative expenditure elasticity. As expenditure shares grow temporally, the absolute magnitude of the expenditure elasticity declines, and for large enough expenditure shares, expenditure elasticities can become positive—as they do for private-label and branded milk. Indeed, this kind of temporal change in expenditure elasticities for organic half gallons is evident in the current sample (Table 5). A less technical, more heuristic explanation is that as milk expenditures decline, quantities consumed of organic milk actually increase.

Over the sample period, expenditures on some types of milk in half gallons have declined in nominal terms.

Table 5. Uncompensated Expenditure Elasticities

	Whole Milk	2% Milk	1% Milk	Nonfat/Skim Milk
Sample Mean	-5.730	-2.836	-8.678	-2.807
Last Period	-2.679	-1.298	-4.105	-1.242

Conclusions

This analysis of national-level supermarket scanner data focused on beverage milk, excluding buttermilk and flavored milk, in quart, half-gallon, and gallon containers. Sales of organic milk in mainstream supermarkets have grown over the last 8 years, reaching 106.3 million 16-oz. units and $75.7 million in 1999.

Container size is important in analyzing supermarket sales of organic milk for two reasons. Unit (16-oz.) prices of all types of milk—whole, 2%, 1% and nonfat/skim—vary significantly by containers size. Unit prices of gallons are less than those of half gallons, and unit prices of half gallons are, in turn, lower than those of quarts. Second, the market for half gallons accounts for the majority of organic milk sales regardless of fat content. More organic milk processors market half gallons than those selling either quarts or gallons. Taken together, these facts suggest that the relevant market for studying the growth of organic milk at retail is the market for half-gallon containers.

Price premiums for organic milk averaged 60% of branded milk prices and 75% of private-label milk prices during the study period (the 4 weeks ending 12/8/96 to the 4 weeks ending 1/2/00). The range of premiums across fat contents and container sizes was smallest for half gallons (50% to 72%) and largest for quarts (25% to 103%). For most fat-content types in half-gallon containers, organic premiums declined during the sample period, although not all decreases were statistically significant.

The nonlinear AIDS specification estimated for each demand system distinguished by fat content yielded statistically significant elasticities in most cases. Of the 45 expenditure, own- and cross-price elasticities, only five were statistically insignificant and four of those five were for whole milk in half gallons. In general, branded milk was own-price inelastic but only slightly less so than private-label milk. Organic milk, by contrast, was highly own-price elastic though these elasticities declined in absolute value over the sample period. These results suggest that either short-lived price promotions or longer term reductions in retail prices could stimulate retail sales of organic milk considerably.

Cross-price elasticities usually indicate that organic and branded milks are substitutes. Not surprisingly, these two types of milk tend to be the two higher priced types of milk, with private-label milk as the lowest priced of the three types. Asymmetry in substitution responses is evident wherein changes in organic milk prices have little effect on branded purchases but changes in branded prices have very pronounced effects on organic purchases. This asymmetry might suggest that some portion of consumers purchasing organic milk could be enticed to switch to branded milk when branded products are placed on sale. Of course, only estimates based on store-level data or household panel data could verify this type of consumer behavior.

The expenditure elasticities estimated in the AIDS model were all statistically significant and the elasticities for branded and private-label milk tended to center around unity. Expenditure elasticities for organic milk, however, were all very large and negative though their absolute values declined over the sample period as market shares and expenditures shares of organic milk increased. These large negative values appear implausible but may make sense given the peculiarities of the beverage milk market. As per capita consumption of beverage milk declines, nominal expenditures on some types of milk decrease. In the context of declining expenditures, the organic expenditure elasticities indicate that organic milk purchases will increase as milk expenditures decline.

From an econometric standpoint, the performance of the AIDS model appears reasonable and the model produces statistically precise elasticity estimates given our sample data. Yet the magnitudes of some of the estimated elasticities for organic milk are large in absolute value when compared to some previous estimates of comparable elasticities. The large values occur because of the relative magnitudes of expenditure shares in our system are quite different: private-label and branded shares of 45% or more contrasted with organic shares of less than 5%. When a very small expenditure share appears in the denominator of formulas used to calculate the elasticities from the AIDS model, elasticity estimates at that sample point are large. This sensitivity of elasticity estimates to the relative magnitudes of expenditure shares should be recognized when the AIDS model is used for analyzing newly introduced products for which market and expenditure shares are quite small at some sample points.

Our analysis has several limitations. We only have access to national-level scanner data but beverage milk tends to be supplied regionally or locally. Companies such as Horizon Organic Dairy are billed as national companies but they do not sell products in every state. Nor do the largest private-label retail firms like Kroger have stores in every state. Hence, our analysis of the "national" market entails aggregating prices and quantities of local and regional dairies, which do not compete directly in each local market. Accordingly, our elasticity estimates should not be taken as reflective of individual geographic markets in which only a subset of firms compete.

A second limitation is that our scanner data did not include natural-product supermarkets, which are an important sales outlet for organic dairy products. Accordingly, our findings may not extend to these markets in which retail pricing and consumer behavior may differ from mainstream supermarkets.

Lastly, we do not have ready access to scanner data for other beverages. Our maintained hypothesis that the market for milk sold in half gallons is separable from other food and beverage categories permits us to ignore how the relative prices of other beverages would affect milk consumption. But with the proliferation and growing popularity of soy-based drinks, potential substitution relationships between milk and other beverages could be important. Our analysis cannot address these potentially important relationships.

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