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My name is Oral Capps, Jr., and I have been asked to be an expert witness on behalf of the International Dairy Foods Association (IDFA) concerning the own-price elasticities of demand for milk products. I am Executive Professor and Regents Professor, Co-Director, Agribusiness, Food, and Consumer Economics Research Center, and Holder of the Southwest Dairy Marketing Endowed Chair, in the Department of Agricultural Economics at Texas A&M University.

The own-price elasticity of demand for any commodity is defined as the percentage change in the quantity of that commodity divided by the percentage change in price of that commodity. Conventional wisdom, as noted by Dr. Harry Kaiser in his recent testimony presented at the Federal Milk Marketing Order hearings, suggests that the own-price elasticity of demand for milk is inelastic, that is, not very sensitive to price changes. The own-price elasticities of demand cited by Dr. Kaiser ranged from -0.003 to -0.873.[1] Additional support for this notion comes from the annual U.S. Dairy Sector Model, developed by the USDA Economic Research Service (Cessna, DelCurto, Teran, and Crouse, 2023). This multi-equation econometric model serves to provide projections over a 10-year time span for the supply, demand, and other factors for milk and dairy products in the United States. The model includes equations related to demand, allocation, exports, imports, stocks, and prices of milk and dairy products. The model includes numerous identities related to the allocation of milk fat and nonfat solids, the Federal Milk Marketing Order (FMMO) System, and various government policies. The own-price elasticity based on the U.S. Dairy Sector Model was estimated to be -0.035 for fluid milk. This estimate was arrived at using annual data from 1990 to 2020, a total of 31 observations.

Of the 38 studies cited by Dr. Kaiser (see pages 4 and 5 of his testimony), only two were published after 2021. The remaining articles were published over the period 1964 to 2020. Also, only a few of the studies dealt with milk by fat type and organic milk. These venerable studies are dated and consequently do not reflect the current retail marketplace for milk. None of the studies cited considered health-enhanced milk or lactose-free milk as separate segments. Their volume presumably had been included in the total milk volume in other studies, if at all.

Capps and Brown (2023), in their most recent Congressional study, reported that per capita consumption of fluid milk was lower by 3.3 percent due to the onset of the pandemic. This study is the only one that estimated the impact of the pandemic on per capita consumption of fluid milk. That said, this study did NOT estimate the own-price elasticities of fluid milk during the pre-pandemic period and during the COVID-affected period.

Additionally, in updating Congressional studies annually since 2011 as required by contracts with the Agricultural Marketing Service (AMS), I had to limit these updates to the estimation of a single-demand function for fluid milk to be consistent in making comparisons of key parameters year-over-year. Importantly, the emphasis in these respective studies was on the impacts of

[1] That said, Dr. Kaiser reported that one study by Davis *et al*. (2012) estimated the demand for milk to be elastic. In this instance, the own-price elasticity of demand for milk was estimated to be -1.633.

advertising and promotion efforts of Dairy Management, Inc. (DMI), MilkPEP, and Qualified Programs (QPs). The data associated with the Congressional studies (both Reports to Congress and accompanying Technical Reports) in which I have been involved began in 1995 and were sequentially updated annually with four additional quarterly observations. Because the coverage of the data started in 1995, it was not possible to retrieve data on plant-based milk alternatives and health-enhanced-milk, for example, back to 1995. Also, the Congressional studies do not involve demand systems models. That is, there is no consideration of interrelationships among fluid milk and its primary competitors.

The consumption of plant-based milk alternatives has been steadily building over the past decade. Based on data available from Circana, exhibited in Table 1, plant-based milk products now account for about 10% of the market. In the pre-pandemic period covering the period January 8, 2017, to March 15, 2020, the share of the market for plant-based milk alternatives was 7.75% on average, this percentage rose to 10.30% over the period June 28, 2020, to May 15, 2022, on average, and to 10.32% over the period March 22, 2022, to August 13, 2023, on average. Increasing sales of plant-based milk alternatives contributed to the accelerated rate at which U.S. per capita fluid milk consumption decreased during the 2010s (Badruddoza, 2020; Stewart *et al*., 2020). Dharmasena and Capps (2014) provided empirical evidence that soy-based milk analogues, traditional white milk, and traditional flavored milk were substitutes. On the other hand, Wolf, Malone, and McFadden (2020) reported that although milk consumption had been to a degree substituted with plant-based alternatives, many plant-based drinkers had not entirely shifted their consumption behavior away from milk. Finally, at present, beverages in general are no longer considered simply as thirst-quenchers. To illustrate, lactose-free milk is easier to digest for people who are lactose intolerant, while organic milk utilizes distinct farming practices that promote ecological balance. A newer segment, ultra-filtered milk, is also lactose-free and provides added protein and calcium while having half the sugar of conventional milk.

Without question, notable changes have taken place in the fluid milk market. These changes have both economic and nutritional ramifications which in turn affect not only food policy but also dietary outcomes. U.S. per capita fluid milk consumption fell by 7.4% in the 1950s, 8.4% in the 1960s, 9.9% in the 1970s, 5.4% in the 1980s, 10.9% in the 1990s, 7.9% in the 2000s, and 20.2% in the 2010s (Stewart and Dong, 2023).

A variety of factors have contributed to the persistent downward trend in U.S. per capita fluid milk consumption. Pre-school and pre-adolescent children at present account for a shrinking share of the U.S. population. U.S. consumers purchase more meals and snacks at food service establishments where the presence of fluid milk is less common. Beverages such as bottled water, refrigerated and shelf stable juices and drinks, sports drinks, and plant-based milk alternatives compete with fluid milk (Dharmasena and Capps (2012), Okrent and MacEwan (2014), Zhen *et al.* (2014), and Heng *et al.* (2018). Further, according to Stewart, Dong, and Carlson (2012) generational differences contributed to the decline in fluid milk consumption. Moreover, U.S. consumers of all ages are drinking less milk and milk drinks (Stewart *et al*, 2021).

The general objective of my research is to investigate demand interrelationships among fluid milk and various alternatives. This approach is consistent with the work of Zhen *et al.* (2014) in estimating the demand for 23 foods and beverages using weekly scanner data for 2006. Whole milk, lower fat milks, carbonated soft drinks (regular and diet), bottled water, and juices were included among the products. Additionally, Heng *et al.* (2018) estimated a demand system for 15 beverages including plain milk and flavored milk using weekly scanner data from April 2013 to April 2015. But unlike these and other previous studies, the fluid milk category in my research addressed in this study is disaggregated into five segments: traditional white milk, traditional flavored milk, organic milk, lactose-free milk, and health-enhanced milk (products with added protein, calcium, or other health benefits). This disaggregation in my view more accurately captures what consumers face when shopping at various retail outlets. Alternative products to fluid milk include plant-based milk alternatives (the aggregate of almond, oat, cashew, coconut, rice, and soy), bottled water, refrigerated juices and drinks as well as shelf-stable bottled juices, sports drinks, refrigerated yogurt, and protein beverages. Separate analyses were carried out for the United States market as well as eight regional markets or Census regions—California, West, Mid-South, Northeast, Great Lakes, Plains, South Central, and Southeast.

My research serves to provide a more up-to-date demand systems analysis for fluid milk products as well as for plant-based beverages and other alternatives to milk currently lacking in extant literature. Importantly, this research is the first to deal with a granular array of fluid milk product segments as well as alternatives to fluid milk.[2] Also, my research addresses the impact of the pandemic concerning own-price and cross-price elasticities associated with the previously mentioned product categories. Further, my work addresses not only the national market but also eight regional markets. Hence, this study adds measurably to the economic literature associated with the demand for fluid milk.

Attention is centered on the U.S. market in this report. While differences in the magnitude of the own-price elasticities are evident for the five fluid milk segments across regions, the trends across the three respective periods are similar both nationally and regionally. Hence, coverage is limited to the U.S. market exclusively.

Weekly data procured from Circana (formerly Information Resources, Inc. (IRI)) over the period January 8, 2017, to August 13, 2023, were used in my analysis. The IRI data provide information on volume, dollar sales, average price per volume, and total points of distribution (a measure associated with market reach). To discern the impact of the COVID-19 pandemic, the data are divided into three periods: (1) the pre-COVID period—January 8, 2017, to March 15, 2020; (2) the COVID-affected period— June 28, 2020, to May 15, 2022; and (3) the moving-past COVID period—May 22, 2022, to August 13,2023. This separation into the pre-COVID and COVID-affected periods is consistent with that of Zhao, Wang, Hu, and Zheng (2022). Like Das, Sarkar, and Debroy (2022), we investigate the impact of COVID-19 on changing consumer behavior.

Based on the all-channel tracking report provided by Prime Consulting (May 2023), the syndicated retail data from Circana constitute 64% of milk volume. The remaining 36% of milk volume is attributed to: (1) untracked retail (12%); (2) foodservice (15%); (3) schools (8%); and shrink/other (1%). Therefore, the Circana data cover roughly 76% of the milk volume sold at retail outlets. The foodservice category encompasses limited-service restaurants, full-service restaurants, and other establishments including but not limited to colleges/universities, long-term care and senior living, hospitals, and correctional institutions.

[2] The basis of my work rests on the use of the Barten Synthetic Model (Barten, 1993) augmented to include adjustments for seasonality as well as total points of distribution to capture market reach. Yang and Dharmasena (2021) also rely on the Barten Synthetic Model to investigate consumer demand for plant-based alternative beverages.

The USDA data, available from the Agricultural Marketing Service (AMS), pertain to monthly estimated fluid milk products sales (volume in terms of millions of pounds). Unlike the data obtained from Circana, the USDA, AMS data correspond to dispositions (deliveries) of fluid milk products in consumer type packages from milk processing (bottling) plants to outlets in Federal Order marketing areas. These outlets include food stores, convenience stores, warehouse stores/wholesale clubs, non-food stores, schools, food service industry, and home delivery. The USDA data are available nationally and regionally for **total milk** in the 11 Federal Milk Orders.

Importantly, the own-price elasticity of milk based exclusively on data dealing with schools, colleges/universities, long-term care and senior living, hospitals, and correctional institutions is likely to be highly inelastic. That is, I would not expect much sensitivity concerning quantities purchased with respect to price changes in these instances. As such, studies based on the estimated fluid milk sales data provided by USDA, AMS should result in lower own-price elasticities than studies based on the sales reported at various retail outlets. Many of the studies cited by Dr. Kaiser as well as the USDA Economic Research Service U.S. Dairy Sector Model study, rely on estimated fluid milk sales data. The issue, as stated previously, is that studies which rely solely on estimated fluid milk sales, do not reflect the current retail marketplace for milk.

Summary statistics of average prices per volume, quantities sold, and budget shares for the eleven product categories by pre-COVID, COVID-affected period, and moving-past COVID periods are exhibited in Table 1. The average price of traditional white milk was $3.07/gallon in the pre-COVID period, $3.48/gallon in the COVID-affected period, and $3.97/gallon in the moving-past COVID period; $8.01 for organic milk in the pre-COVID period, $8.27/gallon in the COVID-affected period, and $9.40 in the moving-past COVID period; $5.05 for traditional flavored milk in the pre-COVID period, $5.52/gallon in the COVID-affected period, and $6.54 in the moving-past COVID period; $9.21 for health-enhanced milk in the pre-COVID period, $9.69/gallon in the COVID-affected period, and $11.08 in the moving-past COVID period; and $7.61 for lactose-free milk in the pre-COVID period, $7.66/gallon in the COVID-affected period, and $8.57/gallon in the moving-past COVID period. Average prices for organic milk, health-enhanced milk and lactose-free milk were more than double the average prices for traditional white milk across the respective periods. Additionally, the average prices of the five fluid milk segments rose monotonically across the three time periods, reflecting in part inflationary pressures.

The dominance of traditional white milk in the fluid milk category is evident based on average quantities sold and on average budget shares. The average budget share for traditional white milk was 17.11% in the pre-COVID period, 14.94% in the COVID-affected period, and 14.00% in the moving-past COVID period. The average budget share for traditional flavored milk was 1.46% in the pre-COVID period, 1.31% in the COVID-affected period, and 1.20% in the moving-past COVID period. The average budget share for organic milk was 3.20% in the pre-COVID period, 2.87% in the COVID-affected period, and 2.60% in the moving-past COVID period. The average budget share for lactose-free milk was 1.76% in the pre-COVID period, 1.89% in the COVID-affected period, and 2.03% in the moving-past COVID period. Finally, the average budget share for health-enhanced milk was 1.93% in the pre-COVID period, 1.96% in the COVID-affected period, and 1.92% in the moving-past COVID period. Moreover, the average budget share for the fluid milk category was 25.46% in the pre-COVID period, 22.97% in the COVID-affected period, and 21.75% in the moving-past COVID period.

Based on the average budget shares, bottled water, juices, traditional white milk, refrigerated yogurt, and sports drinks in that order were the chief product categories. Together, these product categories accounted for roughly 85 percent of the total expenditure associated with the eleven products considered in the analysis. Notably, traditional white milk lost 3.71 percentage points from the pre-COVID period to the moving-past COVID period whereas bottled water gained 3.93 percentage points in market share from 25.07% to 29.00%. Essentially bottled water displaced traditional white milk in terms of average budget share. Gains in budget shares from the pre-COVID period to the moving-past COVID period were also evident for sports drinks (7.16% to 9.35%). Juices experienced a loss in market share from 22.70% to 20.97% across the respective three time periods. The average budget shares for protein beverages and for plant-based milk alternatives were relatively stable at 2.70% and 4.07% respectively.

The estimated own-price elasticities for the pre-COVID period, the COVID-affected period, and the moving-past COVID period are provided in Table 2. The side-by-side chart of the uncompensated own-price elasticities for the five sub-categories of milk, five competitive beverages and refrigerated yogurt associated with the respective periods is presented in Figure 1.

All the estimated own-price elasticities of demand were negative across the respective periods, consistent with economic theory. For the pre-COVID period, the demands for traditional white milk, organic milk, and lactose-free milk were inelastic, although the estimated own-price elasticities were larger than reported in the extant literature. For example, a 1% increase in their respective prices led to a 0.77% decrease in quantity demanded for traditional white milk, a 0.94% decrease in quantity demanded for organic milk, and a 0.51% decrease in quantity demanded for lactose-free milk. In contrast, traditional flavored milk and health-enhanced milk were highly responsive to changes in prices. The estimated own-price elasticities associated with traditional flavored milk and health-enhanced milk were -1.33 and -1.55 respectively.

For the COVID-affected period, the own-price elasticity for traditional white milk was -0.30, smaller than the own-price elasticity estimated over the pre-COVID period. However, during the COVID-affected period, the own-price elasticities for traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk were -1.66, -1,61, -1.81, and -4.11 respectively. As such, the demands for these milk categories were elastic, that is, sensitive to price changes.

Table 1. Summary Statistics Associated with Average Prices, Quantities, and Budget Shares of the Eleven Product Categories for the United States for the Pre-COVID Period (January 8, 2017-March 15, 2020), the COVID-Affected Period (June 28, 2020-May 15, 2022), and the Moving-Past COVID Period (May 22, 2022-August 13, 2023)

	Price ($/volume)			Quantity (millions[1])			Budget Share (%)		
	Pre-COVID	COVID-Affected	Moving Past COVID	Pre-COVID	COVID-Affected	Moving Past COVID	Pre-COVID	COVID-Affected	Moving Past COVID
Total Milk[2]	3.79	4.31	4.95	65.39	60.24	56.90	25.46	22.97	21.75
Traditional White Milk	3.07	3.48	3.97	54.39	48.56	45.62	17.12	14.94	14.00
Organic Milk	8.01	8.27	9.40	3.90	3.91	3.58	3.20	2.87	2.60
Traditional Flavored Milk	5.05	5.52	6.54	2.82	2.69	2.39	1.46	1.31	1.20
Health-Enhanced Milk[3]	9.21	9.70	11.08	2.05	2.29	2.25	1.92	1.96	1.92
Lactose-Free Milk	7.61	7.66	8.57	2.26	2.79	3.07	1.76	1.89	2.03
Alternative Beverages & Yogurt									
Juices[4]	0.05	0.05	0.06	4,800.00	5,020.00	4,670.00	22.79	22.60	20.97
Bottled Water	1.50	1.65	1.93	163.97	188.00	195.00	25.08	27.42	29.00
Sports Drinks	0.03	0.04	0.05	2,070.00	2,350.00	2,370.00	7.17	8.50	9.35
Protein Beverages	19.82	20.74	23.87	1.31	1.39	1.58	2.61	2.54	2.91
Plant-Based Milk Alternatives[5]	6.74	6.96	8.20	5.50	6.92	6.55	3.79	4.26	4.15
Refrigerated Yogurt	2.35	2.43	2.85	54.56	54.44	53.96	13.12	11.70	11.87

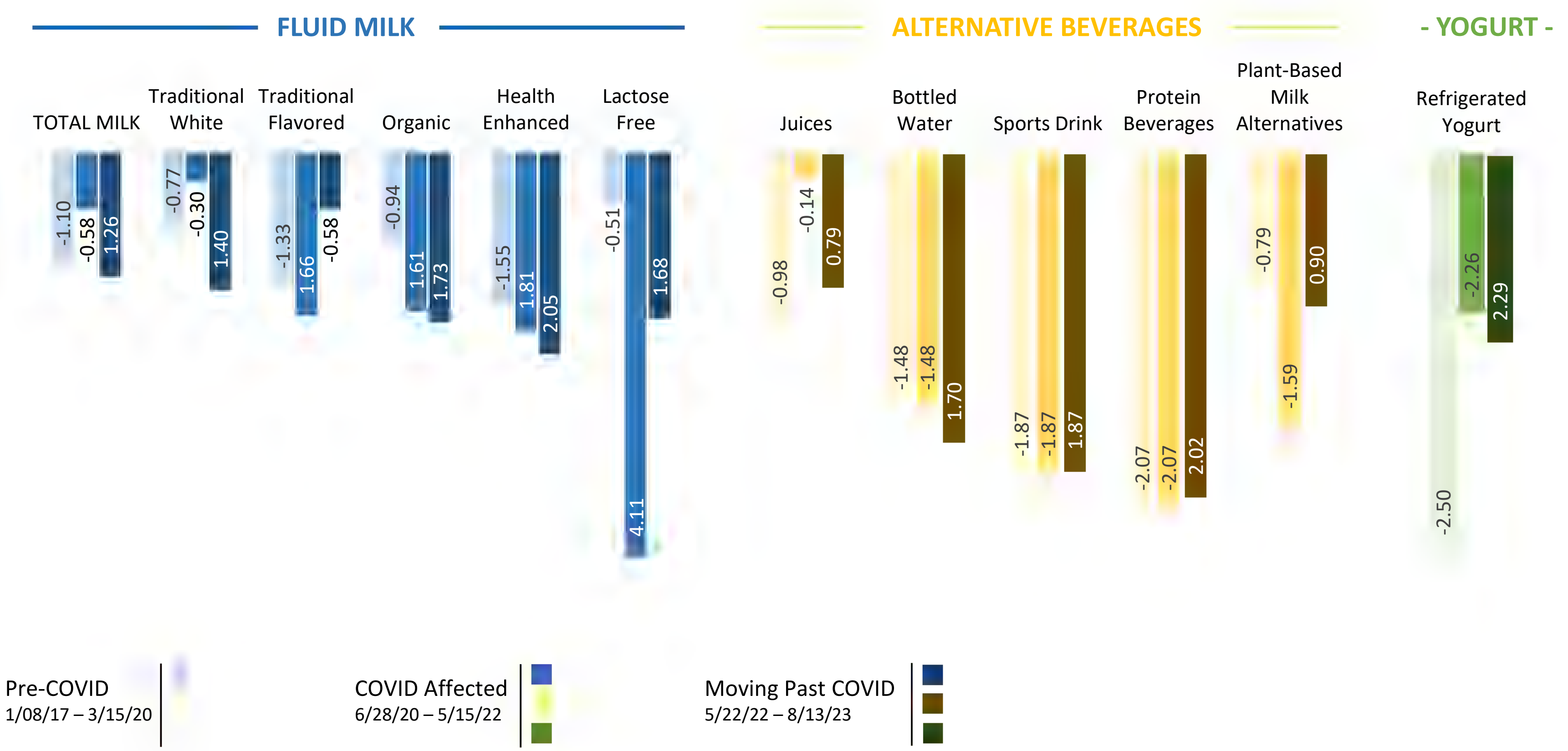
[1]Unit of volume for juices and sports drinks is in terms of ounces, for yogurt pints and for all other categories gallons.
[2]Total milk includes all five sub-categories of milk.
[3]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[4]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[5]Plant-based milk alternatives refer to the aggregate of almond, cashew, coconut, oat, rice, and so

Table 2. Own-Price Elasticities for the United States Estimated Using the Eleven-Product Demand Model for the Pre-COVID Period (January 8, 2017-March 15, 2020), for the COVID-Affected Period (June 28, 2020-May 15, 2022), and for the Moving Past COVID Period (May 22, 2022-August 13, 2023)

	Own-Price Elasticity		
	Pre-COVID	COVID-Affected	Moving Past COVID
Fluid Milk Category			
Traditional White Milk	-0.77	-0.30	-1.40
Organic Milk	-0.94	-1.61	-1.73
Traditional Flavored Milk	-1.33	-1.66	-0.58
Health-Enhanced Milk[1]	-1.55	-1.81	-2.05
Lactose-Free Milk	-0.51	-4.11	-1.68
Alternative Beverages & Yogurt			
Juices[2]	-0.98	-0.14	-0.79
Bottled Water	-2.22	-1.48	-1.70
Sports Drinks	-1.89	-1.87	-1.87
Protein Beverages	-2.11	-2.07	-2.02
Plant-Based Milk Alternatives[3]	-0.79	-1.59	-0.90
Refrigerated Yogurt	-2.58	-2.26	-2.29

[1] Health-enhanced milk (products with added protein, calcium, or other health benefits).
[2]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[33]Plant-based milk alternatives refer to the aggregate of almond, cashew, coconut, oat, rice, and soy.

Figure 1. Own-Price Elasticities for the United States from the Eleven-Product Demand Model for the Pre-COVID Period (January 8, 2017- March 15, 2020), for the COVID-Affected Period (June 28, 2020-May 15, 2022), and for the Moving Past COVID Period (May 22, 2022-August 13, 2023)



Source: IRI Multi-Outlet scan data and calculations by Capps.

For the moving-past COVID period, except for traditional flavored milk, the demands for traditional white milk, organic milk, health-enhance milk, and lactose-free milk were elastic. The respective own-price elasticities for these milk categories were -1.40, -1.73, -2.05, and -1.68. The own-price elasticity for traditional flavored milk was -0.58 during this period.

Further, the categories of fluid milk were combined into a single category (total milk). From the ensuing demand analysis, the own-price elasticity for total milk was estimated to be -1.10 in the pre-COVID period, -0.58 in the COVID-affected period, and -1.26 in the moving-past COVID period. Again, the own-price elasticities were larger than those cited in the economic literature. Based on the aggregated analysis, the magnitude of the own-price elasticity for total milk in the moving-past COVID period was similar to its magnitude in the pre-COVID period.

The major points associated with this analysis are as follows: (1) the more expensive milk sub-categories had higher own-price elasticities, except for lactose-free milk in the pre-COVID period; (2) the own-price elasticities for the granular array of fluid milk categories are indicative of elastic demands, not inelastic demands as suggested Dr. Kaiser; (3) the own-price elasticities are not uniform across the three respective time periods; (4) during the COVID-affected period, the own-price elasticity for traditional white milk was greatly affected, changing in magnitude from -0.77 to -0.30; (5) during the COVID-affected period, the own-price elasticities for traditional flavored milk, organic milk, lactose-free milk, and health-enhance milk rose notably in magnitude; and (6) during the moving-past COVID period, the own-price elasticities for traditional white milk, organic milk, and health-enhanced milk were higher compared to the pre-COVID period and the COVID-affected period. The own-price elasticity for traditional flavored milk however was lower in the moving-past COVID period compared to the to the pre-COVID period and the COVID-affected period. Finally, the own-price elasticity for lactose-free milk was greater than 1 in the COVID-affected period and the moving-past COVID period, but not so in the pre-COVID period.

Importantly, the vast majority of the own-price elasticities gleaned from the extant literature were reported for periods prior to the pandemic. Consequently, our study adds notable content to the economic literature since we provide estimated elasticities not only during the pre-COVID period but also during the COVID-affected period and the moving-past COVID period. Comparisons from the literature, however, only make sense in considering our estimated elasticities during the pre-COVID period.

The estimated own-price elasticities for traditional white milk from the economic literature ranged from -0.59 to -0.15 (Adachi and Lui, 2010; Blisard *et al*., 1991, 1999; Cakir and Balagtas, 2010; Dong *et al.*, 2012; Huang, 1993; Lenz *et al*., 1998; Okrent and MacEwan, 2014; Schmit and Kaiser, 2004; Schmit *et al*., 2002; Tomek and Kaiser, 1999; Vande Kamp and Kaiser, 1999; Zheng and Kaiser, 2009). The estimated own-price elasticities for traditional flavored milk ranged from -3.82 to -1.39 (Davis *et al.,* 2012, Dharmasena and Capps, 2014, Hu *et al.*, 2020, Maynard and Liu, 1999). Consequently, the demand for traditional flavored milk was very sensitive to changes in prices. Finally, the estimated own-price elasticities for organic milk from the economic literature ranged from -4.22 to -0.63 (Alviola and Capps, 2010, Chen *et al.,* 2018, Choi *et al.,* 2013, Dhar and Foltz, 2005, Li *et al.,* 2018, Lopez and Lopez, 2009, Scott, 2013). Zhen *et al.* (2014) estimated the own-price elasticity of demand for lower-fat milks to be -1.20 and for whole milk to be -0.90.

With respect to alternative beverages, the own-price elasticities of some products were greatly affected by the pandemic. The own-price elasticity for juices was estimated to be -0.98 during the pre-COVID period, -0.14 during the COVID-affected period, and -0.79 in the moving-past COVID period. The demand for traditional white milk and the demand for juices were highly inelastic during the COVID-affected period. One of the possible explanations associated with this finding is that these products are geared predominantly toward children. Moreover, the own-price elasticity for plant-based milk alternatives was estimated to be -0.79 during the pre-COVID period, -1.59 during the COVID-affected period, and -0.90 in the moving-past COVID period.

On the other hand, the estimated own-price elasticities for sports drinks, protein beverages, and yogurt were similar across the respective time periods. Also, all the estimated own-price elasticities were greater than 1 in magnitude, indicative of elastic demands. Hence, these three products were quite sensitive to own-price changes. Further, the estimated own-price elasticity for bottled water was -2.22 in the pre-COVID period, -1.48 in the COVID-affected period, and -1.70 in the moving-past COVID period. While there were differences in the own-price elasticity for bottled water across the three time periods, the own-price elasticities for bottled water were greater than 1, indicative of sensitivity to own-price changes.

Plant-based milk alternatives were substitutes for traditional white milk and organic milk in the three respective periods for the United States. Sports drinks and refrigerated yogurt were substitutes for traditional flavored milk, health-enhanced milk, and lactose-free milk across the three periods. Further, bottled water and protein beverages were substitutes for traditional white milk, organic milk, traditional flavored milk, health-enhanced milk, and lactose-free milk in the three time periods as well.

Traditional white milk and organic milk were substitutes in the COVID-affected period but not so in the pre-COVID period and the moving-past COVID period. Organic milk was a substitute for health-enhanced milk and lactose-free milk in the COVID-affected period but not in the pre-COVID period and the moving-past COVID period. However, traditional flavored milk was a substitute for health-enhanced milk and lactose-free milk in the pre-COVID period and the moving-past COVID period, but these relationships were not evident in the COVID-affected period. Bottom line, substitution patterns among traditional white milk, traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk differed in the respective periods. Evidence of substitution among the eleven products was more prominent during the COVID-affected period than during the pre-COVID-period and the moving-past COVID period.

Traditional white milk was a complement to traditional flavored milk and health-enhanced milk in the three respective periods. In addition, organic milk was a complement to traditional flavored milk, and health-enhanced milk and lactose-free milk were complements in the respective periods. Juices were complements to traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk across the three periods. In economic parlance, goods that are complements means that they are purchased or bought together.

Conclusion

Several major takeaways are evident from my research concerning own-price elasticities for milk products. First, to better understand the demand for fluid milk, it is necessary to disaggregate this category into various segments, namely traditional white milk, traditional flavored milk, organic milk, lactose-free milk, and health-enhanced milk. This disaggregation more accurately captures the reality of what consumers face when shopping at various retail outlets. Additionally, it is necessary to consider the interrelationships with plant-based milk alternatives, bottled water, juices, sports drinks, refrigerated yogurt, and protein beverages. The prices of these alternative beverages and refrigerated yogurt had statistically significant impacts on the quantities purchased of the respective milk sub-categories.

Second, because of the pandemic, a structural shift in the demand for fluid milk occurred across all fluid milk segments. During the COVID-affected period, the own-price elasticity for traditional white milk was impacted notably. The magnitude of the own-price elasticity decreased from -0.77 to -0.30. During the COVID-affected period, the own-price elasticities for traditional flavored milk, organic milk, lactose-free milk, and health-enhance milk rose notably in magnitude. During the moving-past COVID period, the own-price elasticities for traditional white milk, organic milk, and health-enhanced milk were higher compared to the pre-COVID period and the COVID-affected period. The own-price elasticity for traditional flavored milk however was lower in the moving-past COVID period compared to the to the pre-COVID period and the COVID-affected period. Finally, the own-price elasticity for lactose-free milk was greater than 1 in the COVID-affected period and the moving-past COVID period, but not so in the pre-COVID period.

Third, the frequency of the time-series data in my analysis was weekly, whereas in the majority of studies cited in the economic literature, the frequency of the time-series data was either monthly, quarterly, or annual. Elasticity estimates based on shorter time periods usually differ from those based on longer time periods (Manderscheid 1964; Pasour and Schrimper 1965; Capps and Nayga, 1990). Elasticities based on shorter-term frequencies are likely to be greater in magnitude than elasticities based on longer-term frequencies. Given the finding of the elastic nature of the respective demands for the products associated with my analysis, my empirical results support this contention. Presumably, consumers shop at retail outlets on a weekly basis rather than on a monthly, quarterly, or annual basis, especially for milk and beverages. Consequently, own-price elasticities based on weekly data represent a more realistic picture of the frequency of consumer shopping behavior.

Fourth, a fundamental economic principle associated with own-price elasticities is that the greater the number of substitutes for any product, the greater the magnitude of the own-price elasticity. Based on the substitution relationships previously described among the various products considered in my analysis, the magnitudes of the estimated own-price elasticities reported are consistent with this economic principle. Using a demand systems analysis (technically the use of the Exact Affine Stone Index (EASI) model) and weekly data from IRI over the period 2012 to 2017, Ghazaryan, Bonanno, and Carlson (2023) estimated own-price elasticities to be -1.297 for skim milk, -1.666 for reduced fat milk, and -1.450 for whole milk. As well, using a demand systems analysis (technically the use of the Almost Ideal Demand System (AIDS) model) and weekly data from IRI from the second week of March 2018 to the first week of December 2022 provided by Nielsen, Son, and Lusk (2023) estimated the own-price elasticity for regular dairy milk to be -0.946 and for lactose-free milk to be -1.387. These results are consistent with my findings. Each of these studies employed a demand systems approach coupled with the use of weekly data from IRI and from Nielsen. Hence, these respective studies further support my contention that the demands for disaggregated milk products are sensitive to changes in prices.

Fifth, the more expensive milk sub-categories had higher own-price elasticities, except for lactose-free milk in the pre-COVID period. Sixth, the own-price elasticities are not uniform across the three respective time periods considered. The own-price elasticity for traditional white milk went from -0.77 in the pre-COVID period to -0.30 in the COVID-affected period, and to -1.40 in the moving-past COVID period. The own-price elasticity for traditional flavored milk changed from

-1.33 in the pre-COVID period to -1.66 in the COVID-affected period, and to -0.58 in the moving-past COVID period. The own-price elasticity for lactose-free milk in the pre-COVID period was estimated to be -0.51, -4.11 in the COVID-affected period, and -1.68 in the moving-past COVID period. Finally, the own-price elasticities for organic milk and health-enhanced milk were not only in the elastic range but also rose monotonically across the three periods.

Based on testimony from Dr. Kaiser, the National Milk Producers Federation proposal recommended increasing the Class I price by 8.6%. Assuming that the elasticity of price transmission from the farm level to the retail level to be 0.54929% as calculated by Dr. Kaiser, this 8.6% increase in the Class I price results in a 4.72% increase in the retail price for milk products. The elasticity of price transmission denotes the percentage change in the retail price attributed to a 1% change in the farm price. Hence, the percentage change in the retail price of milk is equal to the product of the percentage change in the Class I price and the elasticity of price transmission from the farm level to the retail level.

Subsequently, we need to determine the impact of this 4.72% increase in the retail price of milk on the retail price of each of the five milk segments. To obtain each of these five retail percentage price increases, we multiply this 4.72% increase by the percentage change in each of the respective five segments due to a 1% change in the price of the aggregate category of milk.

To determine these percentages, I regressed each of the respective milk price segments on the retail price of the aggregate category of milk accounting for seasonality based on the use of the Circana data over the period 1/8/2017 to 8/13/2023. The results of the regression analyses are as follows:

- Traditional White milk 0.949887%
- Traditional Flavored milk 0.876239%
- Lactose-free milk 0.346271%
- Organic milk 0.502453%
- Health-enhanced milk 0.585540%

Note that these figures represent the percentage change in each of the respective five segments due to a 1% change in the price of the aggregate category of milk.

Consequently, the 8.6% increase in the Class I price translates into the following percentage increases in the retail prices of the five milk segments:

- Traditional White milk 4.49%
- Traditional Flavored milk 4.14%
- Lactose-free milk 1.64%
- Organic milk 2.37%
- Health-enhanced milk 2.77%

Using the estimated own-price elasticities of traditional white milk, traditional flavored milk, organic milk, lactose-free milk, and health-enhanced milk from the moving-past COVID period, the most recent period in my analysis, these respective percentage increases in the retail prices for the five milk product segments translate to a:

- 6.28% decrease in the quantity purchased of traditional white milk.
- 2.40% decrease in the quantity purchased of traditional flavored milk.
- 4.11% decrease in the quantity purchased of organic milk.
- 2.75% decrease in the quantity purchased of lactose-free milk; and
- 5.67% decrease in the quantity purchased of health-enhanced milk.

For the aggregate total milk category, the 4.72% increase in retail price translates into a 5.98% decrease in the quantity of milk purchased. This result is at odds with the inferences drawn by Dr. Kaiser based on his calculations who assumed that the own-price elasticity of total milk was either -0.20 or -0.35. To illustrate, based on the average retail price elasticity of -0.35 from his literature review, Dr. Kaiser calculated that a 4.73% increase in the retail price of milk would decrease the quantity of milk purchased by 1.66%. Based on the median retail price elasticity of -0.20 from his literature review, Dr. Kaiser calculated that a 4.73% increase in the retail price of milk would decrease the quantity of milk purchased by 0.95%. Based on my analysis, the 8.6% increase in Class I price would lead to a 2.1% increase in gross revenue for dairy farmers. But based on Dr. Kaiser's analysis, the 8.6% increase in Class I price would lead to a 6.8% to 7.6% increase in gross revenue for dairy farmers. Bottom line, unlike previous studies cited by Dr. Kaiser in his testimony as well as the own-price elasticity of demand for milk estimated in the recent ERS study (-0.035), retail purchases of milk products indeed are far more sensitive to price changes than suggested by conventional wisdom.

No other studies in the literature report own-price elasticities for milk and plant-based milk alternatives during the pre-COVID period and during the COVID-affected period. Using data from Nielsen from the first week of January 2017 to the second week of July 2020, Zhao, Wang, Hu, and Zheng (2021) derived own-price elasticities for plant-based meat alternatives, beef, chicken, turkey, pork, fish, and other meats for pre-COVID and COVID-affected periods based on the Almost Ideal Demand System (AIDS). The own-price elasticities for plant-based meat alternatives were -0.840 pre-COVID and -1.551 COVID-affected; for beef -0.935 pre-COVID and -1.002 COVID-affected; for chicken -0.930 pre-COVID and -0.963 COVID-affected; for turkey -1.441 pre-COVID and -1.394 COVID-affected; for pork -0.946 pre-COVID and -0.604 COVID-affected; for fish -0.974 pre-COVID and -1.066 COVID-affected; and for other meats -0.896 pre-COVID and -0.678 COVID-affected. Thus, based on weekly data, the own-price elasticities ranged from -0.840 to -1.441 during the pre-COVID period and from -0.604 to -1.551 during the COVID-affected period. This study thus reported changes in own-price elasticities for various meat products and plant-based meat alternatives that are congruent to those derived in my analysis for various milk products and plant-based milk alternatives. Consequently, the work of Zhao, Wang, Hu, and Zheng (2021) reinforces the credibility of my work.

Bottom line, I strongly believe the more accurate measurement of own-price elasticity for purposes of the FMMO system needs to consider current market conditions, more frequent information regarding consumer behavior (e.g., weekly data in lieu of quarterly, monthly, or annual data as well as consideration of the impacts of the pandemic), and most importantly the primary competitors of various milk products. My research at present is the only study which fulfills these conditions.

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