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U.S. Consumer Demand for Organic Fluid Milk by Fat Content

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Abstract

This study examined consumer demand for organic fluid milk in the current maturing organic market using a nationwide weekly retail scanner data set. An Almost Ideal Demand System in which both organic milk and conventional milk were further decomposed into products with different fat content was estimated. The demand for organic milk was shown to be price elastic. The results also revealed substitutions between organic milk and conventional milk products differing in fat content. The substitution pattern was asymmetric and there was greater movement toward organic milk than back toward conventional milk for the same relative change in price.

Keywords: Demand, organic milk, fat content, elasticity

Introduction

The U.S. organic food industry expanded rapidly during the last several decades. The sales of organic food increased to $26.7 billion in 2010 from $1 billion in 1990, representing 4% of the total food sales. The annual growth rate of organic food sales from 2000 to 2008 ranged around 15 to 21%. In spite of the economic downturn, organic food sales maintained a relatively strong increasing rate of growth of 7.7% in 2010 compared to the total food growth of 0.6%. Organic dairy is regarded as a "gateway" to organic consumption, as one of the first organic products experienced by consumers. It constitutes the second largest segment of the organic food market, with its sales accounting for 14.6% of organic food sales in 2010. Organic dairy accounted for nearly 6% of all U.S. sales of dairy products in 2010 (Organic Trade Association 2011).

Consumer demand for organic milk is driven by various reasons including health and environment benefits and concerns over animal welfare (Liu et al. 2011). In early years of the rapid expansion of the organic milk market, supply could not keep pace with the fast increasing demand. In recent years, however, the growth of demand for organic milk slowed down because of the economic recession, while supply continued to expand. Supply of organic milk exceeded demand for the first time in 2007 (Westervelt 2007). In 2009, U.S. organic milk sales actually experienced a 3% decline from 2008 sales, losing $45 million (Bast 2010).

Such changes in the organic dairy market call for a timely analysis of consumer demand for organic fluid milk. Farmers continue to pursue better payoffs through producing organic milk, but their economic gains depend on consumer demand and the premium associated with organic milk. Understanding consumer demand for organic milk can provide insight into the future growth of the industry and can help make effective production and marketing strategies to promote sustainable growth of the industry.

Literature

Growth of the organic fluid milk market prompted researchers' interests on examining consumer valuation on organic milk. Some of the previous studies used consumer surveys and experiments to examine consumers' stated preference over organic milk and found that consumers were willing to pay a premium for the organic attribute and demand for organic milk was own-price elastic (Bernard and Bernard 2009; Brooks and Lusk 2010). However, this type of studies provided only a snapshot of consumer preferences towards organic milk.

A few studies attempted to study consumers' revealed preferences using retail data (Glaser and Thompson 2000; Dhar and Foltz 2005; Alviola and Capps 2010; Chang et al. 2011). The results on response of organic milk demand to price were rather diverse, ranging from -1.37 to -9.73 (Glaser and Thompson 2000; Dhar and Foltz 2005; Alviola and Capps 2010). Chang et al. (2011) found organic demand was inelastic. Demand for organic milk was shown to be more sensitive to price changes than its conventional coun-

terpart (Glaser and Thompson 2000; Dhar and Foltz 2005). Organic and conventional milk were revealed to be substitutes with asymmetric pattern (Glaser and Thompson 2000; Dhar and Foltz 2005; Alviola and Capps 2010).

Past studies using retail data were limited in several ways. First, most of these studies examined the early development stage of the organic milk market by using data before 2005 except for Chang et al. (2011). As the organic milk market matured, consumer demand for organic milk has likely evolved. Studies using data in the early stage of the organic market development may not reflect the demand for organic milk in the current situation. Second, most of these studies focused on a regional rather than national market (Dhar and Foltz 2005; Chang et al. 2011). Dhar and Foltz (2005) used 12-city retail data, while Chang et al. (2011) used data from central Ohio. These results are likely not applicable to the national market. Furthermore, milk products are fundamentally differentiated by fat content, and relationships among products of different fat content should be understood to draw any practical implications. Most of the past studies did not differentiate organic milk by fat content (Dhar and Foltz 2005; Alviola and Capps 2010). Glaser and Thompson (2000) looked into the fat content issue but ran separate systems for each milk fat level. Hence, in this paper, we analyze consumer demand for organic milk differentiated by fat content using a nationwide data set from 2008 to 2010.

Research Methods

The analysis used AC Nielsen's national weekly scanner data from April 2008 to April 2010 (104 observations). Because the majority of organic milk is sold in half gallon (64 ounces) cartons, only the data for 64 ounces milk products were included in the study. Table 1 show the sample average market shares of organic milk and conventional milk by fat content. During the period under study, conventional milk accounted for most of the sales, representing 83.8% of the total fluid milk sales, while the organic milk accounted for the remaining 16.2%. Among various types of conventional milk, the reduced fat milk (2% milk fat) registered the highest share (27.9%) and the low-fat milk (1% milk fat) had the lowest share (13.9%). In contrast skim milk constituted the highest share (5.4%) among organic milk with different fat content probably due to higher health consciousness among organic milk consumers. The low-fat milk had the lowest share (2.8%) among organic milk similar to the conventional.

Over the sample period, organic milk continued to enjoy significant price premium over conventional milk (Table 2). Among organic milk, reduced fat milk averaged the highest price of $3.95 per half gallon and skim milk had the lowest price of $3.61 per half gallon. In contrast, the average price of conventional skim milk was the highest among the prices of all half gallon conventional milk products. The price of the conventional reduced fat milk was the lowest at $2.16 per half gallon.

An Almost Ideal Demand System (AIDS; Deaton and Muellbauer 1980) was specified to examine the demand for organic fluid milk. In the demand system, both organic milk and

conventional milk were further decomposed into products with different fat content to examine possible substitution patterns among milk with various fat contents. Hence, the demand system was specified as follows:

$$W_{it} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \, logP_{jt} + \beta_i \log\left(\frac{X_t}{P_t}\right) + \delta_i T_{it} + \varepsilon_{it} \quad (1)$$

where i, j= {organic skim, organic 1%, organic 2%, organic whole, conventional skim, conventional 1%, conventional 2%, conventional whole}. W_{it} is the share of subcategory i in total milk expenditure in week t and was computed by dividing the sales of subcategory i by the total milk expenditure X_t. T is the time trend and α_i is the intercept. P_{jt} is the weighted price (dollar per half gallon) of subcategory j and calculated as the sales divided by the corresponding quantity. In the estimation, index P_t is a linear approximation based on the Stone index and defined as

$$logP_t = \sum_{j=1}^{n} W_{jt} \, logP_{jt} \quad (2)$$

Model Estimation and Results

The above demand system was first differenced to account for autocorrelation. The homogeneity and symmetry conditions were imposed. The model was estimated by iterative seemingly unrelated regression. The expenditure and price elasticities were calculated based on parameter estimates of the model at the sample mean.

Table 3 presents the estimated expenditure elasticities. All expenditure elasticities are statistically significant at the 1% level. The expenditure elasticities of organic milk with different fat content were lower than those of their conventional counterparts. The magnitudes of the organic expenditure elasticities were all statistically below one at the 1% significance level except for organic skim milk, indicating organic milk was not a luxury item but a necessity for an average consumer during the sample period. This result is consistent with Dhar and Foltz (2005) and some results in Chang et al. (2011). The finding suggests that the demand for organic milk may be driven by factors other than income such as beliefs about health benefits. Among organic milk, skim milk had the largest expenditure elasticity. A 1% increase in the expenditure on milk would lead to a 0.87% increase in the quantity demanded for organic skim milk, while a 1% increase in the expenditure on milk would cause the demand for organic whole milk to increase by 0.71%.

The expenditure elasticities of conventional milk were around one and not statistically different from unity at the 5% significance level, which is consistent with previous studies (Glaser and Thompson 2000; Dhar and Foltz 2005; Chang et al. 2011). Among conventional milk products, demand for skim milk was the least responsive and demand for low fat milk was the most responsive to a rise in total milk expenditure

The own price elasticities are presented in table 4 and were all statistically significant at the 1% level. As expected, the uncompensated own price elasticities were all larger in

magnitude than the compensated elasticities. The compensated and uncompensated elasticities for all four types of organic milk were not much different. Since organic milk is commonly perceived to be associated with groups of the population with higher income, a smaller income effect was expected. For conventional milk, however, the uncompensated elasticities were significantly greater in magnitude than the compensated elasticities. This result indicates income changes playing a relatively more important role in demand for conventional milk than for organic milk.

The demand for all four types of organic milk was own-price sensitive; suggesting lowering the price of organic milk would likely lead to a greater increase in the quantity demanded of organic milk. Among organic products, skim milk was the most sensitive to own-price changes. Given a 1% increase in price, the quantity demanded for organic skim milk would drop by 1.6%. The demand for organic whole milk was less responsive to price changes (1.04%). The magnitudes of organic price elasticities were notably lower than those estimated from data before 2000 (Glaser and Thompson 2000), suggesting that organic products have indeed become much more mainstream. The estimates are higher than the ones estimated using recent but regional data (Chang et al. 2011), where nationwide demand is expected to be more elastic than demand in smaller markets.

Comparing organic and conventional results by fat content, the compensated own-price elasticities of 1% and 2% milk were quite similar between organic and conventional counterparts, where both organic and conventional 1% and 2% milk were sensitive to their own-price changes. In contrast, demands for organic skim milk and whole milk were more own-price elastic than their conventional counterparts based on compensated terms; both conventional skim milk and whole milk demands were price inelastic. Among conventional milk products, 1% milk was the most price sensitive followed by 2% milk. In contrast to the organic milk group where skim milk demand was the most elastic, conventional skim milk was the most insensitive to its price changes compared to other conventional milk products. The demand for conventional skim milk would decrease by 0.59% if its price increases by 1%.

Table 5 shows the compensated cross price elasticities, which reveal the net relationship among products in the system by excluding income effects. Within the organic complex, skim and 2% milk were shown to be substitutes. A 1% increase in organic skim milk price would results in 0.49% increase in the demand for organic 2% milk. A smaller, 0.40% increase in the demand for skim milk would be caused by a 1% increase in the price of 2% milk, suggesting that skim milk leads the price in the organic complex.

With respect to the conventional milk complex, 1% milk was a substitute to 2% milk, skim milk, and whole milk. Conventional skim and 2% milk were also substitutes. The transmitting patterns among the above substitute pairs were asymmetric. For instance, demand for conventional 1% milk would increase by 0.51% in response to a 1% increase in conventional 2% milk price. However, if the price of conventional 1% milk rises by 1%, the increase in the quantity demanded for 2% milk would be only 0.25%, equaling

half of 0.51%. Although conventional 1% milk was a substitute to all the other three conventional milk products, the substitution effect between 1% and 2% milk was the strongest and the substitution between 1% and skim milk was relatively weak.

Estimation results also revealed substitutions between organic milk and conventional milk products differing in fat content. In general, substitution effects caused by price changes of conventional milk on the demand for organic milk (the upper right quadrant of Table 5) were stronger than the effects of organic milk price changes on conventional milk demand (the lower left quadrant). Conventional 2% milk was shown to be a substitute to all four types of organic milk. An increase in the price of conventional 2% milk would cause the quantity demanded for organic 1% milk to increase the most and the quantity demanded for organic skim milk to increase the least. On the other hand, the same change in the price of one type of organic milk would result in a much smaller change in the quantity demanded for conventional 2% milk with the substitution elasticities being around 0.08. The conventional 1% milk was also a substitute to organic skim and 1% milk. A 1% increase in conventional 1% milk price would cause the demand for organicskim and 1% milk to rise by 0.45% and 0.46%, respectively. On the contrary, changes in prices of organic 1% and 2% milk would have less impact, i.e., 0.18% and 0.09% respectively, on the demand for conventional 1% milk. Conventional whole milk were shown to be a substitute to organic 2% and organic whole milk but to a lesser extent.

Conclusion and Discussion

With the expansion of the organic food industry in the U.S., the demand for organic milk has been changing. This study used a recent data set to examine the nationwide demand for organic fluid milk by fat content. The results suggested that, during the sample period of 2008 to 2010, organic milk was no longer a luxury good for consumers who chose to consume organic milk. The demand for organic milk was price elastic. Hence, lowering price is probably an effective way to increase sales of organic milk. However, the effects would be different for organic milk products with different fat content. Reducing price would be most effective to promote the demand for organic skim milk and most ineffective to increase demand for organic whole milk.

Previous research showed that organic milk and conventional milk at the aggregated level were substitutes (Dhar and Foltz 2005; Alviola and Capps 2010). This study disaggregated milk into different fat levels and found organic milk and conventional milk could be substitutes among products with certain levels of fat content but not all. Moreover, the substitution pattern is asymmetric in the sense that for the same relative change in price, there was greater movement toward organic milk than back toward conventional milk, suggesting consumption stickiness among organic consumers.

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Tables

Table 1. Average Market Share of Milk by Fat Content (104 weekly observations)

Type	Skim	Low Fat (1%)	Reduced Fat (2%)	Whole
Organic	5.40%	2.78%	4.42%	3.61%
Conventional	21.67%	13.86%	27.94%	20.33%

Table 2. Average Market Price of Milk by Fat Content ($/half gallon)

Type	Skim	Low Fat (1%)	Reduced Fat (2%)	Whole
Organic	3.61	3.86	3.95	3.95
Conventional	2.33	2.22	2.16	2.19

Table 3. Estimated Expenditure Elasticities

Type	Skim	Low Fat (1%)	Reduced Fat (2%)	Whole
Organic	0.871^{***}	0.854^{***}	0.726^{***}	0.706^{***}
Conventional	0.998^{***}	1.069^{***}	1.044^{***}	1.061^{***}

Note: ***, **, and * imply statistical significance at the 1, 5, and 10% levels, respectively.

Table 4. Estimated Own-Price Elasticities

Product Type		Compensated	Uncompensated
Organic	Skim	-1.598^{***}	-1.645^{***}
	1%	-1.320^{***}	-1.344^{***}
	2%	-1.149^{***}	-1.181^{***}
	Whole	-1.046^{***}	-1.071^{***}
Conventional	Skim	-0.585^{***}	-0.801^{***}
	1%	-1.319^{***}	-1.467^{***}
	2%	-1.022^{***}	-1.314^{***}
	Whole	-0.861^{***}	-1.077^{***}

Note: ***, **, and * imply statistical significance at the 1, 5, and 10% levels, respectively.

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Table 5. Compensated Price Elasticities for Organic and Conventional Milk

		Organic				Conventional			
		Skim	1%	2%	Whole	Skim	1%	2%	Whole
Organic	Skim	-1.598***	0.026**	0.392***	0.162	0.186	0.431***	0.393***	-0.122
	1%	0.050	-1.320***	0.085	0.274	-0.269	0.444***	0.766***	-0.176
	2%	0.471***	0.050	-1.149***	-0.346*	0.184	-0.102	0.455***	0.163
	Whole	0.233	0.207	-0.425*	-1.046***	0.141	-0.124	0.482***	0.238
Conventional	Skim	0.053	-0.030	0.050	0.034	-0.585***	0.171***	0.172*	0.133
	1%	0.179***	0.095***	-0.017	-0.019	0.282***	-1.319***	0.526***	0.342***
	2%	0.085***	0.081***	0.086***	0.074***	0.143**	0.258***	-1.022***	0.338***
	Whole	-0.022	-0.018	0.050*	0.055*	0.156	0.232***	0.469***	-0.861***

Note: ***, **, and * imply statistical significance at the 1, 5, and 10% levels, respectively.