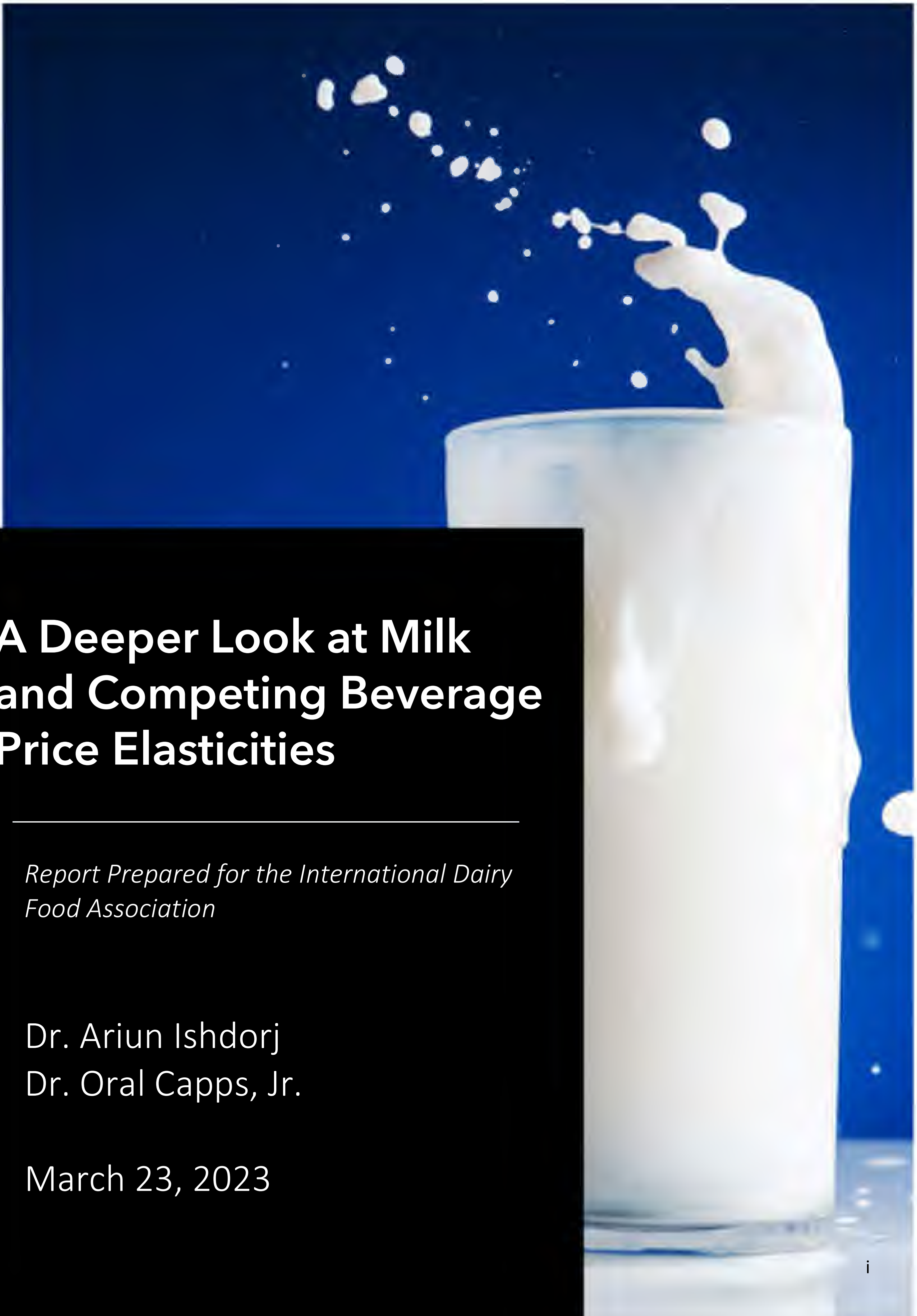

A Deeper Look at Milk and Competing Beverage Price Elasticities

Report Prepared for the International Dairy Food Association

Dr. Ariun Ishdorj
Dr. Oral Capps, Jr.

March 23, 2023

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By

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We would like to thank Doug Adams at Prime Consulting for providing the IRI data and guidance during the preparation of this report. Any errors or omissions are the sole responsibility of the authors.

"THE IMPORTANCE OF MILK as a food can hardly be overestimated. There is no other single food of such vital importance to our national welfare." — *Farmers' Bulletin*, USDA, August 1921

"In the context of current dietary practices, it is difficult for most individuals to meet national nutrition guidance goals unless they are consuming dairy products." — *What We Eat in America,* USDA, 2010

Most individuals would benefit by increasing intake of dairy in fat-free or low-fat forms, whether from milk (including lactose-free milk), yogurt, and cheese, or from fortified soy beverages or soy yogurt." — *Dietary Guidelines for Americans,* 2020-2025

Executive Summary

The general objective of this study was to investigate demand interrelationships among fluid milk and various competitive products. In the case of fluid milk, this category was broken down into five milk segments: traditional white milk, traditional flavored milk, organic milk, lactose-free milk, and health-enhanced milk. The competitive products included plant-based milk alternatives (including but not limited to almond, oat, cashew, coconut, rice, and soy), bottled water, refrigerated juices and drinks as well as shelf-stable bottled juices, sports drinks, yogurt, and protein beverages.

Economists often measure the sensitivity of consumption of these respective products to changes in demand drivers such as prices and income. In economic jargon, the term sensitivity is tantamount to elasticity. Own-price elasticity is defined as the percentage change in consumption due to a one percent change in the price of the product in question. Cross-price-elasticity refers to the percentage change in consumption due to a one percent change in the price of another product. Income elasticity pertains to the percentage change in consumption due to a one percent change in income. Elasticities are unitless measures, dealing only with percentage changes in consumption due to unit percentage changes in own-price, other prices, or income.

The specific objectives were: (1) to estimate own-price, cross-price, and total expenditure elasticities for the previously mentioned products on a national and regional (eight IRI regions) basis using data procured from Information Resources Inc. (IRI), (2) to estimate own-price elasticities for conventional milk for the eleven Federal Milk Orders using data procured from the Agricultural Marketing Service (AMS, USDA); and (3) to provide a detailed literature review of the demand for fluid milk and milk related products.

Of particular importance is the fact that the most recent demand system analyses associated with different dairy categories in the United States were done a decade ago (Davis et al, 2010; Chouinard et al. 2010; Davis et al. 2011; Davis et al. 2012). As such, our contribution serves to provide a more up-to-date demand systems analysis for fluid milk products as well as for plant-based milk alternatives currently lacking in extant literature. Additionally, with the use of the IRI data, we analyzed the substitutability and complementarity among the specified distinct products. With the demand systems approach, we ensure not only that our econometric findings are consistent with demand theory but also would stand up to peer review. Importantly, this report is the first to study such a granular array of milk and milk related products. Hence, this study adds measurably to the economic literature associated with the demand for milk and milk related products.

Analysis Based on IRI Data

The estimated uncompensated own-price elasticities,[1] expenditure elasticities and income elasticities for pre-COVID and COVID-affected periods are provided in Table ES1. The side-by-side chart of the uncompensated own-price elasticities for total milk, five sub-categories of milk, five competitive beverages and yogurt associated with pre-COVID and COVID-affected periods are presented in Figure ES1.

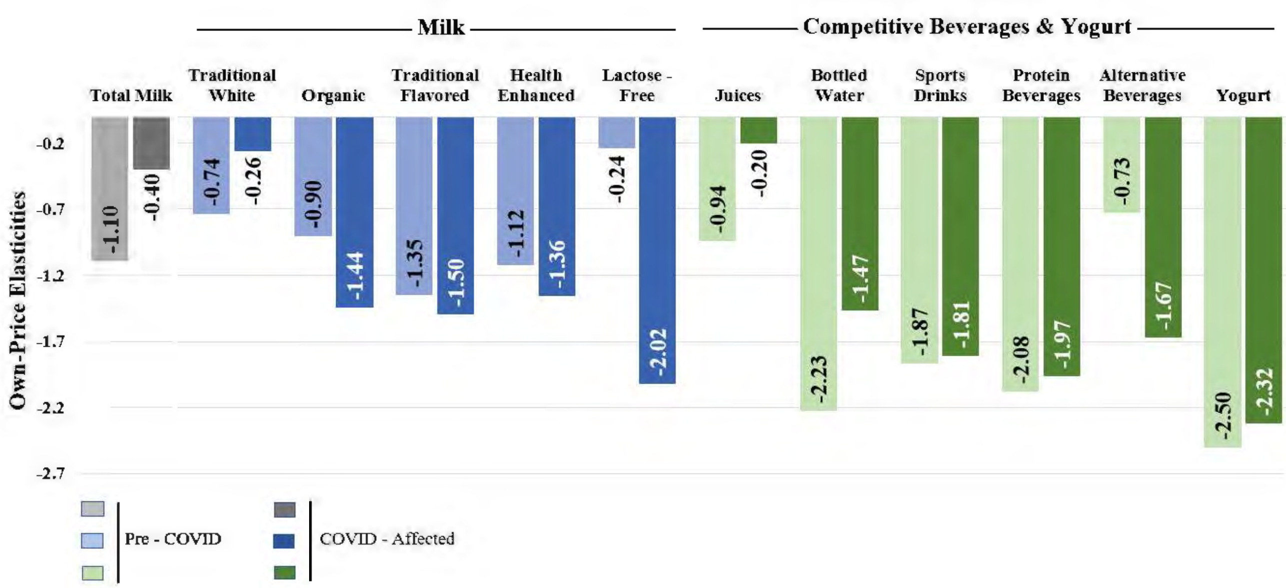
[1] Uncompensated own-price elasticity, often referred to as Marshallian elasticity, is a measure of responsiveness of demand attributed to changes in own price, assuming no changes in other prices or income.

Table ES1. Own-Price Elasticities, Expenditure Elasticities and Income Elasticities for the United States Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity		Income Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.097**	**-0.403**	**0.774**	**0.475**		
Traditional White Milk	-0.737	-0.260	0.720	0.447	0.258	0.160
Organic Milk	-0.903	-1.445	0.914	0.648	0.327	0.232
Traditional Flavored Milk	-1.353	-1.498	0.787	0.478	0.282	0.171
Health-Enhanced Milk[2]	-1.124	-1.359	0.962	0.972	0.345	0.348
Lactose-Free Milk	-0.240	-2.024	0.891	0.938	0.319	0.336
Competitive Beverages & Yogurt						
Juices[3]	-0.940	-0.201	0.916	0.744	0.328	0.267
Bottled Water	-2.227	-1.466	1.193	1.180	0.427	0.423
Sports Drinks	-1.867	-1.813	1.401	1.557	0.502	0.558
Protein Beverages	-2.081	-1.966	0.928	1.546	0.332	0.554
Alternative Beverages[4]	-0.729	-1.672	0.972	0.977	0.348	0.350
Yogurt	-2.502	-2.320	1.012	1.404	0.362	0.503

[1]Five milk sub-categories were combined into a "Total Milk" category and a seven-product demand model was estimated to obtain elasticity estimates for Total Milk category.
[2] Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, cashew, coconut, oat, rice, and soy).

Figure ES1. Own-Price Elasticities for the United States from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)



Notes: Elasticities for "Total Milk" category were taken from seven-product demand model.

All the estimated own-price elasticities of demand were negative for both pre-COVID and COVID-affected periods, consistent with economic theory. For the pre-COVID period, the elasticities revealed that traditional white milk, organic milk, and lactose-free milk were not very sensitive to price changes. For example, a 1% increase in their respective prices lead to a 0.74% decrease in quantity demanded for traditional white milk, a 0.90% decrease in quantity demanded for organic milk and 0.24% decrease in quantity demanded for lactose-free milk. In contrast, traditional flavored milk, and health-enhanced milk were highly responsive to changes in prices.

Traditional flavored milk was most price sensitive among milk sub-categories with estimated elasticity of -1.35 and lactose-free milk was least price sensitive with estimated elasticity of -0.24. The more expensive milk sub-categories had higher own-price elasticities, with the exception for lactose-free milk.

Notable differences were evident in own-price elasticities between the pre-COVID and COVID-affected periods. Traditional white milk became less price responsive with the onset of COVID, while other milk sub-categories became more sensitive to price changes. The elasticity for total milk changed from being quite responsive to price changes in the pre-COVID period to less sensitive to price changes during the COVID-affected period. Specifically, for a 1% increase in price of total milk, the quantity demanded decreased by 1.10% in the pre-COVID period and 0.40% in the COVID-affected period. This change in total milk elasticity was primarily driven by traditional white milk.

With respect to competitive beverages, while COVID slightly affected the budget shares levels, the own-price elasticities of some products were greatly affected. The own-price elasticity for juices was estimated to be -0.94 pre-COVID and -0.20 during the COVID-affected period. For every 1% change in the price of juices the quantity demanded decreased by 0.94% and 0.20% during the pre-COVID and COVID-affected periods, respectively. The demand for juices then was inelastic, that is, relatively unresponsive to price changes. The demand for plant-based alternative beverages to milk changed from being inelastic (-0.73) to being elastic (-1.67) in the respective periods. All other competitive beverages were quite responsive to price changes pre-COVID and remained so during the COVID-affected period.

All income elasticities were positive and between zero and one for both pre-COVID and COVID-affected periods, indicating that all the products considered were not only normal goods but also necessities in economic parlance. Health-enhanced milk and lactose-free milk had the highest income elasticities among milk products whereas traditional white milk and traditional flavored milk had the lowest.

Plant-based alternative beverages to milk were substitutes for traditional white milk and organic milk in both the pre-COVID and COVID-affected periods for the United States. Sports drinks and yogurt were substitutes for traditional flavored milk, health-enhanced milk, and lactose-free milk. 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 pre-COVID and COVID-affected periods.

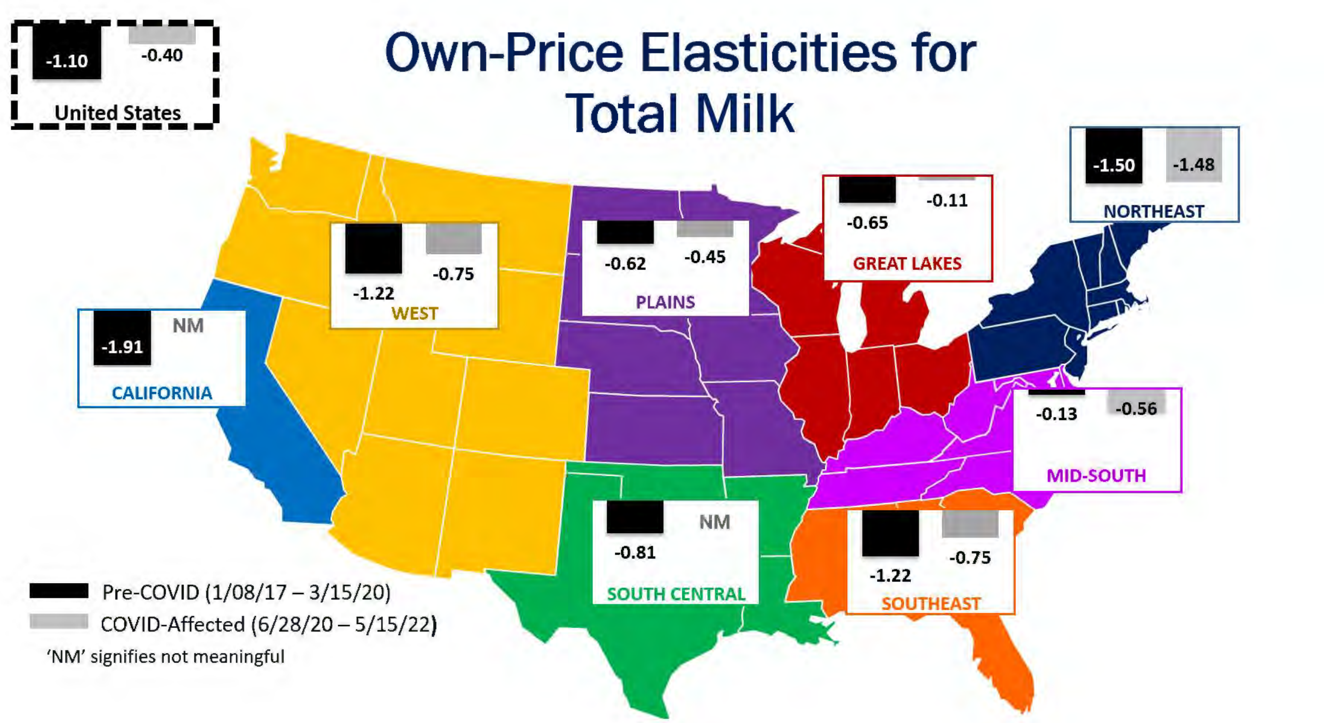
Similar patterns were observed for the COVID-affected period but with even greater number of substitutes compared to the pre-COVID period. Lactose-free milk was a substitute for traditional white milk and organic milk. Traditional white milk and organic milk were substitutes in the COVID-affected period.

Substitution patterns among traditional white milk, traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk differed in the respective periods. Juices were complements to traditional white milk, traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk across the pre-COVID and COVID-affected periods.

In addition to estimating own-price elasticities for milk and milk related products for the United States, the analysis was done by eight IRI regions. Regional differences in average budget shares and own-price elasticities were evident across regions. Noticeable differences also were evident in own-price elasticities between the pre-COVID period and the COVID-affected period. Additionally, noticeable differences across geographies were evident in both the pre-COVID and COVID-affected periods. Partial and complete lockdowns were introduced regionally such as closures of schools, workplaces, non-essential shops, and restaurants, banned events and travel and mobility restrictions which in turn affected food purchase and consumption behaviors.

As exhibited in Figure ES2, the demand for total milk was very sensitive to changes in price in the pre-COVID period for the United States as well as the California, West, Northeast, and Southeast regions. Declines in own-price elasticities for total milk were evident in the COVID-affected period vis-à-vis the pre-COVID period but for the Mid-South region.

Figure ES2. Own-Price Elasticities for Total Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)



As presented in Figure ES3, the demand for traditional white milk was inelastic in the pre-COVID period for all regions except for the Plains region as well as for the United States. Declines in the magnitude of the own-price elasticities for traditional white milk were evident in the COVID-affected period vis-à-vis the pre-COVID period across the board. In the COVID-affected period, own-price elasticities for traditional white milk were positive and hence not meaningful in the California region, the Northeast region, the South Central region, and the Mid-South region. These inconsistencies likely were attributed to changes in consumer behavior brought on by COVID as well as supply disruptions which occurred during the COVID-affected period.

As exhibited in Figure ES4, the demand for organic milk was inelastic in the pre-COVID period in all regions but for the Plains region. In the COVID-affected period, the demand for organic milk was elastic in the United States, the West region, the Great Lakes region, the Northeast region, and the Southeast region. On the other hand, in the COVID-affected region, the demand for organic milk was inelastic in the California region, the Plains region, the South Central region, and the Mid-South region.

As presented in Figure ES5, the demand for traditional flavored milk was elastic in the pre-COVID period for all regions except for the California, the Plains, and the Northeast regions. The magnitude of the own-price elasticities for traditional flavored milk rose in the COVID-affected period vis-à-vis the pre-COVID period for the United States, the West region, and the Great Lakes region. But the magnitude of the own-price elasticities for traditional flavored milk fell in the Plains region, the South Central region, and the Mid-South region. In the COVID-affected period, own-price elasticities for traditional flavored milk were positive and hence not meaningful in the California, the Northeast, and the Southeast regions. These inconsistencies likely were attributed to changes in consumer behavior brought on by COVID as well as supply disruptions which occurred during the COVID-affected period.

As exhibited in Figure ES6, the demand for health-enhanced milk was sensitive to changes to prices in all regions and the United States except for the West region in the pre-COVID period. That is to say, the demand for health-enhanced milk was elastic the pre-COVID period in all regions but for the West region. In the COVID-affected period, however, declines in the magnitude of the own-price elasticities for health-enhanced milk were evident for all regions but for the West region and for the United States. In the COVID-affected period, the demand for health-enhanced milk was inelastic for all regions except for the West region, the Great Lakes region, and the United States as a whole.

As exhibited in Figure ES7, in the pre-COVID period, the demand for lactose-free milk was inelastic in all regions but for the Plains region. In the COVID-affected period, the demand for lactose-free milk was elastic in the Plains region, the Northeast region, the Mid-South region, and for the United States. The demand for lactose-free milk was even more inelastic in the COVID-affected period in the California region, the West region, the Southeast region, and the South Central region.

Figure ES3. Own-Price Elasticities for Traditional White Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

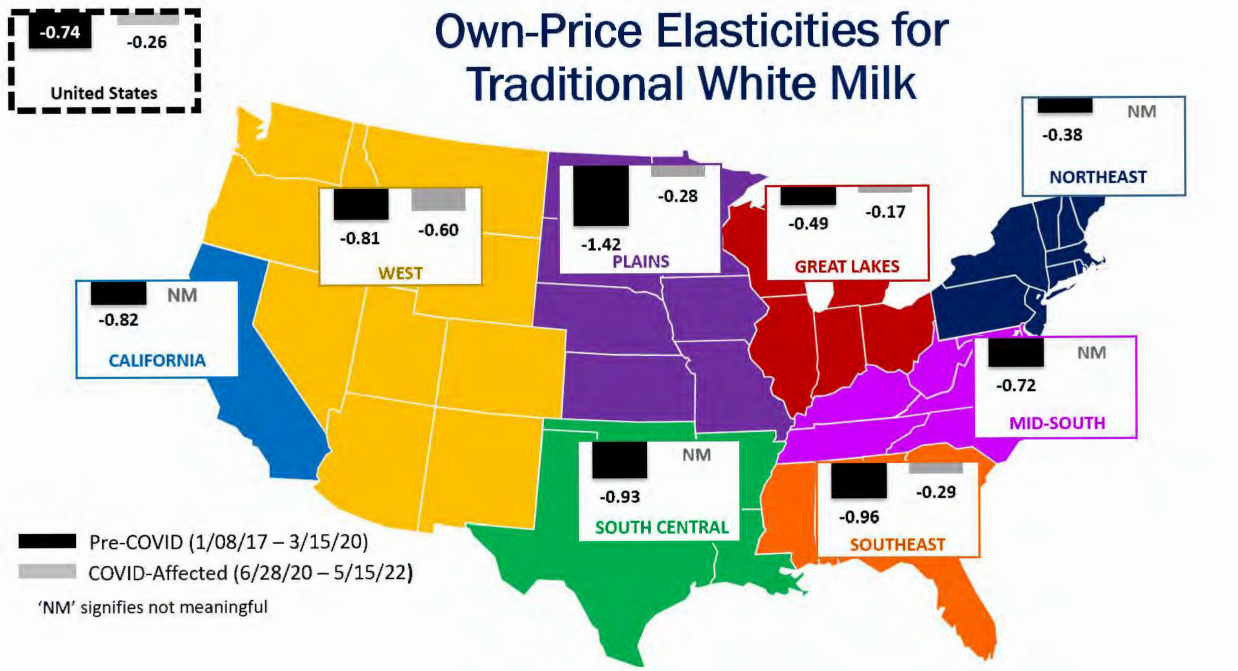


Figure ES4. Own-Price Elasticities for Organic Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

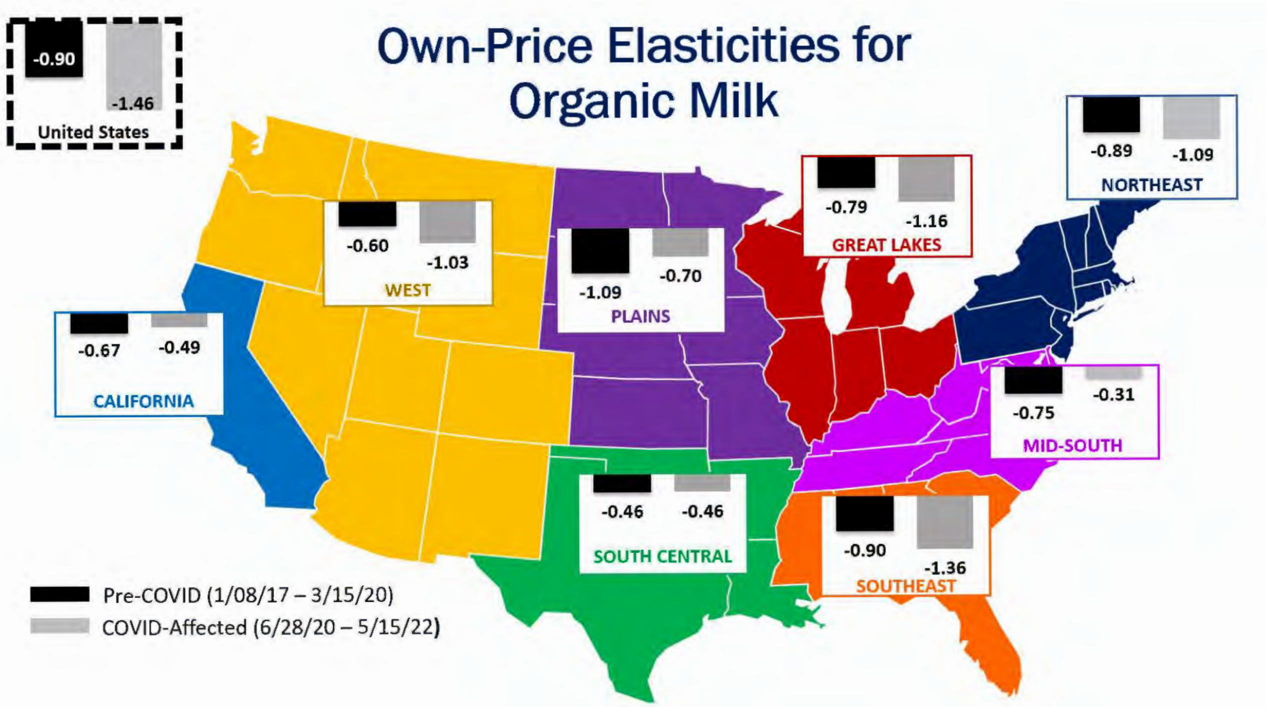


Figure ES5. Own-Price Elasticities for Traditional Flavored Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

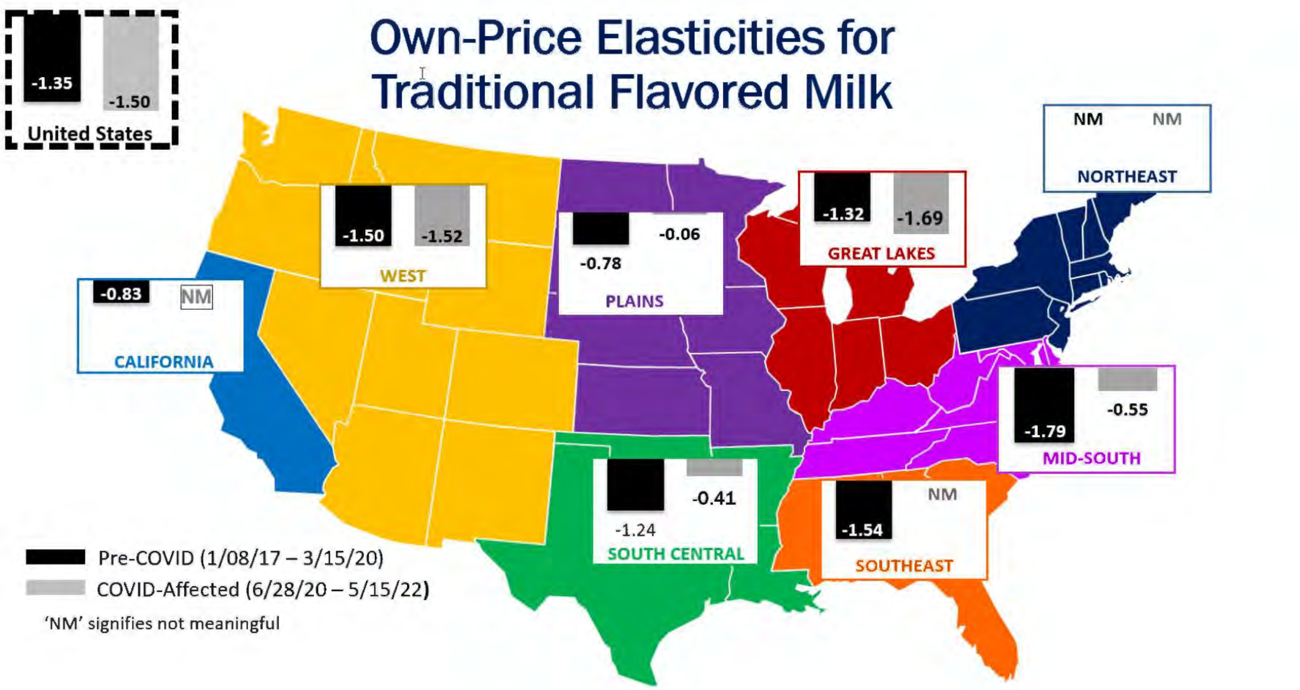


Figure ES6. Own-Price Elasticities for Health-Enhanced Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

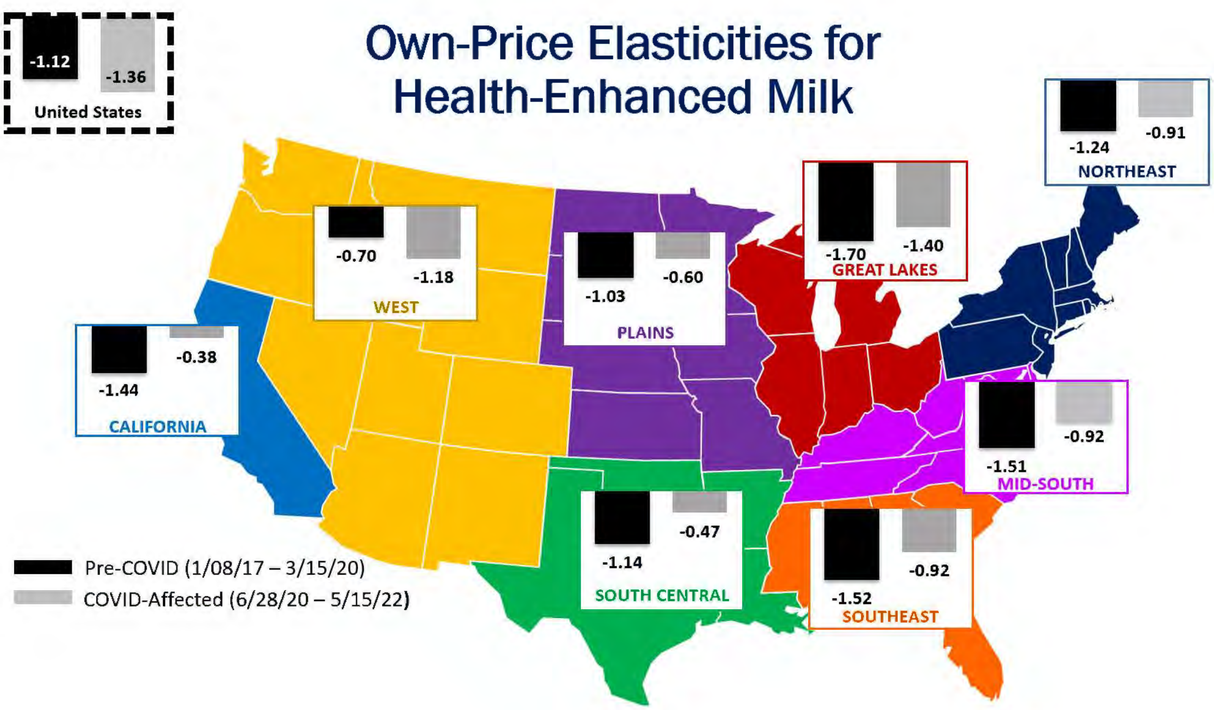
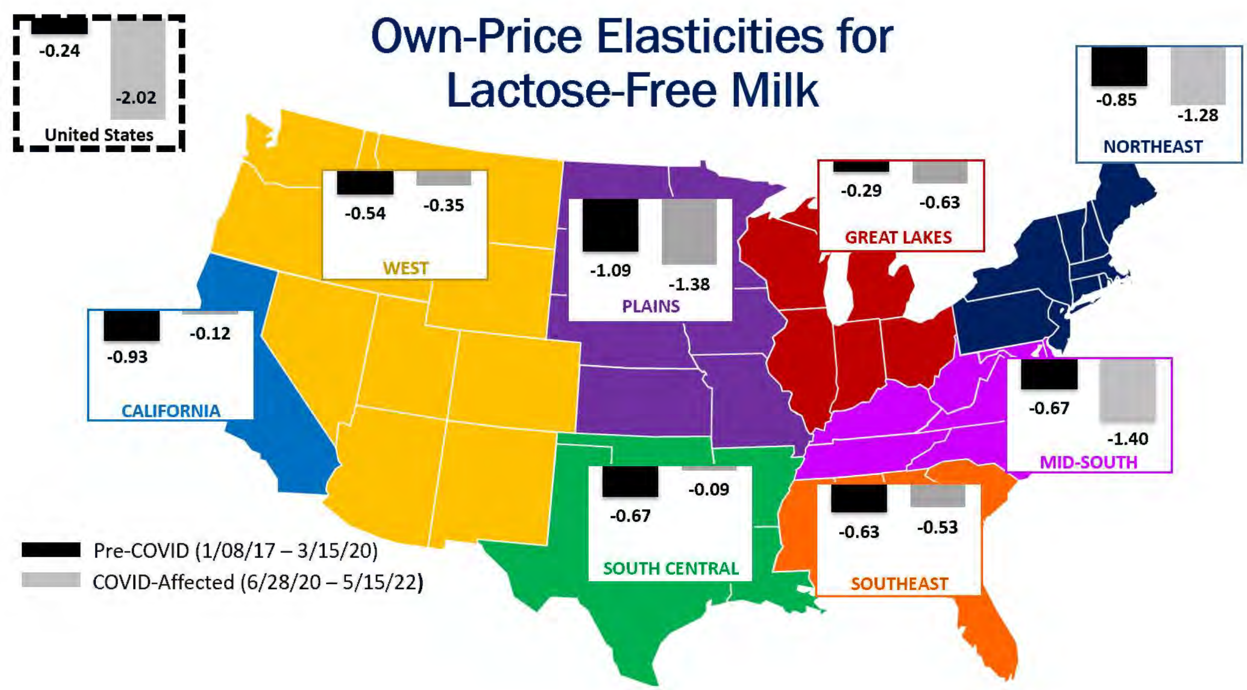


Figure ES7. Own-Price Elasticities for Lactose-Free Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)



Analysis Based on AMS Data

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). The primary motivation for the consideration of the USDA, AMS data is to draw comparisons to the IRI analysis, and to shed light on the **non-retail component** of fluid milk sales. In doing so, IDFA and MilkPEP is in position to highlight the impacts of pricing policy on fluid milk sales.

Unlike the IRI data, these sales 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 products** in the 11 Federal Milk Orders.

To be consistent with the previously discussed IRI national and regional analyses, the AMS data span the period from January 2017 to August 2022 in this analysis. The own-price elasticities were estimated to be -0.24 for total milk, -0.37 for traditional white milk; -0.74 for organic milk; and 1.54 for traditional flavored milk. The respective own-price elasticities except for traditional flavored milk were consistent with the extant literature and economic theory. Further, the own-price elasticities for total milk, traditional white milk, and organic milk were in the inelastic range. As such, as expected, not much price sensitivity was evident concerning these three fluid milk products. A possible explanation for the anomalous positive own-price elasticity for traditional flavored milk may be attributed to deliveries in packages from processing (bottling) plants predominantly to schools. As such, we may argue that price sensitivity was not a prime consideration for schools.

The own-price elasticities for total milk across the respective marketing orders were estimated to be in the inelastic range. In addition, the respective own-price elasticities were not uniform across marketing orders. The lowest own-price elasticity was in the Appalachian Order (-0.0020), while the highest own-price elasticity was in the Southeast Order (-0.1559). As expected, not much price sensitivity was evident concerning total milk by Federal Milk Marketing Order. This result is consistent with the extant economic literature.

Bottom line, largely due to the granular array of products considered in the demand system model, estimated own-price elasticities for milk products using the data from IRI were much greater in magnitude than the corresponding elasticities estimated using the data from AMS. The Barten synthetic demand systems model accounts for interrelationships among the respective products whereas the SUR model does not due to the unavailability of relevant data from AMS. Finally, the demand systems analysis was based on weekly data, while the SUR analysis was based on monthly data. Weekly frequencies of data are more likely to yield higher own-price elasticities of demand compared to monthly frequencies.

Systematic Review of the Existing Literature

A systematic review of the economic literature was conducted to examine and summarize existing research on milk elasticities. Sixty-four studies were included in the review. Uncompensated own-price elasticities for milk (fluid milk, cow's milk, white milk, generic milk, or conventional milk) ranged from -2.41 to zero with the median value of -0.24. The own-price elasticity for total milk from the literature was estimated to be -0.37, ranging from -0.59 to -0.15. Own-price elasticities for flavored milk ranged from -3.82 to -1.39, and for organic milk, the own-price elasticities ranged from -4.22 to -0.63. Although there was a considerable range of own-price elasticity estimates for milk products gleaned from the literature, some generalization can be drawn from this review. The majority of the studies reported inelastic own-price elasticities of demand for traditional white milk but reported elastic own-price elasticities of demand for flavored milk and organic milk. Own-price elasticity estimates for specialty milk (rBST free milk, goat milk, and lactose-free milk) and for plant-based alternative beverages to milk were mixed. No own-price elasticities were reported in the extant literature for health-enhanced milk. Finally, all own-price elasticities were reported for periods prior to the COVID pandemic.

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A Deeper Look at Milk and Competing Beverage Price Elasticities

Objectives of the Study

The general objective of this study was to investigate demand interrelationships between milk sub-categories and other competing beverages using two different datasets: (1) weekly time-series data procured from Information Resources, Inc (IRI) over the last five years; and (2) the USDA data from the Agricultural Marketing Service (AMS) pertaining to monthly estimated fluid milk products sales.

Specific objectives include:

1. To estimate the Barten Synthetic Model, a demand system model, nationally and regionally (eight IRI regions) using data procured from Information Resources, Inc (IRI).
2. To estimate the Seemingly Unrelated Regression (SUR) model on a national level and for the 11 Federal Milk Orders using data procured from AMS, USDA.
3. To derive uncompensated and compensated own-price elasticities as well as expenditure elasticities for these categories using the results from Objective 1.
4. To analyze the substitutability and complementarity among the specified distinct products based on compensated cross-price elasticities using the results from Objective 1.
5. To conduct a systematic review of existing literature and provide the elasticity estimate(s) by extracting data from selected studies and conducting meta-analysis.

Economists often measure the sensitivity of consumption of fluid milk products to changes in demand drivers such as prices and income. In economic jargon, the term sensitivity is tantamount to elasticity. Own-price elasticity is defined as the percentage change in consumption due to a one percent change in the price of the product in question.[2] Cross-price-elasticity refers to the percentage change in consumption due to a one percent change in the price of another product.[3] Income elasticity pertains to the percentage change in consumption due to a one percent change in income. Elasticities are unitless measures, dealing only with percentage changes in consumption due to unit percentage changes in own-price, other prices, or income. Hence the elasticity measures estimated do not depend on the units in which the prices and quantities are expressed. Therefore, elasticities for different goods and markets can be directly compared.

[2] Since quantity demanded generally decreases when the price increases, the own-price elasticity is usually expected to be negative. Products with elasticities less than one in absolute value are commonly referred to as having inelastic or price insensitive demand. In this situation, increasing the price will increase the revenue of the producer of the product. Products with elasticity greater than one in absolute value are referred to as having elastic or price sensitive demand and therefore, increasing the price will result in revenue decrease to the producer of the product.

[3] When the compensated cross-price elasticity is positive, the two goods are substitutes, when it is negative, the two goods are complements.

Of particular importance is the fact that the most recent demand system analyses associated with different dairy categories in the United States were done a decade ago (Davis et al, 2010; Chouinard et al. 2010; Davis et al. 2011; Davis et al. 2012). As such, our contribution serves to provide a more up-to-date demand systems analysis for fluid milk products as well as for plant-based milk alternatives and other competing beverages currently lacking in extant literature. Further, with the use of a demand systems approach, we account for interrelationships among the various products. With this approach, we insure not only that our econometric findings are consistent with demand theory but also would stand up to peer review.

Analysis of the IRI Scanner Data

The Information Resources, Inc. (IRI) weekly data from January 2017 to May 2022 were used to estimate the eleven-equation Barten Synthetic Model,[4] a demand system model, and derive own-price, cross-price, and total expenditure elasticities of demand for milk and milk sub-categories. The IRI data provide information on volume sales, dollar sales, unit sales, average price per volume, average price per unit, base price per volume, base price per unit, percentage of volume with any price reductions, and total points of distribution.[5]

In the demand system estimation, milk was divided into five sub-categories: (1) traditional white milk; (2) organic milk; (3) traditional flavored milk; (4) health-enhanced milk (products with added protein, calcium, or other health benefits); and (5) lactose-free milk. Elasticities can vary depending on the availability of substitutes and therefore, five competing beverages and yogurt were included in the demand model to account for potential substitutability and complementarity; (6) refrigerated juices and drinks and shelf-stable bottled juices (hereinafter "juices"); (7) bottled water; (8) sports drinks; (9) protein beverages; (10) alternative (plant-based) beverages (almond, cashew, coconut, oat, rice, and soy); and (11) yogurt.

The weekly data used in the analysis cover the recent five-year period,[6] hence to discern the impact of the COVID-19 pandemic, the data were divided into two periods: (1) Pre-COVID — January 8, 2017 to March 15, 2020 (166 weekly observations); and (2) COVID-affected — June 28, 2020 to May 15, 2022 (100 observations). This span is 14 weeks after the beginning of the pandemic. This selection of this period allows for adjustments to take place because of the onset of COVID.

For all product categories, gallons were used as a unit of volume, and the associated price was expressed as dollars/ gallon (based on volume metrics). The exceptions to the use of gallons as the

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[4] The description of the Barten Synthetic Model is provided in Appendix A.

[5] The total point of distribution is a measure that reports the distribution of a product aggregate while taking into account the number of UPCs selling within that aggregate.

[6] The World Health Organization formally declared COVID-19 a pandemic on March 11, 2020. Two days later March 13, 2020, the Trump Administration declared COVID-19 a national emergency. We adopt this period to indicate the start of market disruption attributed to COVID-19. That said, we acknowledge that initial consumer reaction to the pandemic could have happened before March 11, 2020, given that the first COVID-19 case in the United States could be traced back to January 21, 2020, and given that the CDC expressed a warning of a looming pandemic on February 25, 2020.

See also: Zhao, S., L. Wang, W. Hu, and Y. Zheng. 2022. Meet the Meatless: Demand for New Generation Plant-Based Meat Alternatives. *Applied Economic Perspectives and Policy*, 2022:1-18.

volume unit of measurement in this analysis were juices and sports drinks expressed in terms of ounces and for yogurt wherein the volume unit of measurement was expressed in terms of pints. Prices were derived as the ratio of dollar sales to volume expressed as either gallons, ounces (for juices and sports drinks), or pints (yogurt). This volume-based price is commonly referred to as unit value,[7] in the economic literature. These respective volume-based measures serve as a proxy for retail prices.

The results of the model were checked to ensure that the estimated elasticities satisfy the demand theoretic conditions of homogeneity, symmetry, and adding-up restrictions. In the estimation of the eleven-equation system, traditional flavored milk was arbitrarily chosen as the base or reference category and the parameter estimates for this category were recovered from adding-up restrictions. Stationarity was not an issue since the Barten Synthetic Model is expressed in terms of logarithmic differences. With respect to endogeneity of unit values as proxies for retail prices, instrumental variables to mitigate potential endogeneity tantamount to the use of unit values in other neighboring markets could have been used (Hausman and Taylor, 1981; Hausman, Leonard, and Zona, 1994; Hausman, 1996). But the correlation of unit values across all IRI regions was not only positive but also very large in magnitude. Finally, in the case of the United States market, no neighboring prices/unit values are evident.

The Barten Synthetic Model was augmented to include quarterly dummy variables to capture not only seasonality but also the total points of distribution to capture market reach. Arbitrarily, the fourth quarter was omitted as a reference category for seasonality.

To obtain the own-price elasticity for milk, the five milk sub-categories were combined into a "total milk" category and a seven-product demand model was estimated. The seven product categories include: (1) total milk; (2) refrigerated juices and drinks and shelf stable bottled juices (hereinafter "juices"); (3) bottled water; (4) sports drinks; (5) protein beverages; and (6) alternative (plant-based) beverages (almond, cashew, coconut, oat, rice, and soy); and (7) yogurt.

Barten Synthetic Model Results for the United States

The parameter estimates, standard errors, t-statistics, and p-values from eleven-product Barten Synthetic Model for the United States are reported in Appendix B and provide 10 expenditure

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[7] The issue of volume-based prices or unit values merits attention. The use of unit values often makes own-price elasticities look larger (in absolute value) than they really are. Unit values (expenditures/quantities) particularly from household budget surveys often serve as proxies for unobservable market prices. Deaton (1988, 1990, 1997) and Niimi (2005) point out that bias associated with the use of unit values may occur. The bias is attributed to quality variation and reporting errors in expenditures and/or quantities (measurement errors). Deaton (1988) suggests that the bias associated with quality variation makes the demand for a commodity appear to be more elastic, overstating the response of quantity to changes in price. Gibson and Rozelle (2006) suggest that two types of measurement error bias that exist are attenuation bias because unit values are noisy measures of market prices and bias due to correlated errors in measuring expenditures and/or quantities. In the case of attenuation bias, Gibson and Rozelle (2006) point out that the bias is in the opposite direction to that attributed to quality variation. If so, then the bias due to quality variation and the bias due to attenuation are offsetting. However, Gibson and Rozelle (2006) also point out that the bias due to correlated errors operates in the operation direction to attenuation bias. Consequently, the bias due to correlated errors reinforces the bias due to quality effects. Further, Gibson and Rozelle (2006) find that the bias associated with quality variation is relatively minor, also consistent with the finding of Deaton (1997). In this study, we assume that any bias that may occur when using unit values as proxies for retail prices is negligible.

coefficients, 55 price coefficients, 30 seasonality coefficients, and 10 total points of distribution coefficients estimated for each of the pre-COVID and COVID-affected periods. These estimated coefficients were used to calculate the uncompensated and compensated own-price and cross-price elasticities and expenditure elasticities.

The summary statistics of price per volume, quantity sold, and budget shares for the eleven product categories by pre-COVID and COVID-affected periods are provided in Table 1. The average price of five milk sub-categories ranged from $3.07 for traditional white milk to $9.21 for health-enhanced milk during the pre-COVID period. In general, an increase in average price per volume for total milk and for each of the five milk sub-categories was observed from the pre-COVID period to the COVID-affected period. This observation is consistent with economic theory. With increases in demand and decreases in supply in response to pandemic, it is natural to expect increases in price, especially in the long run.[8]

The highest price increase from the pre-COVID period to the COVID-affected period was observed for traditional white milk (14% increase), followed by traditional flavored milk (11% increase) and health-enhanced milk (5% increase), and the least price increase was observed for lactose-free milk (1%).

The average prices for organic milk, health-enhanced milk and lactose-free milk were more than double the average prices for traditional white milk for the pre-COVID period and for the COVID-affected. Despite the relative lower prices compared to other milk products, the "dominance" of traditional white milk is evident from data pertaining to the average quantities sold and the budget shares. Most of the total milk budget share (67% for the pre-COVID period and 64% for the COVID-affected period) was attributable to traditional white milk, followed by organic milk (13%).

Additionally, increases in prices of competitive beverages and yogurt were evident from the pre-COVID period to the COVID-affected period. The highest increase in average price was observed for sports drinks (23% increase) and smallest increase was observed for alternative or plant-based beverages (3%) from the pre-COVID period to the COVID-affected period.

The average quantity sold decreased for traditional white milk and traditional flavored milk from the pre-COVID period to the COVID-affected period, but average quantities sold increased for all other milk sub-categories. Milk and dairy products were particularly in demand in grocery stores as consumers stayed home during pandemic due to mass closures of schools and restaurants.

Out of the eleven product categories, milk represented about 26% of the market share pre-COVID and slightly more than 23% of the market share during the COVID-affected period. Milk lost two

[8] In general, when demand increases, price would increase because of the rightward shift of the demand curve. The price of the good would further increase as the supply decreases and the supply curve shifts to the left. With closure of schools and restaurants and stay-at-home order issued across country, consumers notably changed their consumption behavior by reallocating activities away from restaurants and towards grocery stores and other food retailers. This re-shuffling led to increases in demand for food at-home consumption. This increase in demand also created stress in the supply chain, especially for perishable products such as dairy. Grocery stores placed quantity restrictions on selected items to support more customers and to limit panic buying. In addition, supply disruptions were evident ranging from transportation to labor shortages to processing of food and in case of milk, figuring out the logistics of moving large volumes of milk processed for institutional buyers because of school and restaurant closures.

percentage points from the pre-COVID period to the COVID-affected period whereas bottled water gained two percentage points in market share (from 25% to 27%).

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

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**3.69**	**4.24**	**65.43**	**60.79**	**25.47**	**23.25**
Traditional White Milk	3.07	3.48	54.39	48.56	17.11	14.82
Organic Milk	8.01	8.29	3.90	3.99	3.20	2.91
Traditional Flavored Milk	5.05	5.60	2.82	2.69	1.46	1.32
Health-Enhanced Milk[3]	9.21	9.64	2.05	2.72	1.93	2.30
Lactose-Free Milk	7.61	7.66	2.26	2.83	1.76	1.90
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.05	4,800.00	5,010.00	22.77	22.37
Bottled Water	1.50	1.65	163.97	188.15	25.07	27.13
Sports Drinks	0.03	0.04	2,070.00	2,350.00	7.16	8.42
Protein Beverages	19.82	20.49	1.31	1.69	2.64	3.03
Alternative Beverages[5]	6.74	6.94	5.50	6.92	3.79	4.21
Yogurt	2.35	2.43	54.56	54.43	13.11	11.59

[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]Alternative beverages refer to plant-based alternatives (almond, cashew, coconut, oat, rice, and soy).

The estimated uncompensated own-price elasticities, expenditure elasticities and income elasticities for pre-COVID and COVID-affected periods are provided in Table 2. The side-by-side chart of the uncompensated own-price elasticities for total milk, five sub-categories of milk, five competitive beverages and yogurt between pre-COVID and COVID-affected periods is presented in Figure 1.

All the estimated own-price elasticities of demand were negative for both pre-COVID and COVID-affected periods, consistent with economic theory. For the pre-COVID period, the elasticities presented in Table 2 revealed that traditional white milk, organic milk and lactose-free milk were not very sensitive to price changes. For example, a 1% increase in their respective prices lead to a 0.74% decrease in quantity demanded for traditional white milk, a 0.90% decrease in quantity demanded for organic milk and 0.24% decrease in quantity demanded for lactose-free milk. In contrast, traditional flavored milk, and health-enhanced milk were highly responsive to changes in prices.

Traditional flavored milk was most price sensitive among milk sub-categories with estimated own-price elasticity of -1.35 and lactose-free milk was least price sensitive with estimated elasticity of -0.24. The more expensive milk sub-categories had higher own-price elasticities, with the exception for lactose-free milk.

There were notable differences in own-price elasticities between pre-COVID and COVID-affected periods. Traditional white milk became less price responsive with the onset of COVID, while other milk sub-categories became more sensitive to price changes. The own-price elasticity for total milk changed from being quite responsive to price changes in the pre-COVID period to less sensitive to price changes during the COVID-affected period. Specifically, for a 1% increase in price of total milk, the quantity demanded decreased by 1.10% in the pre-COVID period and 0.40% in the COVID-affected period. This change in the own-price elasticity for total milk was primarily driven by traditional white milk. The most noticeable change in own-price elasticity was observed for lactose-free milk from being almost unresponsive to price changes (-0.24) during the pre-COVID period to being highly sensitive to price changes (-2.02) in the COVID-affected period.

With respect to competitive beverages, while COVID slightly affected the budget shares levels, the own-price elasticities of some products were greatly affected. The own-price elasticity for juices was estimated to be -0.94 pre-COVID and -0.20 during the COVID-affected period. For every 1% change in the price of juices the quantity demanded decreased by 0.94% and 0.20% during the pre-COVID and COVID-affected periods, respectively. The demands for traditional white milk and juices were more inelastic during the COVID-affected period. One of the possible explanations associated with this finding is that these products are geared toward children.

The demand for plant-based alternative beverages to milk changed from being inelastic (-0.73) to being elastic (-1.67). All other competitive beverages were quite responsive to price changes pre-COVID and remained so during the COVID-affected period.

Traditional white milk was found to be the least expenditure-elastic in both periods whereas sports drinks were the most expenditure-elastic. All the income elasticities were positive and between zero and one for both pre-COVID and COVID-affected periods, indicating that all the products considered were not only normal goods but also necessities in economic parlance. Health-enhanced milk and lactose-free milk had the highest income elasticities among milk products whereas traditional white milk and traditional flavored milk had the lowest.

Table 2. Own-Price Elasticities, Expenditure Elasticities and Income Elasticities for the United States Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity		Income Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.097**	**-0.403**	**0.774**	**0.475**		
Traditional White Milk	-0.737	-0.260	0.720	0.447	0.258	0.160
Organic Milk	-0.903	-1.445	0.914	0.648	0.327	0.232
Traditional Flavored Milk	-1.353	-1.498	0.787	0.478	0.282	0.171
Health-Enhanced Milk[2]	-1.124	-1.359	0.962	0.972	0.345	0.348
Lactose-Free Milk	-0.240	-2.024	0.891	0.938	0.319	0.336
Competitive Beverages & Yogurt						
Juices[3]	-0.940	-0.201	0.916	0.744	0.328	0.267
Bottled Water	-2.227	-1.466	1.193	1.180	0.427	0.423
Sports Drinks	-1.867	-1.813	1.401	1.557	0.502	0.558
Protein Beverages	-2.081	-1.966	0.928	1.546	0.332	0.554
Alternative Beverages[4]	-0.729	-1.672	0.972	0.977	0.348	0.350
Yogurt	-2.502	-2.320	1.012	1.404	0.362	0.503

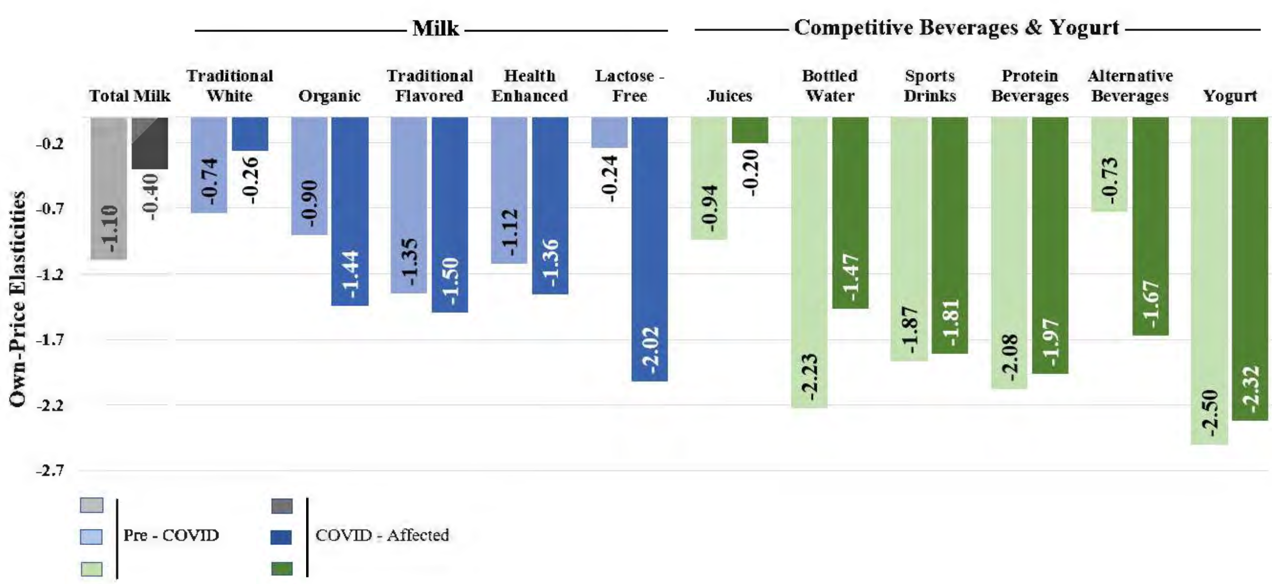
[1]Five milk sub-categories were combined into a "Total Milk" category and a seven-product demand model was estimated to obtain elasticity estimates for Total Milk category.

[2] Health-enhanced milk (products with added protein, calcium, or other health benefits).

[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.

[4]Alternative beverages refer to plant-based alternatives (almond, cashew, coconut, oat, rice, and soy).

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



Notes: Elasticities for "Total Milk" category were taken from seven-product demand model.

The estimated compensated own-price and cross-price elasticities of demand are provided for pre-COVID period in Table 3 for COVID-affected in Table 4. The values in these tables describe the substitutability and complementarity patterns among the eleven product categories. Most cross-price elasticities of demand were positive in both time periods, indicating the presence of substitution relationships over complementary relationships among the respective products in question.

Plant-based alternative beverages were substitutes for traditional white milk and organic milk in both the pre-COVID and COVID-affected periods for the United States. Sports drinks and yogurt were substitutes for traditional flavored milk, health-enhanced milk, and lactose-free milk. 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 pre-COVID and COVID-affected periods. Bottled water was substitute for all milk sub-categories, competitive beverages, and yogurt.

Similar patterns were observed for the COVID-affected period but with even greater number of substitutes compared to the pre-COVID period. Lactose-free milk was a substitute for traditional white milk and organic milk. Traditional white milk and organic milk were substitutes in the COVID-affected period.

Table 3. Compensated Own- and Cross-Price Elasticities for the United States, Pre-COVID period (January 8, 2017-March 15, 2020)

	Milk					Competitive Beverages and Yogurt					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.614***	-0.114	-0.121	-0.275	-0.197	-0.051	**0.336**	-0.026	**0.160**	**0.452**	**0.450**
Organic Milk	-0.608	***-0.873***	-0.042	-0.385	-0.128	-0.041	**0.535**	-0.051	**0.122**	**0.312**	**1.160**
Traditional Flavored Milk	-1.413	-0.093	***-1.341***	**0.535**	**0.218**	-0.350	**0.730**	**0.562**	**0.338**	-0.119	**0.932**
Health-Enhanced Milk	-2.435	-0.637	**0.404**	***-1.105***	-0.219	-2.337	**0.856**	**1.006**	**0.539**	-0.414	**4.343**
Lactose-Free Milk	-1.913	-0.233	**0.180**	-0.240	***-0.224***	-1.777	**0.598**	**0.605**	**0.370**	-0.456	**3.090**
Juices	-0.038	-0.006	-0.022	-0.198	-0.138	***-0.732***	**0.266**	**0.385**	-0.014	**0.338**	**0.159**
Bottled Water	**0.229**	**0.068**	**0.043**	**0.066**	**0.042**	**0.242**	***-1.928***	**0.307**	**0.103**	**0.151**	**0.677**
Sports Drinks	-0.063	-0.023	**0.115**	**0.272**	**0.149**	**1.223**	**1.076**	***-1.766***	**0.017**	-0.502	-0.497
Protein Beverages	**1.040**	**0.148**	**0.187**	**0.395**	**0.247**	-0.120	**0.980**	**0.046**	***-2.056***	-0.361	-0.507
Alternative Beverages	**2.040**	**0.264**	-0.046	-0.212	-0.212	**2.035**	**1.001**	-0.949	-0.252	***-0.692***	-2.977
Yogurt	**0.588**	**0.283**	**0.104**	**0.641**	**0.416**	**0.277**	**1.294**	-0.271	-0.102	-0.860	***-2.369***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 4. Compensated Own- and Cross-Price Elasticities for the United States, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					Competitive Beverages and Yogurt					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.193***	**0.017**	-0.157	-0.118	**0.001**	**0.202**	**0.029**	-0.037	**0.025**	**0.295**	-0.063
Organic Milk	**0.087**	***-1.426***	-0.206	**0.053**	**0.281**	-0.282	**0.424**	**0.074**	**0.032**	**0.547**	**0.414**
Traditional Flavored Milk	-1.770	-0.454	***-1.491***	-0.203	-0.227	-2.406	**0.823**	**1.298**	**1.163**	**0.074**	**3.193**
Health-Enhanced Milk	-0.758	**0.067**	-0.116	***-1.337***	-0.970	-3.211	**1.250**	**0.568**	**0.723**	**0.877**	**2.907**
Lactose-Free Milk	0.005	**0.431**	-0.158	-1.174	***-2.006***	-2.340	**0.959**	**0.648**	**0.489**	**0.242**	**2.904**
Juices	**0.134**	-0.037	-0.142	-0.330	-0.199	***-0.034***	-0.233	**0.154**	**0.038**	**0.462**	**0.186**
Bottled Water	**0.016**	**0.045**	**0.040**	**0.106**	**0.067**	-0.192	***-1.146***	**0.203**	**0.158**	**0.087**	**0.615**
Sports Drinks	-0.065	**0.026**	**0.203**	**0.155**	**0.146**	**0.409**	**0.655**	***-1.682***	**0.100**	-0.150	**0.202**
Protein Beverages	**0.121**	**0.031**	**0.505**	**0.548**	**0.306**	**0.283**	**1.417**	**0.277**	***-1.919***	-0.601	-0.968
Alternative Beverages	**1.038**	**0.378**	**0.023**	**0.480**	**0.109**	**2.458**	**0.560**	-0.299	-0.433	***-1.631***	-2.682
Yogurt	-0.081	**0.104**	**0.363**	**0.577**	**0.476**	**0.358**	**1.440**	**0.147**	-0.253	-0.974	***-2.158***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Substitution patterns among traditional white milk, traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk differed in the respective periods. Juices were complements to traditional flavored milk, organic milk, health-enhanced milk, and lactose-free milk across the pre-COVID and COVID-affected periods.

Barten Synthetic Model Results for the Eight IRI Geographic Regions

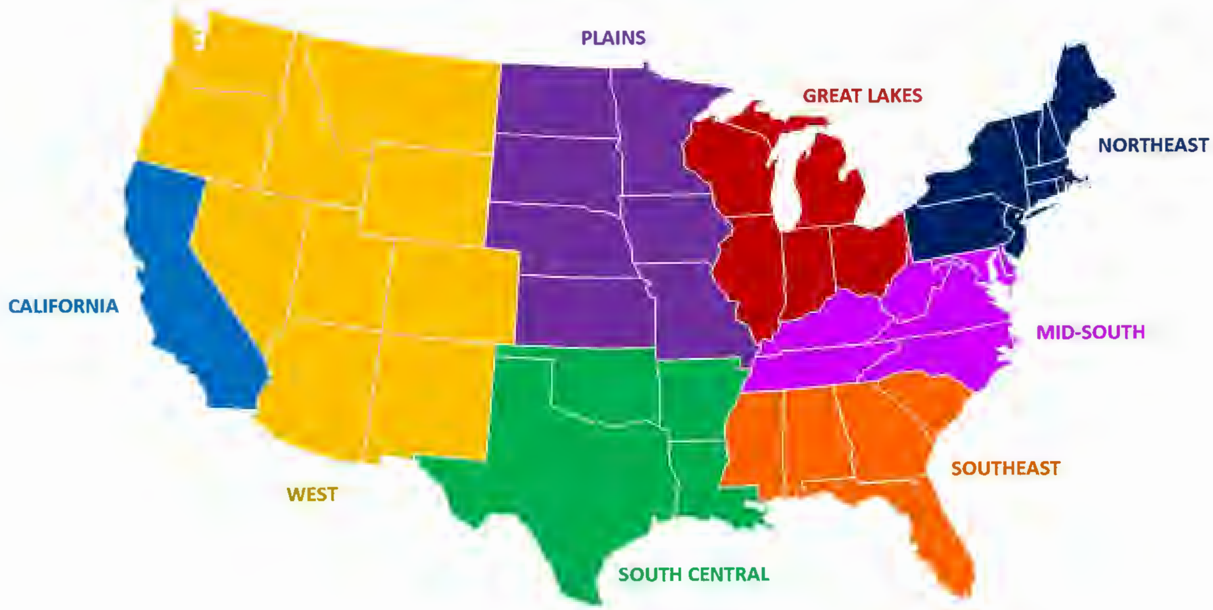
In addition to estimating elasticities for total milk and milk sub-categories for the United States, the analysis was replicated for eight IRI regions (Figure 2): (1) California; (2) West (Montana, Wyoming, Colorado, Idaho, New Mexico, Nevada, Arizona, Utah, Washington, and Oregon); (3) Plains (Minnesota, Iowa, Missouri, Nebraska, Kansas, North Dakota, and South Dakota); (4) Great Lakes (Ohio, Indiana, Illinois, Michigan, and Wisconsin); (5) Northeast (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania); (6) Mid-South (Maryland, Delaware, Virginia, West Virginia, North Carolina, Kentucky, and Tennessee); (7) South Central (Arkansas, Louisiana, Oklahoma, and Texas);and (8) Southeast (Alabama, Mississippi, Georgia, South Carolina, Florida). Hawaii and Alaska are not part of the respective IRI regions. The eight IRI regions account for roughly 99% of the U.S. population.

Existing research suggests that consumption of patterns for fluid milk products differ noticeably among regions of the United States (Blisard et al., 1991; Capps and Schmitz, 1991; Chidmi and Murova, 2011; Choi et al, 2013; Green and Park, 1998). These regional differences in consumption patterns may arise from variations in demographic composition and characteristics, income levels, relative price levels, and tastes and preferences of consumers. With respect to the pandemic, federal, state, and local government regulations, restrictions concerning social behavior also may affect consumption patterns.

The parameter estimates, standard errors, t-statistics, and p-values from the eleven-product Barten Synthetic Model for each of the eight IRI regions are reported in Appendix C and provide 10 expenditure coefficients, 55 price coefficients, 30 seasonality coefficients, and 10 total points of distribution coefficients estimated for each region by pre-COVID and COVID-affected periods.

Regional differences in average budget shares and own-price elasticities were evident across regions. Noticeable differences also were evident in own-price elasticities between the pre-COVID period and the COVID-affected period. Fourteen of the 192 own-price elasticities were positive, inconsistent with demand theory. Except for traditional flavored milk in the Northeast, the anomalous results occurred in the COVID-affected period. Most of the positive own-price elasticities observed in the COVID-affected period were for traditional white milk, traditional flavored milk, and juices. This inconsistency likely was attributed to changes in consumer behavior brought on by COVID as well as supply disruptions which occurred during the COVID-affected period. In particular, positive own-price elasticities for traditional white milk occurred in the California region, the Northeast region, the Mid-South region, and the South Central region. Positive own-price elasticities for traditional flavored milk were evident in the California region, the Northeast region, and the Southeast region. Further, positive own-price elasticities for total milk were evident in the California region and the South Central region. In the West region, the Plains region, and the South Central region, positive own-price elasticities for juices were evident. Finally, in the South Central region, a positive own-price elasticity for yogurt was recorded.

Figure 2. Eight IRI Regions of the United States



Additionally, noticeable differences across geographies were evident in both the pre-COVID and COVID-affected periods. Partial and complete lockdowns were introduced regionally such as closures of schools, workplaces, non-essential shops and restaurants, banned events and travel and mobility restrictions which in turn affected household food purchase and consumption behaviors.

The own-price elasticity estimates for total milk for the Unites States and for each of the eight IRI regions for the pre-COVID and COVID-affected periods are exhibited in Figure 3. The demand for total milk was very sensitive to changes in price in the pre-COVID period in the United States as well as the California, West, Northeast, and Southeast regions. Consumers were less responsive to price changes in the Plains, Great Lakes and South Central regions. The own-price elasticity for total milk in the Mid-South region was close to zero indicating that consumers were almost unresponsive to price changes in this region in the pre-COVID period. Declines in own-price elasticities for total milk were evident in the COVID-affected period vis-à-vis the pre-COVID period but for the Mid-South region. Own-price elasticities for total milk in the Northeast were elastic in the pre-COVID period and stayed the same during the COVID-affected period. Similar to the finding for the United States, across all IRI regions the largest share of total milk purchases was attributed to traditional white milk.

The own-price elasticity estimates for traditional white milk for the United States and for each of the eight IRI regions are presented in Figure 4. The regional own-price elasticities for traditional white milk ranged from -1.42 to -0.38 in the pre-COVID period with -1.42 being the only elastic value and became even less elastic with the onset of COVID with elasticities ranging from -0.60 to -0.17. In general, consumers were less price responsive across all eight regions and the United States, except for the Plains region, during the pre-COVID period and became even less responsive, with some elasticities closer to zero, to price changes with the onset of COVID-19. In the COVID-affected period, own-price elasticities for traditional white milk were positive and hence not meaningful in the California region, the Northeast region, the South Central region, and

Figure 3. Own-Price Elasticities for Total Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

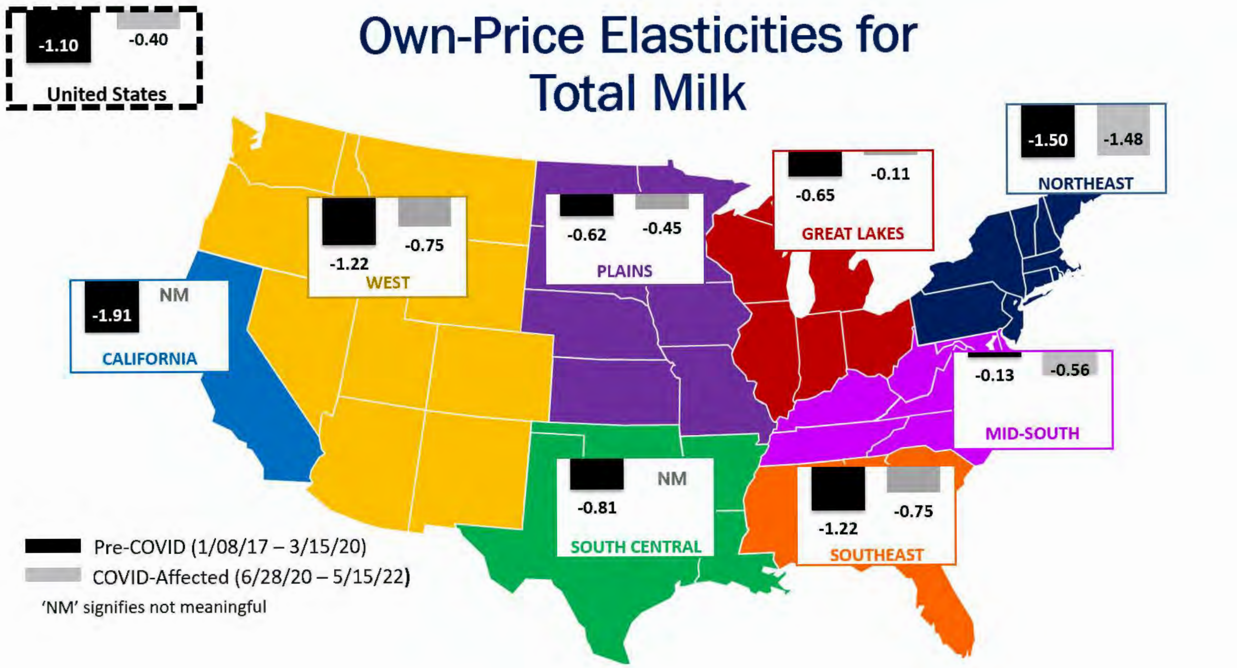
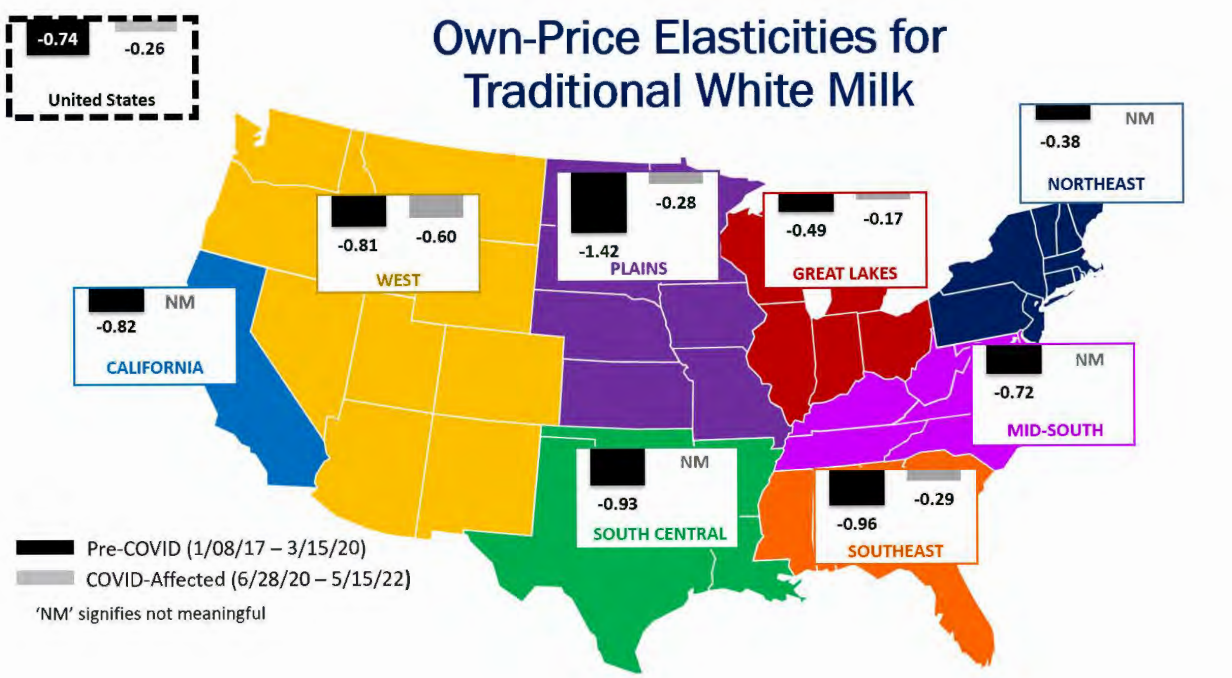


Figure 4. Own-Price Elasticities for Traditional White Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)



the Mid-South region. Likely other factors were at play such as availability of traditional white milk in stores and changes in demand patterns, especially for household with children. The pandemic changed lifestyle patterns of consumers and their buying behavior by restricting mobility since consumers were staying home more, working from home, and eating out less. Traditional white milk was a category that adults were buying for their children as well as for themselves, whereas the demand for other milk categories may have been influenced more by preferences and choices of adults in the household. Hence, when prices went up and availability became an issue, sensitivity to changes in prices was not a concern to consumers during the COVID-affected period. As such, the own-price elasticity for traditional white milk declined for most regions and even turned positive in some regions. We delineate positive own-price elasticities as "not meaningful" to signify that these instances are at odds with economic theory.

As exhibited in Figure 5, the demand for organic milk was inelastic in the pre-COVID period in all regions but for the Plains region. In the COVID-affected period, the demand for organic milk was elastic in the United States, the West region, the Great Lakes region, the Northeast region, and the Southeast region. On the other hand, in the COVID-affected period, the demand for organic milk was inelastic in the California region, the Plains region, the South Central region, and the Mid-South region.

As presented in Figure 6, the demand for traditional flavored milk was elastic in the pre-COVID period for all regions except for the California, and the Plains regions. The magnitude of the own-price elasticities for traditional flavored milk rose in the COVID-affected period vis-à-vis the pre-COVID period for the United States, the West region, and the Great Lakes region. But the magnitude of the own-price elasticities for traditional flavored milk fell in the Plains region, the South Central region, and the Mid-South region. In the COVID-affected period, own-price elasticities for traditional flavored milk were positive and hence not meaningful in the California, the Northeast, and the Southeast regions. These inconsistencies likely were attributed to changes in consumer behavior brought on by COVID as well as supply disruptions which occurred during the COVID-affected period.

As exhibited in Figure 7, the demand for health-enhanced milk was sensitive to changes in prices in all regions and the United States except for the West region in the pre-COVID period. In the COVID-affected period, however, declines in the magnitude of the own-price elasticities for health-enhanced milk were evident for all regions but for the West region and for the United States. In the COVID-affected period, the demand for health-enhanced milk was inelastic for all regions except for the West region, the Great Lakes region, and the United States as a whole.

As exhibited in Figure 8, in the pre-COVID period, the demand for lactose-free milk was inelastic in all regions but for the Plains region. In the COVID-affected period, the demand for lactose-free milk was elastic in the Plains region, the Northeast region, the Mid-South region, and for the United States. The demand for lactose-free milk was even more inelastic in the COVID-affected period in the California region, the West region, the Southeast region, and the South Central region.

Figure 5. Own-Price Elasticities for Organic Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

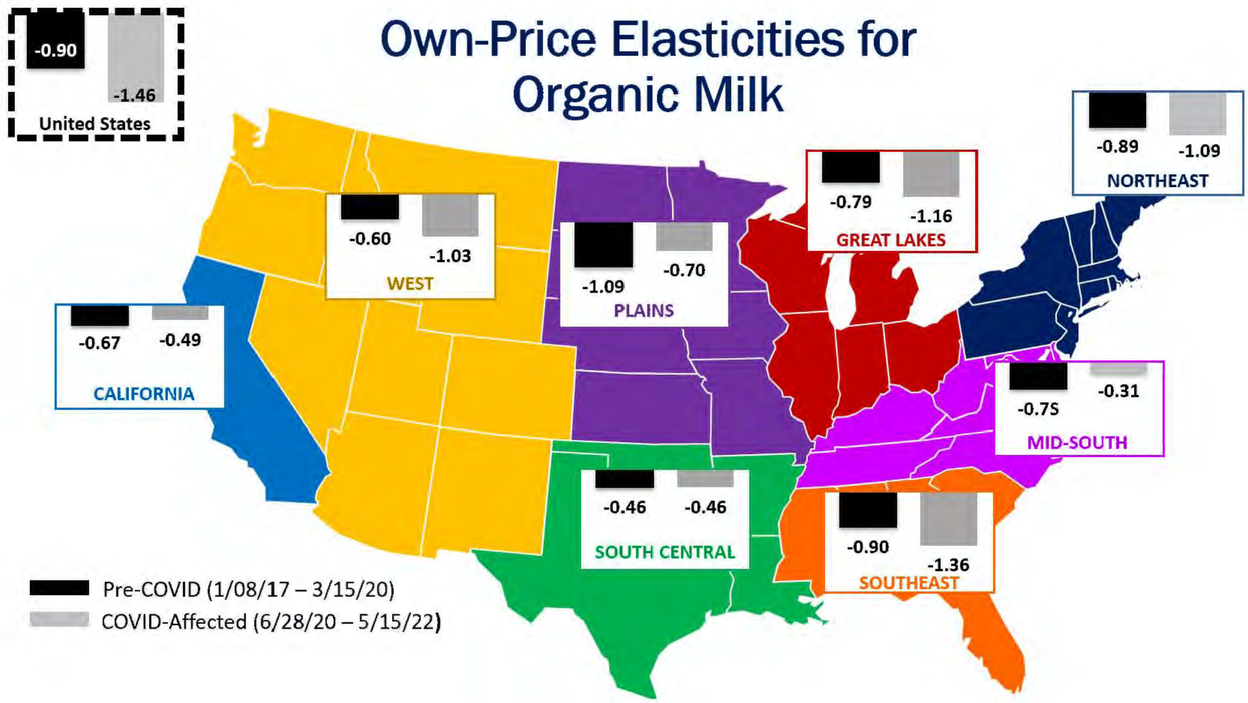


Figure 6. Own-Price Elasticities for Traditional Flavored Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

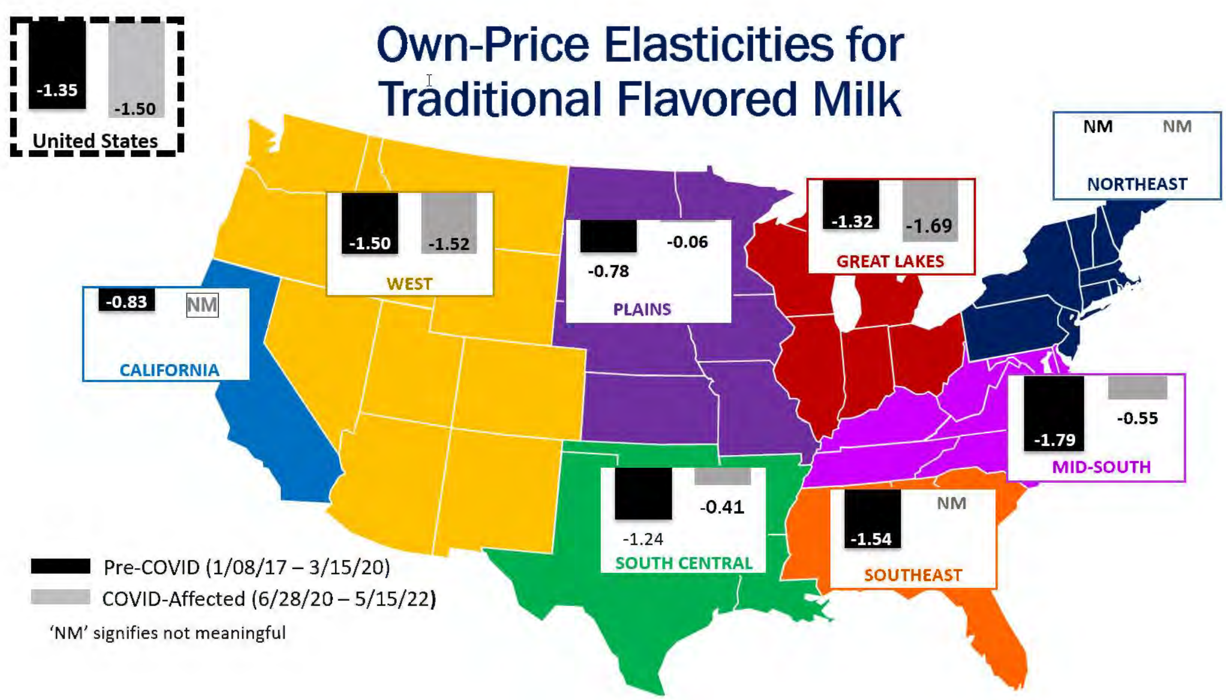


Figure 7. Own-Price Elasticities for Health-Enhanced Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

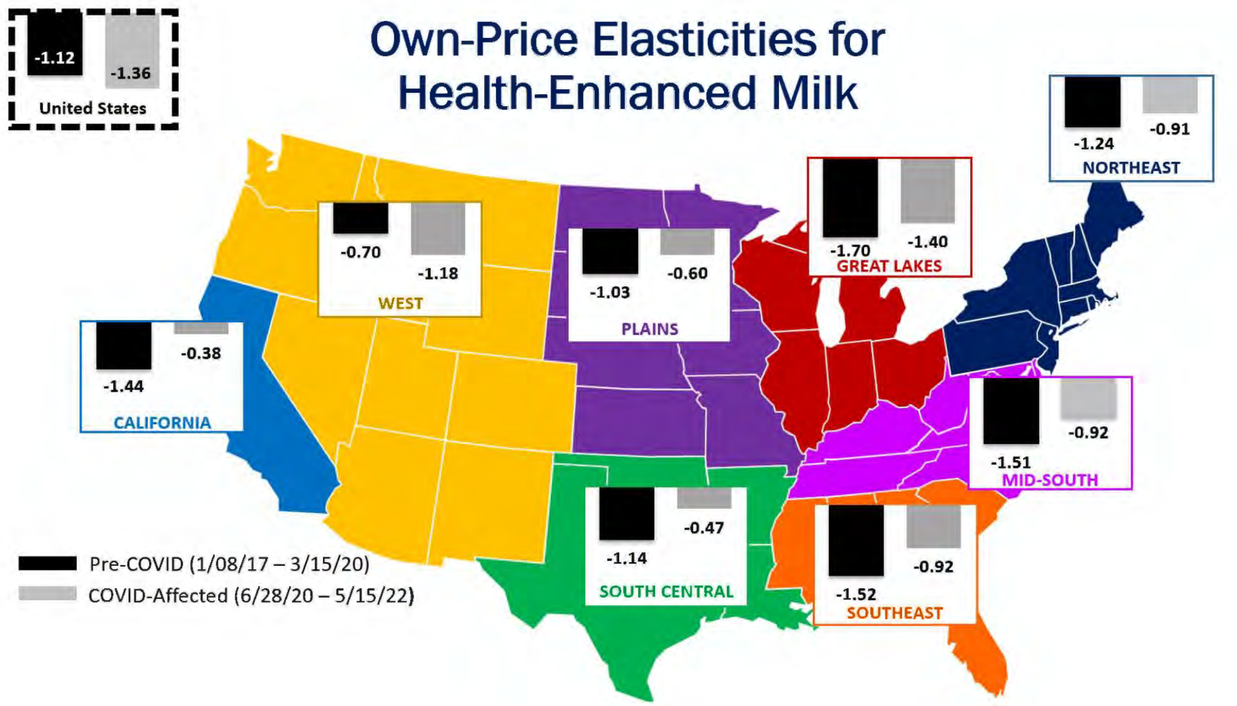
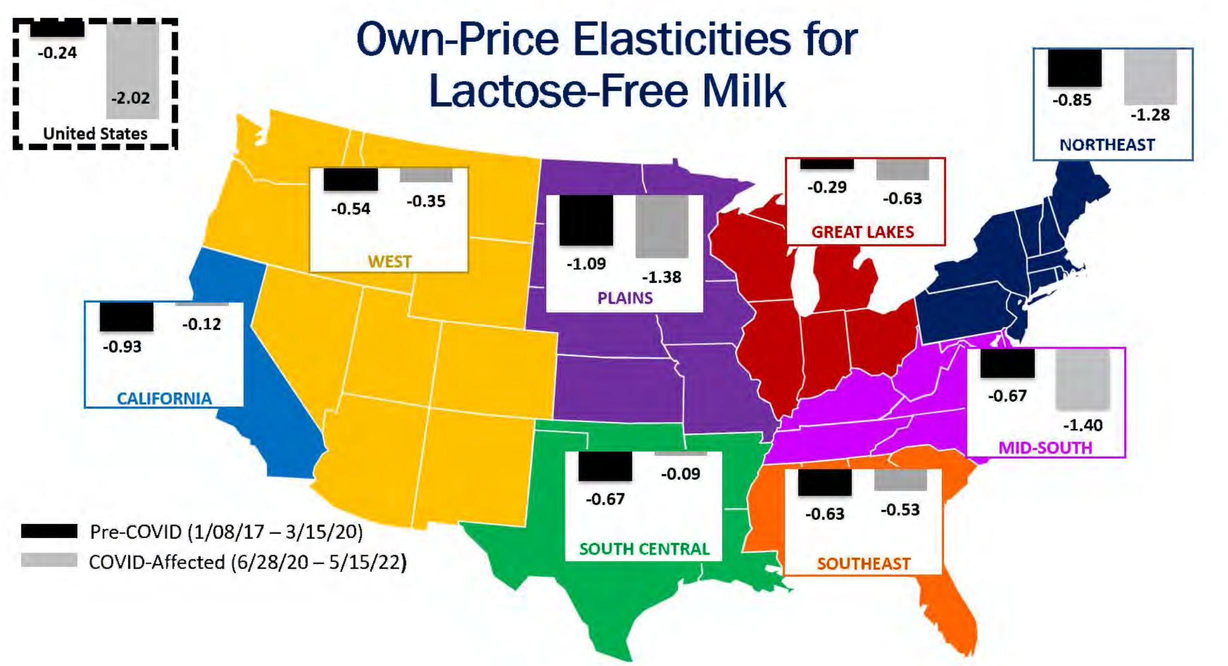


Figure 8. Own-Price Elasticities for Lactose-Free Milk for the United States and Eight IRI Regions by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)



With respect to own-price elasticity for competitive beverages, the demands for sports drinks and protein beverages were relatively less affected by the pandemic. Consumers were quite sensitive to price changes in both these products across all the IRI regions and the United States in both time periods (Table 6, 10, 14, 18, 22, 26, 30, and 34). The demand for plant-based alternative beverages to milk was highly responsive to prices changes in the pre-COVID period, except for the United States and for the Great Lakes region, but the demand for plant-based alternative beverages was less responsive to price changes with onset of the COVID-19. The demand for juices was less responsive to price changes in the pre-COVID period and was even less responsive to price changes in COVID-affected period. On the other hand, the demand for bottled water was highly responsive to price changes and stayed the same even during the COVID-affected period.

Consistent with what was observed for the Unites States (Table 1), increases in average price per volume for total milk and for each of the five milk sub-categories as well as for competitive beverages and yogurt were observed for each of the eight IRI regions from the pre-COVID period to the COVID-affected period (Tables 5, 9, 13, 17, 21, 25, 29 and 33).

As reported in the same tables previously listed, the quantity sold decreased for total milk and traditional white milk for the United States and across all the regions from the pre-COVID to COVID-affected period. Similarly, the quantity sold for traditional flavored milk also decreased, except for the Southeast and South Central regions. Noticeable increases in quantities sold for health-enhanced milk and for lactose-free milk were observed for the United States and across all the IRI regions from the pre-COVID period to COVID-affected period.

The budget shares for traditional white milk, traditional flavored milk and organic milk decreased whereas the budget shares for health-enhanced milk and for lactose-free milk increased for the United States and for each of the eight IRI regions from the pre-COVID period to COVID-affected period. Out of stock issues have been evident for traditional white milk during the COVID-affected period. Other milk categories, such as health-enhanced milk and lactose-free milk, might have benefited when traditional white milk was out of stock.

The California and Northeast regions experienced similar patterns, perhaps driven by extended COVID restrictions during the COVID-affected period. These regions had the highest budget share for organic milk, health-enhanced milk and lactose-free milk and the lowest budget shares for traditional white milk and traditional flavored milk compared to other regions in both the pre-COVID and COVID-affected periods.

Existing research on the effect of disruptions such as natural disasters on dietary and consumption behavior have found that consumers have been observed to have spent on luxury brands and premium categories displaying both cross-category indulgence and impulsive buying behaviors (Kennett-Hensel et al., 2012; Mark et al., 2016; Sneath et al., 2009). Furthermore, increased awareness towards health and hygiene during the pandemic likely had a notable and positive effect on the demand for products related to health as well as on the demand for healthy substitute products of daily necessities (Das et al., 2022). These factors serve as explanations for the respective changes observed in quantities sold, budget shares and consumer responses to price changes for the respective milk categories of interest.

Early on during the COVID-affected period some regions had much stricter rules regarding social distancing. Additionally, consumers wanted to avoid exposure to each other, and therefore they did not shop at as many stores searching for competitive prices. Consumers reduced the number of shopping trips in addition to stores putting a limit on number of items purchased which in turn resulted in less price sensitivity. This situation likely varied across the eight IRI regions.

The regional expenditure elasticities resembled those estimated for the United States. As well, major differences among the regional expenditure elasticities were not observed.

The estimated compensated own-price and cross-price elasticities for each of the eight IRI regions for the pre-COVID period are provided in Tables 7, 11, 15, 19, 23, 27, 31, and 35 and for the COVID-affected period are provided in Tables 8, 12, 16, 20, 24, 28, 32, and 36. Noticeable differences were observed in compensated cross-price elasticity estimates among the eight IRI regions in both pre-COVID and COVID-affected periods. Similar to what was observed for the Unites States, the majority of the compensated cross-price elasticities were positive across all regions in both pre-COVID and COVID-affected periods, indicating substitutability among the respective products of interest.

For the pre-COVID period, protein beverages, plant-based alternative beverages to milk and yogurt were substitutes for traditional white milk across all the eight IRI regions. Traditional white milk was a substitute for health-enhanced milk and lactose-free milk in the California, Plains, Northeast and Southeast regions as well as a substitute for all the competitive beverages and yogurt in the California, Plains, and Northeast regions.

Marked changes in traditional white milk substitutes were observed between regions from pre-COVID period to COVID-affected period. Traditional white milk was a substitute for organic milk in the West, Plains, Great Lakes and Southeast during both pre-COVID and COVID-affected periods. With the onset of COVID-19 traditional white milk was a substitute for organic milk in the California, Northeast, Mid-South and South Central regions. Traditional white milk also was a substitute for all the milk sub-categories, juices and alternative beverages in the California region and in the West region.

Similar to what was observed for the United States, the protein beverages were substitutes for almost all milk sub-categories in the California, Plains, Great Lakes, Mid-South and Southeast.

Bottled water was a substitute for all milk products, competitive beverages, and yogurt across all the IRI regions, except for traditional white milk in the South Central and the Southeast regions in the pre-COVID period. This pattern changed with the onset of COVID-19 where slightly fewer substitutes to bottled water were observed during COVID-affected period.

California

Table 5. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the California Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**4.61**	**5.30**	**5.97**	**5.38**	**26.29**	**24.21**
Traditional White Milk	3.48	3.92	4.72	3.92	15.70	13.03
Organic Milk	9.19	9.39	0.56	0.59	4.91	4.72
Traditional Flavored Milk	7.89	8.07	0.09	0.09	0.71	0.64
Health-Enhanced Milk[3]	9.22	9.72	0.26	0.35	2.32	2.90
Lactose-Free Milk	8.22	8.09	0.34	0.42	2.64	2.92
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.06	467.00	464.00	22.82	22.48
Bottled Water	1.64	1.84	16.27	17.53	25.28	27.20
Sports Drinks	0.03	0.04	193.00	197.00	6.08	6.83
Protein Beverages	21.57	21.96	0.10	0.12	2.13	2.30
Alternative Beverages[5]	7.33	7.65	0.68	0.83	4.79	5.40
Yogurt	2.49	2.58	5.31	5.30	12.62	11.57

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).

Table 6. Own-Price Elasticities and Expenditure Elasticities for the California Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.908**	— [5]	**0.702**	**0.266**
Traditional White Milk	-0.824	— [5]	0.633	0.201
Organic Milk	-0.672	-0.489	0.695	0.329
Traditional Flavored Milk	-0.826	— [5]	0.315	1.303
Health-Enhanced Milk[2]	-1.435	-0.377	0.592	0.567
Lactose-Free Milk	-0.933	-0.122	0.662	0.408
Competitive Beverages & Yogurt				
Juices[3]	-0.783	-0.540	1.069	0.812
Bottled Water	-1.729	-1.065	1.253	1.430
Sports Drinks	-1.942	-1.583	1.861	2.062
Protein Beverages	-2.006	-1.646	0.758	1.234
Alternative Beverages[4]	-1.063	-0.774	0.920	0.789
Yogurt	-1.481	-1.291	0.784	1.194

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5]A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 9. Own-Price Elasticities for the California Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

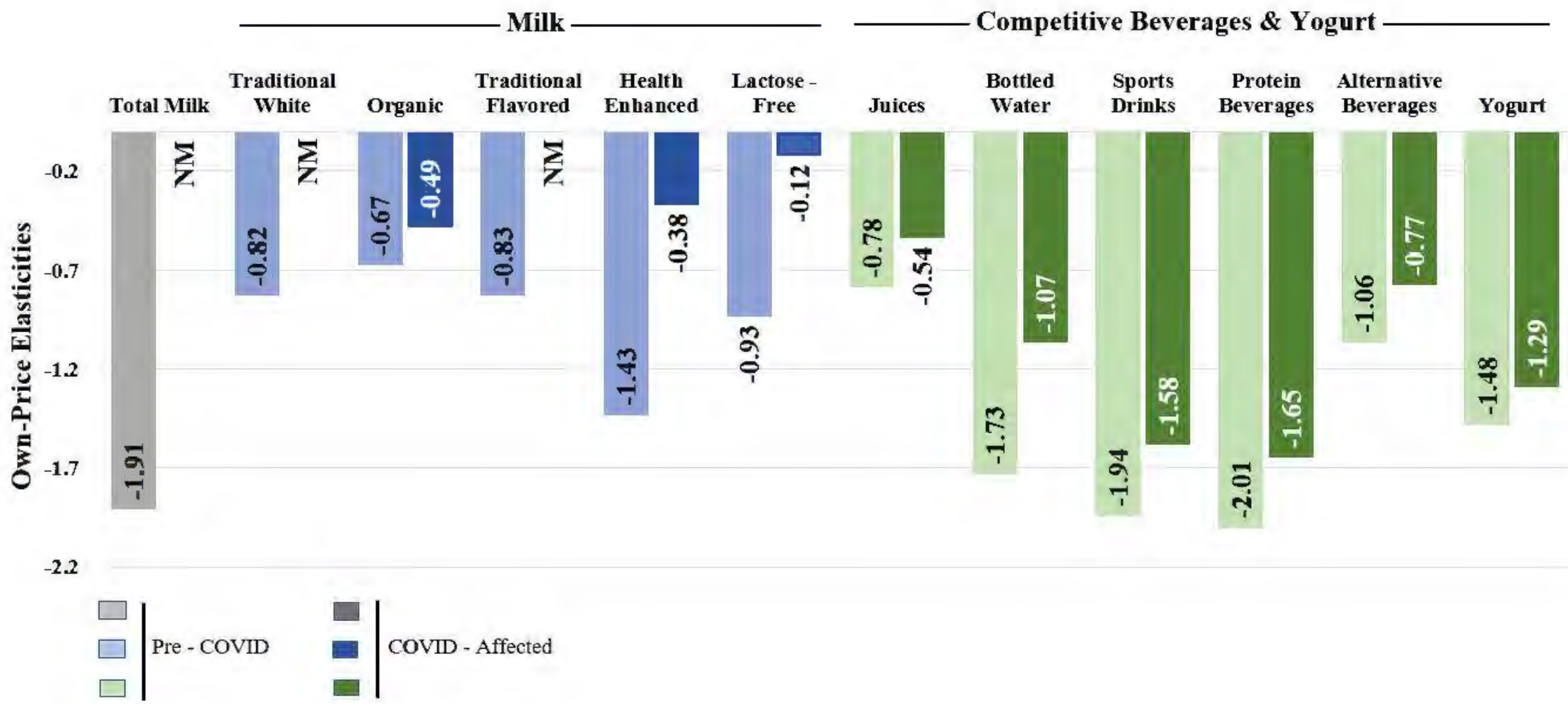


Table 7. Compensated Own- and Cross-Price Elasticities for the California Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

Compensated Price Elasticities	Milk					Competitive Beverages & Yogurt					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.724***	-0.153	-0.197	**0.033**	**0.054**	**0.076**	**0.415**	**0.077**	**0.111**	**0.078**	**0.231**
Organic Milk	-0.490	***-0.638***	-0.165	-0.159	**0.144**	**0.121**	**0.606**	**0.019**	**0.086**	**0.055**	**0.420**
Traditional Flavored Milk	-4.329	-1.133	***-0.824***	**0.282**	-0.725	-2.863	**0.571**	**1.342**	**1.844**	-0.338	**6.173**
Health-Enhanced Milk	**0.220**	-0.336	**0.087**	***-1.421***	-0.670	-1.195	**0.654**	**0.168**	**0.484**	**0.131**	**1.879**
Lactose-Free Milk	**0.321**	**0.268**	-0.196	-0.590	***-0.916***	-0.238	**0.507**	**0.087**	**0.084**	**0.172**	**0.501**
Juices	**0.053**	**0.026**	-0.090	-0.122	-0.027	***-0.539***	**0.516**	**0.238**	-0.031	**0.043**	-0.066
Bottled Water	**0.258**	**0.118**	**0.016**	**0.060**	**0.053**	**0.466**	***-1.412***	**0.087**	**0.043**	**0.133**	**0.178**
Sports Drinks	**0.198**	**0.016**	**0.158**	**0.064**	**0.038**	**0.892**	**0.364**	***-1.829***	**0.054**	-0.006	**0.053**
Protein Beverages	**0.817**	**0.198**	**0.620**	**0.529**	**0.104**	-0.337	**0.509**	**0.155**	***-1.990***	-0.247	-0.358
Alternative Beverages	**0.257**	**0.056**	-0.050	**0.063**	**0.095**	**0.204**	**0.704**	-0.008	-0.110	***-1.019***	-0.192
Yogurt	**0.288**	**0.164**	**0.350**	**0.346**	**0.105**	-0.119	**0.357**	**0.026**	-0.060	-0.073	***-1.382***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 8. Compensated Own- and Cross-Price Elasticities for the California Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

Compensated Price Elasticities	Milk					Competitive Beverages & Yogurt					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	*0.185*	-0.012	0.007	**0.013**	**0.057**	-0.184	-0.083	-0.102	-0.003	**0.117**	0.004
Organic Milk	**-0.034**	***-0.474***	-0.105	**0.242**	**0.067**	-0.278	-0.019	**0.011**	**0.169**	**0.225**	**0.195**
Traditional Flavored Milk	**0.149**	-0.781	*0.851*	-0.298	**1.075**	-0.020	**0.655**	-0.158	**0.162**	-1.279	-0.358
Health-Enhanced Milk	**0.057**	**0.394**	-0.066	***-0.360***	-0.330	-0.507	**0.039**	-0.112	**0.335**	**0.022**	**0.528**
Lactose-Free Milk	**0.256**	**0.109**	**0.235**	-0.328	***-0.110***	-0.367	-0.173	-0.194	**0.117**	**0.102**	**0.354**
Juices	**-0.106**	-0.058	-0.001	-0.065	-0.048	***-0.357***	**0.118**	**0.177**	**0.038**	**0.109**	**0.194**
Bottled Water	-0.040	-0.003	**0.015**	0.004	-0.019	**0.098**	***-0.676***	**0.283**	**0.039**	**0.054**	**0.245**
Sports Drinks	-0.194	0.008	-0.015	-0.047	-0.083	**0.582**	**1.127**	***-1.442***	**0.042**	-0.033	**0.055**
Protein Beverages	**-0.018**	**0.346**	**0.045**	**0.421**	**0.148**	**0.367**	**0.457**	**0.124**	***-1.618***	-0.243	-0.029
Alternative Beverages	**0.282**	**0.196**	-0.151	**0.012**	**0.055**	**0.454**	**0.271**	-0.042	-0.104	***-0.731***	-0.242
Yogurt	0.005	**0.080**	-0.020	**0.132**	**0.089**	**0.376**	**0.577**	**0.033**	-0.006	-0.113	***-1.153***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

West

Table 9. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the West Region by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**4.18**	**4.65**	**9.24**	**8.72**	**25.02**	**21.90**
Traditional White Milk	2.72	3.12	6.79	6.05	17.65	15.17
Organic Milk	7.50	7.84	0.47	0.51	3.38	3.20
Traditional Flavored Milk	4.80	5.41	0.36	0.32	1.65	1.37
Health-Enhanced Milk[3]	8.93	9.48	0.20	0.29	1.67	2.20
Lactose-Free Milk	7.30	7.52	0.23	0.30	1.59	1.83
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.06	458.00	475.00	22.29	21.39
Bottled Water	1.59	1.82	15.33	17.63	23.06	25.58
Sports Drinks	0.03	0.04	227.00	257.00	7.02	8.32
Protein Beverages	19.38	20.40	0.14	0.18	2.66	2.96
Alternative Beverages[5]	6.71	7.07	0.71	0.88	4.56	5.01
Yogurt	2.29	2.40	6.61	6.74	14.48	12.95

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice).

Table 10. Own-Price Elasticities and Expenditure Elasticities for the West Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017- March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.220**	**-0.750**	**0.727**	**0.446**
Traditional White Milk	-0.809	-0.600	0.691	0.477
Organic Milk	-0.605	-1.031	0.792	0.545
Traditional Flavored Milk	-1.501	-1.524	0.892	1.087
Health-Enhanced Milk[2]	-0.702	-1.182	0.893	0.602
Lactose-Free Milk	-0.543	-0.350	0.830	0.729
Competitive Beverages & Yogurt				
Juices[3]	-0.377	— [5]	0.939	0.718
Bottled Water	-1.480	-1.074	1.118	1.215
Sports Drinks	-1.494	-1.262	1.507	1.585
Protein Beverages	-1.731	-2.000	1.060	1.529
Alternative Beverages[4]	-1.148	-0.981	1.077	1.017
Yogurt	-1.314	-0.616	1.093	1.360

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5]A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 10. Own-Price Elasticities for the West Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

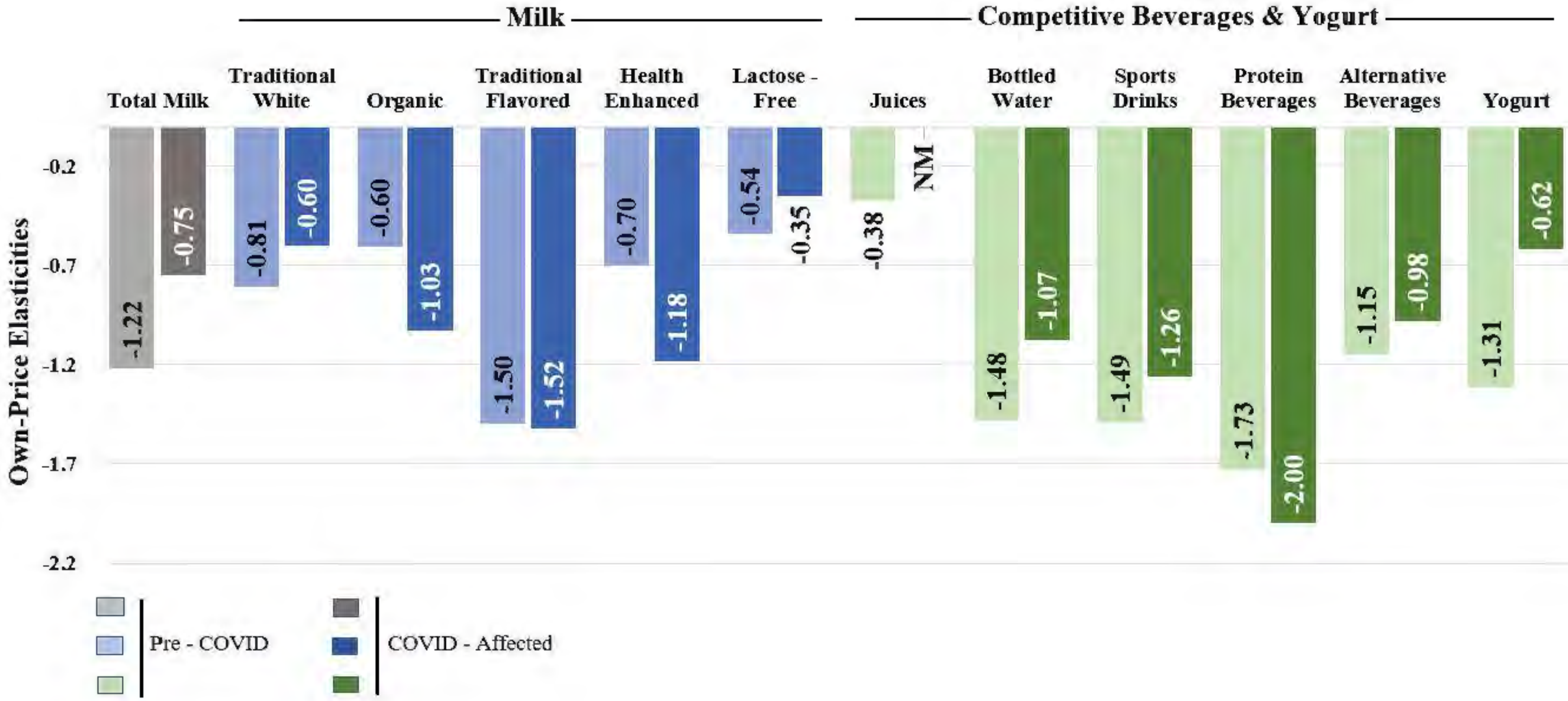


Table 11. Compensated Own- and Cross-Price Elasticities for the West Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					**Competitive Beverages & Yogurt**					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.687***	**0.051**	-0.012	-0.101	**-0.060**	**0.069**	**0.263**	0.000	**0.080**	**0.127**	**0.269**
Organic Milk	**0.268**	***-0.578***	0.004	-0.402	-0.092	**0.373**	**0.340**	-0.019	-0.064	-0.004	**0.173**
Traditional Flavored Milk	-0.124	0.008	***-1.486***	**0.324**	**0.185**	**0.605**	**0.404**	**0.191**	-0.050	-0.048	-0.009
Health-Enhanced Milk	-1.066	-0.813	**0.321**	***-0.687***	-0.241	-1.748	**0.355**	**0.348**	**0.870**	**0.161**	**2.499**
Lactose-Free Milk	-0.668	-0.194	**0.191**	-0.252	***-0.529***	-0.959	**0.296**	**0.163**	**0.356**	**0.243**	**1.353**
Juices	**0.055**	**0.057**	**0.045**	-0.131	-0.068	***-0.168***	**0.332**	**0.087**	-0.048	**0.050**	-0.210
Bottled Water	**0.201**	**0.050**	**0.029**	**0.026**	**0.020**	**0.321**	***-1.222***	**0.126**	**0.053**	**0.097**	**0.298**
Sports Drinks	-0.001	**-0.009**	**0.045**	**0.083**	**0.037**	**0.275**	**0.415**	***-1.388***	**0.091**	**0.021**	**0.432**
Protein Beverages	**0.531**	-0.081	-0.031	**0.545**	**0.213**	-0.398	**0.456**	**0.239**	***-1.703***	-0.110	**0.339**
Alternative Beverages	**0.493**	-0.003	-0.017	**0.059**	**0.085**	**0.246**	**0.493**	**0.032**	-0.065	***-1.099***	-0.225
Yogurt	**0.327**	**0.040**	-0.001	**0.288**	**0.149**	-0.324	**0.475**	**0.210**	**0.062**	-0.071	***-1.156***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 12. Compensated Own- and Cross-Price Elasticities for the West Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					**Competitive Beverages & Yogurt**					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.528***	0.054	**0.025**	**0.098**	**0.053**	**0.293**	**0.035**	-0.143	-0.006	**0.067**	**0.051**
Organic Milk	**0.256**	***-1.013***	-0.015	-0.059	**0.071**	0.260	-0.024	-0.049	-0.015	**0.362**	**0.226**
Traditional Flavored Milk	**0.279**	-0.036	***-1.509***	**0.157**	**0.030**	-0.109	**0.293**	**0.016**	**0.267**	**0.073**	**0.539**
Health-Enhanced Milk	**0.674**	-0.085	**0.098**	***-1.169***	-0.568	-2.366	**0.324**	**0.317**	**0.835**	**0.200**	**1.741**
Lactose-Free Milk	**0.438**	**0.124**	**0.023**	-0.682	***-0.336***	-1.070	**0.111**	-0.006	**0.230**	**0.335**	**0.833**
Juices	**0.208**	**0.039**	-0.007	-0.244	-0.092	***0.795***	**0.000**	**0.045**	-0.092	-0.005	-0.648
Bottled Water	**0.021**	-0.003	**0.016**	**0.028**	0.008	0.000	***-0.764***	**0.253**	**0.092**	**0.052**	**0.297**
Sports Drinks	-0.260	-0.019	0.003	**0.084**	**-0.001**	**0.116**	**0.779**	***-1.130***	**0.143**	**0.058**	**0.228**
Protein Beverages	-0.030	-0.017	**0.124**	**0.621**	**0.143**	-0.667	**0.793**	**0.402**	***-1.954***	-0.189	**0.773**
Alternative Beverages	**0.204**	**0.231**	**0.020**	**0.088**	**0.123**	-0.022	**0.267**	**0.096**	-0.112	***-0.930***	**0.034**
Yogurt	0.059	**0.056**	**0.057**	**0.296**	**0.118**	-1.070	**0.587**	**0.147**	**0.177**	0.013	***-0.440***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Plains

Table 13. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the Plains Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**3.58**	**4.10**	**5.31**	**4.97**	**30.54**	**28.42**
Traditional White Milk	3.18	3.60	4.64	4.25	23.73	21.32
Organic Milk	8.03	8.23	0.12	0.13	1.55	1.46
Traditional Flavored Milk	4.70	5.28	0.36	0.34	2.72	2.47
Health-Enhanced Milk[3]	9.32	9.56	0.10	0.16	1.54	2.07
Lactose-Free Milk	7.31	7.35	0.09	0.11	1.01	1.09
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.05	290.00	295.00	21.59	20.46
Bottled Water	1.55	1.71	8.20	9.85	20.35	23.35
Sports Drinks	0.04	0.04	134.00	154.00	7.32	8.63
Protein Beverages	18.83	19.64	0.09	0.12	2.68	3.34
Alternative Beverages[5]	6.46	6.54	0.32	0.38	3.29	3.49
Yogurt	2.23	2.28	3.97	3.87	14.22	12.31

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice).

Table 14. Own-Price Elasticities and Expenditure Elasticities for the Plains Region Estimated Using the Eleven-Produce Demand Model by Pre-COVID Period (Jan. 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-0.624**	**-0.449**	**0.744**	**0.471**
Traditional White Milk	-1.422	-0.281	0.704	0.418
Organic Milk	-1.089	-0.695	0.826	0.615
Traditional Flavored Milk	-0.777	-0.062	0.732	0.550
Health-Enhanced Milk[2]	-1.029	-0.599	0.924	0.815
Lactose-Free Milk	-1.085	-1.380	0.861	0.789
Competitive Beverages & Yogurt				
Juices[3]	-0.637	—[5]	0.851	0.686
Bottled Water	-1.382	-1.374	1.217	1.377
Sports Drinks	-1.994	-1.654	1.740	1.974
Protein Beverages	-2.219	-1.530	0.993	1.347
Alternative Beverages[4]	-1.161	-0.938	0.967	0.821
Yogurt	-1.562	-0.547	1.126	1.274

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5] A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 11. Own-Price Elasticities for the Plains Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

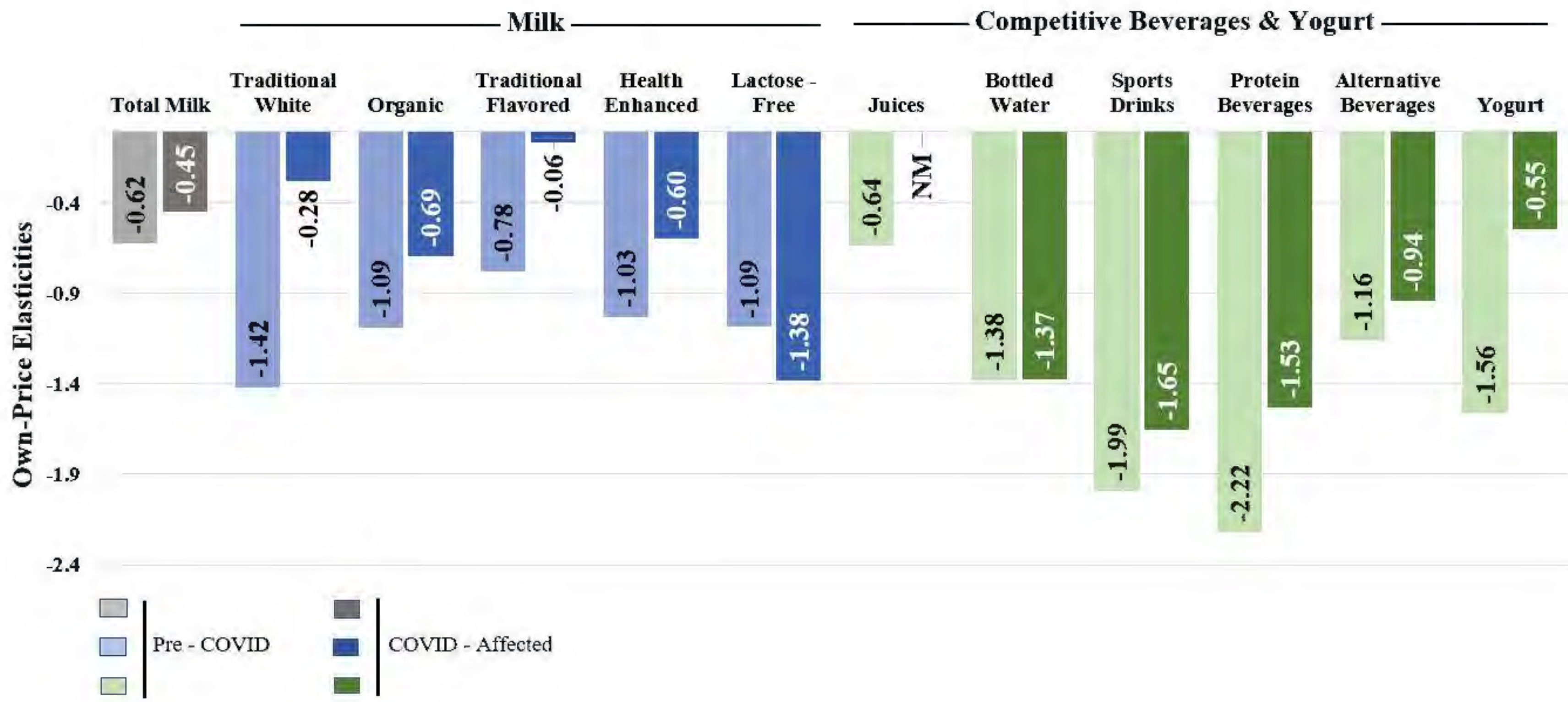


Table 15. Compensated Own- and Cross-Price Elasticities for the Plains Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					**Competitive Beverages & Yogurt**					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.667***	0.003	-0.024	**0.025**	**0.020**	**0.127**	**0.054**	0.010	**0.108**	**0.072**	**0.273**
Organic Milk	**0.046**	***-1.076***	**0.067**	**0.071**	-0.011	**0.425**	**0.045**	**0.168**	**0.119**	**0.096**	**0.050**
Traditional Flavored Milk	-0.207	**0.038**	***-0.757***	-0.279	**0.061**	-0.655	**0.703**	**0.160**	**0.064**	**0.178**	**0.695**
Health-Enhanced Milk	**0.381**	**0.072**	-0.495	***-1.015***	-0.556	-0.025	**0.368**	**0.260**	**0.131**	**0.150**	**0.729**
Lactose-Free Milk	**0.465**	-0.017	**0.165**	-0.847	***-1.077***	**0.013**	**0.245**	**0.113**	**0.177**	**0.339**	**0.423**
Juices	**0.139**	**0.030**	-0.083	-0.002	0.001	***-0.453***	**0.214**	**0.079**	**0.015**	**0.058**	0.001
Bottled Water	**0.063**	**0.003**	**0.094**	**0.028**	**0.012**	**0.227**	***-1.134***	**0.284**	**0.056**	**0.025**	**0.343**
Sports Drinks	**0.032**	**0.035**	**0.060**	**0.055**	**0.016**	**0.233**	**0.788**	***-1.867***	**0.071**	**0.088**	**0.490**
Protein Beverages	**0.958**	**0.069**	**0.065**	**0.075**	**0.066**	**0.120**	**0.422**	**0.193**	***-2.192***	**0.090**	**0.134**
Alternative Beverages	**0.520**	**0.045**	**0.147**	**0.070**	**0.104**	**0.379**	**0.157**	**0.195**	**0.074**	***-1.390***	-0.299
Yogurt	**0.455**	0.005	**0.133**	**0.079**	**0.030**	0.001	**0.491**	**0.252**	**0.025**	-0.069	***-1.402***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 16. Compensated Own- and Cross-Price Elasticities for the Plains Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					**Competitive Beverages & Yogurt**					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.192***	-0.051	**0.053**	-0.021	-0.055	**0.322**	**0.086**	-0.023	-0.020	**0.059**	-0.159
Organic Milk	**-0.745**	***-0.686***	**0.079**	-0.319	-0.453	-0.080	-0.029	**0.388**	**0.265**	**0.368**	**1.210**
Traditional Flavored Milk	**0.457**	**0.047**	***-0.049***	-0.518	**0.198**	-1.238	**0.791**	-0.445	**0.538**	-0.121	**0.338**
Health-Enhanced Milk	-0.217	**-0.224**	-0.618	***-0.582***	-0.183	-0.587	**0.382**	**0.311**	**0.356**	**0.453**	**0.907**
Lactose-Free Milk	-1.062	-0.604	**0.448**	-0.346	***-1.371***	-0.691	**0.179**	**0.462**	**0.629**	**0.322**	**2.034**
Juices	**0.335**	-0.006	-0.150	-0.059	-0.037	***0.821***	**0.163**	-0.141	-0.163	-0.041	-0.723
Bottled Water	**0.079**	-0.002	**0.084**	**0.034**	0.008	**0.143**	***-1.052***	**0.186**	**0.091**	**0.068**	**0.361**
Sports Drinks	-0.056	**0.066**	-0.128	**0.075**	**0.059**	-0.335	**0.503**	***-1.484***	**0.265**	**0.146**	**0.890**
Protein Beverages	-0.130	**0.116**	**0.399**	**0.221**	**0.206**	-0.998	**0.637**	**0.686**	***-1.485***	-0.095	**0.444**
Alternative Beverages	**0.363**	**0.154**	-0.086	**0.269**	**0.101**	-0.238	**0.457**	**0.362**	-0.091	***-0.909***	-0.383
Yogurt	-0.275	**0.143**	**0.068**	**0.153**	**0.181**	-1.201	**0.685**	**0.624**	**0.120**	-0.108	***-0.390***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Great Lakes

Table 17. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the Great Lakes Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**2.87**	**3.52**	**10.96**	**10.08**	**24.54**	**23.47**
Traditional White Milk	2.32	2.88	9.37	8.41	16.98	15.99
Organic Milk	7.57	7.71	0.43	0.44	2.55	2.22
Traditional Flavored Milk	3.81	4.39	0.72	0.65	2.14	1.90
Health-Enhanced Milk[3]	9.28	9.49	0.24	0.34	1.70	2.10
Lactose-Free Milk	7.49	7.53	0.20	0.25	1.17	1.25
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.05	649.00	679.00	23.27	22.48
Bottled Water	1.47	1.63	21.26	24.48	24.34	26.36
Sports Drinks	0.03	0.04	282.00	326.00	7.38	8.62
Protein Beverages	19.27	20.14	0.17	0.23	2.57	3.00
Alternative Beverages[5]	6.51	6.60	0.66	0.84	3.35	3.65
Yogurt	2.27	2.34	8.22	8.03	14.55	12.41

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice.).

Table 18. Own-Price Elasticities and Expenditure Elasticities for the Great Lakes Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-0.646**	**-0.108**	**0.733**	**0.460**
Traditional White Milk	-0.488	-0.173	0.671	0.421
Organic Milk	-0.787	-1.159	0.833	0.677
Traditional Flavored Milk	-1.321	-1.692	0.890	0.504
Health-Enhanced Milk[2]	-1.696	-1.401	0.910	0.800
Lactose-Free Milk	-0.286	-0.632	0.817	0.795
Competitive Beverages & Yogurt				
Juices[3]	-0.894	-0.137	0.850	0.637
Bottled Water	-1.443	-1.224	1.168	1.300
Sports Drinks	-1.404	-1.267	1.575	1.797
Protein Beverages	-1.738	-1.615	0.917	1.286
Alternative Beverages[4]	-0.851	-1.406	0.932	0.988
Yogurt	-1.647	-1.976	1.151	1.335

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5]A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 12. Own-Price Elasticities for the Great Lakes Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

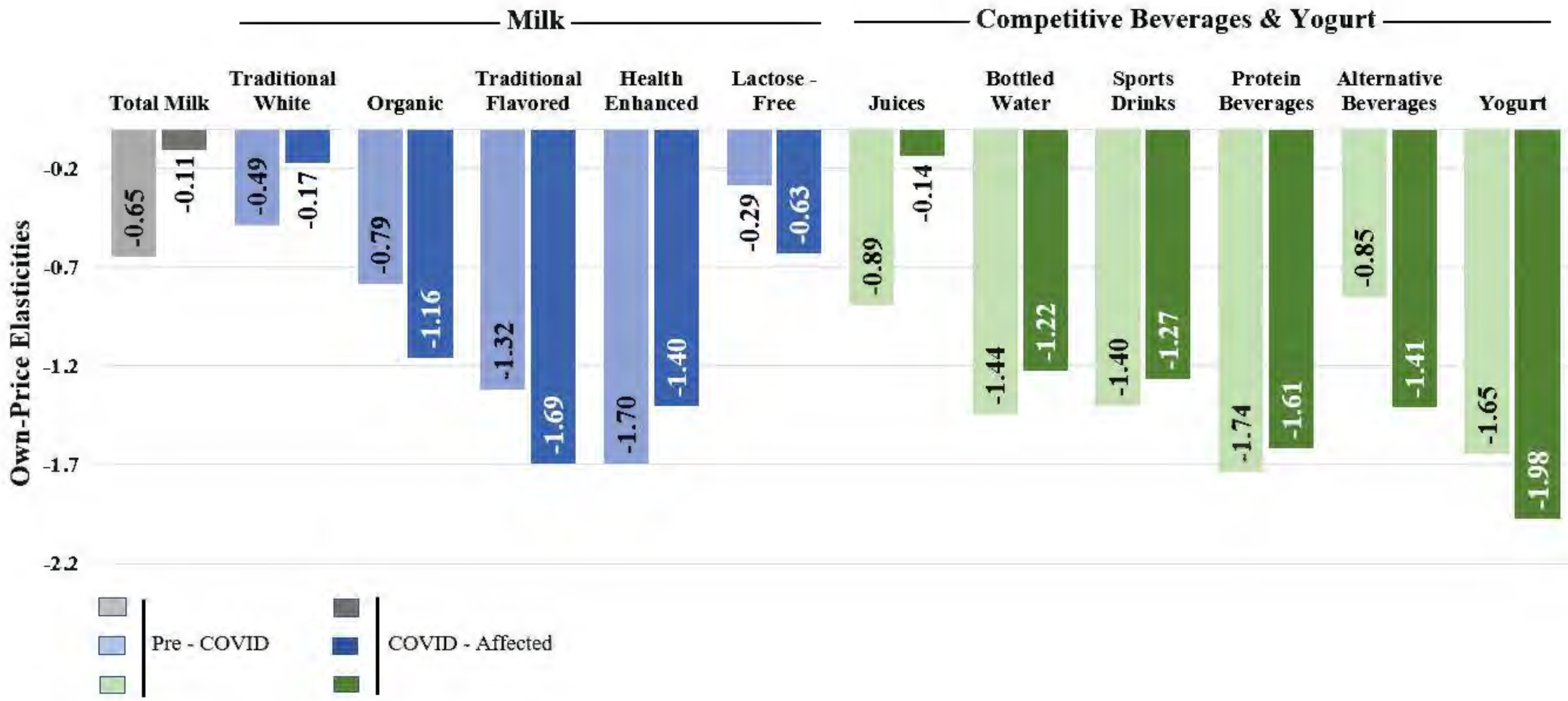


Table 19. Compensated Own- and Cross-Price Elasticities for the Great Lakes Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.374***	**0.021**	**0.049**	-0.085	-0.086	-0.051	**0.034**	-0.103	**0.098**	**0.214**	**0.284**
Organic Milk	**0.143**	***-0.765***	**0.114**	-0.009	**0.065**	**0.076**	**0.222**	-0.330	**0.026**	**0.264**	**0.194**
Traditional Flavored Milk	**0.390**	**0.136**	***-1.302***	**0.591**	**0.271**	-0.629	**0.845**	-0.096	**0.107**	-0.226	-0.088
Health-Enhanced Milk	-0.853	-0.014	**0.744**	***-1.680***	-0.870	**0.105**	**0.259**	**0.444**	**0.188**	**0.188**	**1.490**
Lactose-Free Milk	**-1.247**	**0.141**	**0.494**	-1.259	***-0.277***	**0.096**	**0.031**	**0.371**	**0.239**	-0.074	**1.485**
Juices	-0.037	**0.008**	-0.058	0.008	0.005	***-0.696***	**0.265**	**0.198**	**0.046**	**0.062**	**0.200**
Bottled Water	**0.023**	**0.023**	**0.074**	**0.018**	**0.001**	**0.253**	***-1.158***	**0.248**	**0.056**	**0.067**	**0.393**
Sports Drinks	-0.238	-0.114	-0.028	**0.102**	**0.059**	**0.623**	**0.819**	***-1.287***	**0.065**	-0.158	**0.156**
Protein Beverages	**0.647**	**0.025**	**0.089**	**0.124**	**0.109**	**0.413**	**0.530**	**0.187**	***-1.715***	-0.198	-0.211
Alternative Beverages	**1.084**	**0.201**	-0.144	**0.096**	-0.026	**0.432**	**0.488**	-0.348	-0.152	***-0.820***	-0.811
Yogurt	**0.332**	**0.034**	-0.013	**0.174**	**0.120**	**0.320**	**0.657**	**0.079**	-0.037	-0.186	***-1.479***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 20. Compensated Own- and Cross-Price Elasticities for the Great Lakes Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.106***	**0.038**	-0.011	-0.054	0.004	**0.218**	-0.040	-0.280	**0.089**	**0.146**	-0.004
Organic Milk	**0.276**	***-1.144***	-0.129	-0.020	**0.125**	**0.559**	**0.350**	-0.034	**-0.108**	**0.214**	-0.090
Traditional Flavored Milk	-0.094	-0.151	***-1.683***	**0.421**	**0.054**	-0.775	**0.175**	**0.181**	**0.442**	-0.111	**1.542**
Health-Enhanced Milk	-0.407	-0.021	**0.381**	***-1.384***	-0.508	-1.006	-0.070	**0.508**	**0.210**	**0.382**	**1.915**
Lactose-Free Milk	**0.051**	**0.222**	**0.082**	-0.852	***-0.622***	**0.326**	**0.118**	**0.244**	**0.133**	**0.032**	**0.265**
Juices	**0.155**	**0.055**	-0.066	-0.094	**0.018**	***0.006***	-0.342	-0.168	-0.003	**0.251**	**0.187**
Bottled Water	-0.024	**0.030**	**0.013**	-0.006	0.006	-0.292	***-0.881***	**0.352**	**0.130**	**0.114**	**0.558**
Sports Drinks	-0.520	-0.009	**0.040**	**0.124**	**0.035**	-0.438	**1.077**	***-1.112***	**0.172**	-0.002	**0.632**
Protein Beverages	**0.474**	**-0.080**	**0.280**	**0.147**	**0.056**	-0.021	**1.140**	**0.494**	***-1.576***	-0.149	-0.764
Alternative Beverages	**0.639**	**0.131**	-0.058	**0.220**	**0.011**	**1.544**	**0.826**	-0.004	-0.123	***-1.370***	-1.816
Yogurt	-0.005	-0.016	**0.236**	**0.324**	**0.027**	**0.339**	**1.185**	**0.439**	-0.185	-0.534	***-1.810***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Northeast

Table 21. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the Northeast Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		**Quantity (millions[1])**		**Budget Share (%)**	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**4.61**	**5.18**	**9.95**	**9.20**	**24.67**	**22.90**
Traditional White Milk	3.68	4.10	7.77	6.84	15.38	13.47
Organic Milk	8.04	8.43	0.91	0.89	3.92	3.63
Traditional Flavored Milk	5.97	6.22	0.32	0.32	1.04	0.96
Health-Enhanced Milk[3]	9.48	9.91	0.42	0.51	2.15	2.42
Lactose-Free Milk	7.74	7.86	0.52	0.64	2.18	2.41
Competitive Beverages & Yogurt						
Juices[4]	0.05	0.05	851.00	842.00	22.03	21.58
Bottled Water	1.65	1.79	29.63	32.98	26.13	28.27
Sports Drinks	0.04	0.04	266.00	303.00	5.02	5.97
Protein Beverages	21.58	21.27	0.18	0.24	2.04	2.45
Alternative Beverages[5]	7.14	7.39	1.06	1.31	4.06	4.66
Yogurt	2.52	2.64	11.89	11.20	16.05	14.17

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice.).

Table 22. Own-Price Elasticities and Expenditure Elasticities for the Northeast Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		**Expenditure Elasticity**	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.500**	**-1.481**	**0.742**	**0.698**
Traditional White Milk	-0.375	— [5]	0.735	0.634
Organic Milk	-0.889	-1.088	0.815	0.721
Traditional Flavored Milk	— [5]	— [5]	0.356	2.224
Health-Enhanced Milk[2]	-1.237	-0.910	0.794	0.839
Lactose-Free Milk	-0.853	-1.281	0.810	0.828
Competitive Beverages & Yogurt				
Juices[3]	-2.080	-0.978	0.964	0.818
Bottled Water	-1.780	-1.564	1.183	1.158
Sports Drinks	-1.774	-2.371	1.529	1.507
Protein Beverages	-2.119	-1.713	0.923	0.969
Alternative Beverages[4]	-1.161	-0.874	0.944	0.841
Yogurt	-2.484	-2.167	1.005	1.200

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5]A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 13. Own-Price Elasticities for the Northeast Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

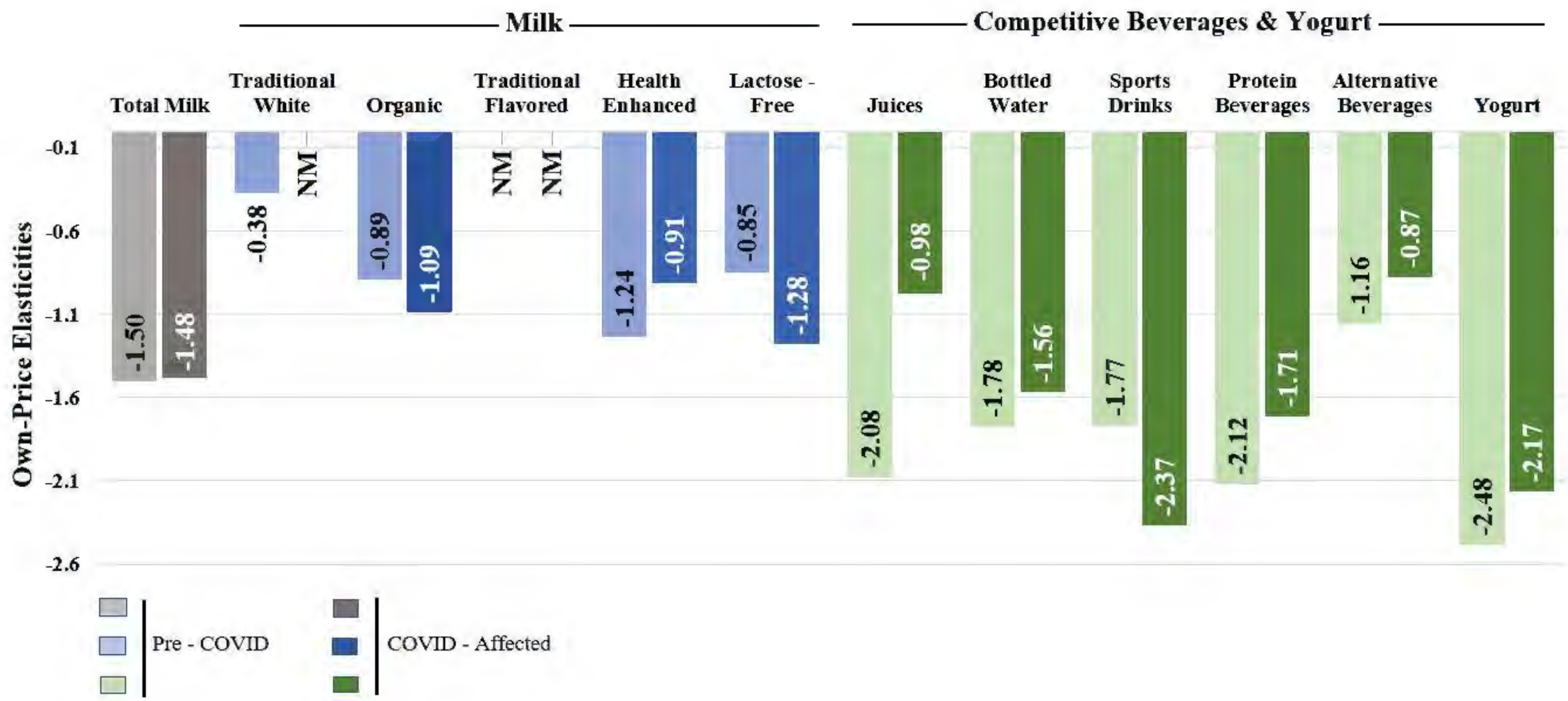


Table 23. Compensated Own- and Cross-Price Elasticities for the Northeast Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	*-0.262*	-0.113	-1.028	0.003	**0.116**	**0.118**	**0.403**	**0.033**	**0.153**	**0.215**	**0.361**
Organic Milk	-0.442	***-0.857***	-0.354	**0.208**	**0.087**	**0.527**	**0.489**	-0.165	-0.024	**0.297**	**0.236**
Traditional Flavored Milk	-15.161	-1.329	***8.748***	**-0.033**	-1.309	-13.181	**0.998**	**1.280**	**2.591**	-1.643	**19.039**
Health-Enhanced Milk	**0.023**	**0.378**	-0.016	***-1.220***	-0.256	**0.532**	**0.433**	-0.038	**0.072**	**0.283**	-0.190
Lactose-Free Milk	**0.822**	**0.156**	-0.627	-0.253	***-0.835***	**0.684**	**0.426**	**0.009**	**0.098**	**0.155**	-0.635
Juices	**0.082**	**0.094**	-0.624	**0.052**	**0.068**	***-1.868***	**0.581**	**0.373**	**0.125**	**0.280**	**0.837**
Bottled Water	**0.237**	**0.073**	**0.040**	**0.036**	**0.035**	**0.490**	***-1.470***	**0.124**	**0.050**	**0.092**	**0.294**
Sports Drinks	**0.100**	-0.129	**0.266**	-0.016	0.004	**1.635**	**0.643**	***-1.697***	-0.106	-0.073	-0.625
Protein Beverages	**1.151**	-0.046	**1.324**	**0.076**	**0.105**	**1.352**	**0.634**	-0.262	***-2.100***	-0.403	-1.832
Alternative Beverages	**0.815**	**0.286**	-0.422	0.150	**0.083**	**1.519**	**0.589**	-0.091	-0.202	***-1.123***	-1.605
Yogurt	**0.347**	**0.058**	**1.237**	-0.025	-0.086	**1.149**	**0.479**	-0.196	-0.233	-0.406	***-2.323***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 24. Compensated Own- and Cross-Price Elasticities for the Northeast Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***0.692***	-0.033	-1.487	-0.042	-0.087	**0.408**	**0.134**	-0.081	**0.031**	**0.461**	0.004
Organic Milk	**-0.121**	***-1.062***	-0.067	**0.019**	-0.204	**0.138**	**0.324**	-0.080	**0.066**	**0.538**	**0.447**
Traditional Flavored Milk	**-20.770**	-0.250	***8.989***	-0.109	**0.841**	-19.091	**8.239**	**4.941**	**3.879**	-1.142	**14.474**
Health-Enhanced Milk	-0.235	**0.028**	-0.043	***-0.890***	**0.070**	-0.147	**0.486**	**0.091**	-0.065	**0.428**	**0.279**
Lactose-Free Milk	-0.487	-0.306	**0.336**	**0.070**	***-1.261***	-1.222	**0.954**	**0.401**	**0.445**	-0.350	**1.420**
Juices	**0.255**	**0.023**	-0.854	-0.017	-0.137	***-0.802***	**0.152**	**0.158**	**0.223**	**0.496**	**0.503**
Bottled Water	**0.064**	**0.042**	**0.281**	**0.042**	**0.082**	**0.116**	***-1.237***	**0.276**	-0.032	-0.033	**0.400**
Sports Drinks	-0.183	-0.048	**0.798**	**0.037**	**0.162**	**0.571**	**1.308**	***-2.281***	**0.130**	-0.433	-0.062
Protein Beverages	**0.170**	**0.098**	**1.526**	**-0.064**	**0.439**	**1.958**	-0.374	**0.316**	***-1.689***	-0.639	-1.739
Alternative Beverages	**1.333**	**0.419**	-0.236	**0.222**	-0.181	**2.293**	-0.200	-0.555	-0.336	***-0.835***	-1.923
Yogurt	0.004	**0.114**	**0.985**	**0.048**	**0.242**	**0.766**	**0.798**	**-0.026**	-0.301	-0.633	***-1.997***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Mid-South

Table 25. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the Mid-South Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**3.68**	**4.11**	**8.62**	**8.23**	**26.03**	**23.18**
Traditional White Milk	2.97	3.26	7.16	6.63	17.45	14.77
Organic Milk	7.67	8.02	0.54	0.53	3.41	2.91
Traditional Flavored Milk	4.91	5.41	0.37	0.37	1.49	1.35
Health-Enhanced Milk[3]	9.15	9.59	0.26	0.35	1.97	2.33
Lactose-Free Milk	7.32	7.45	0.29	0.36	1.72	1.81
Competitive Beverages & Yogurt						
Juices[4]	0.04	0.05	647.00	703.00	23.41	23.43
Bottled Water	1.43	1.57	21.00	24.59	24.42	26.37
Sports Drinks	0.04	0.04	261.00	315.00	7.34	8.91
Protein Beverages	19.30	20.22	0.18	0.23	2.80	3.15
Alternative Beverages[5]	6.44	6.59	0.66	0.86	3.48	3.88
Yogurt	2.32	2.42	6.58	6.70	12.50	11.07

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice).

Table 26. Own-Price Elasticities and Expenditure Elasticities for the Mid-South Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	-0.131	-0.556	0.720	0.577
Traditional White Milk	-0.720	— [5]	0.696	0.480
Organic Milk	-0.750	-0.314	0.779	0.542
Traditional Flavored Milk	-1.793	-0.550	0.703	1.228
Health-Enhanced Milk[2]	-1.506	-0.919	0.801	0.876
Lactose-Free Milk	-0.676	-1.403	0.766	0.932
Competitive Beverages & Yogurt				
Juices[3]	-0.935	-0.470	0.834	0.623
Bottled Water	-2.215	-1.339	1.361	1.291
Sports Drinks	-1.826	-2.172	1.547	1.777
Protein Beverages	-2.173	-2.034	0.877	1.463
Alternative Beverages[4]	-1.338	-1.552	0.934	0.748
Yogurt	-2.397	-1.753	0.915	1.259

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5] A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 14. Own-Price Elasticities for the Mid-South Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

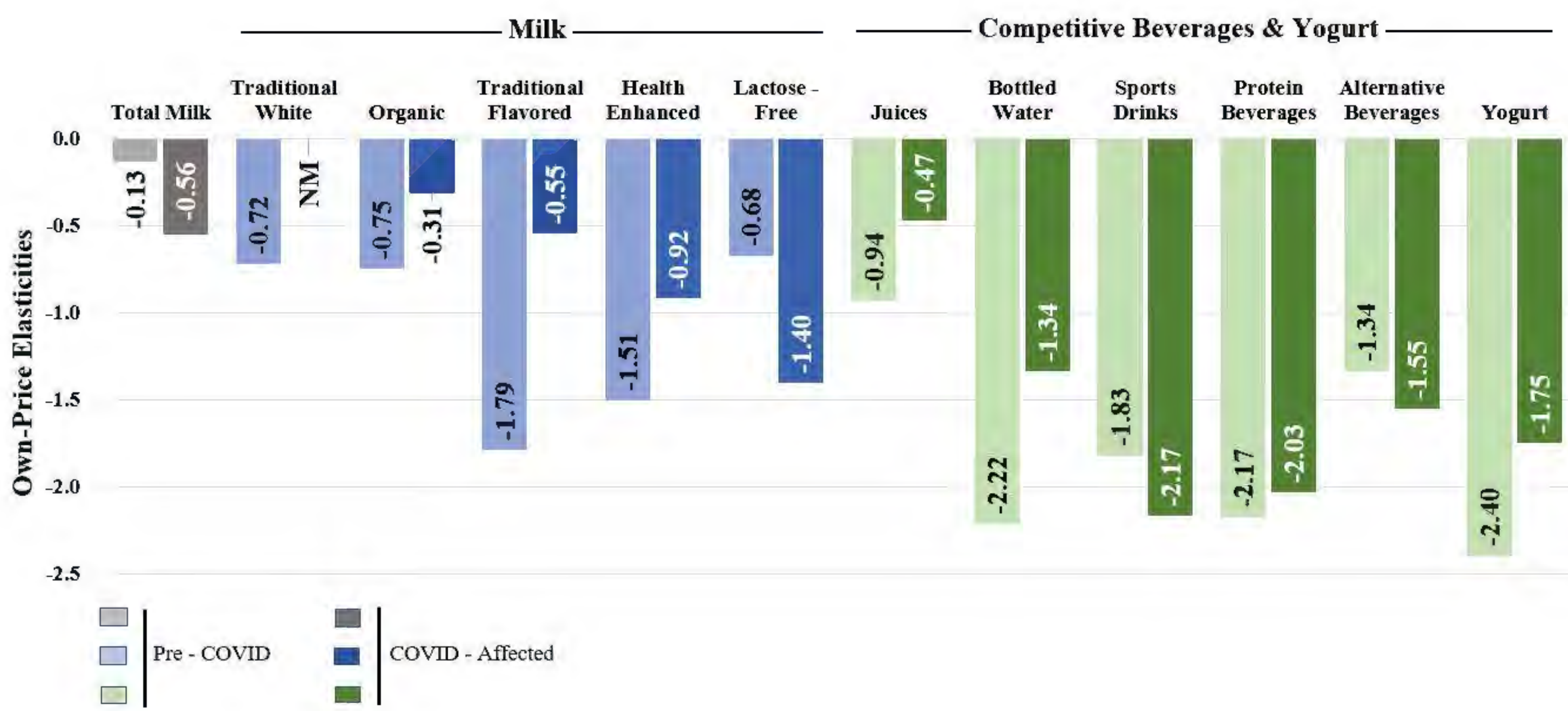


Table 27. Compensated Own- and Cross-Price Elasticities for the Mid-South Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.599***	0.002	-0.123	-0.080	-0.031	-0.112	**0.212**	-0.090	**0.153**	**0.167**	**0.500**
Organic Milk	0.009	***-0.724***	-0.127	-0.005	-0.070	**0.430**	**0.357**	-0.465	-0.004	**0.309**	**0.288**
Traditional Flavored Milk	-1.437	-0.289	***-1.782***	**0.671**	**0.246**	-0.641	**0.974**	**0.825**	**0.389**	-0.273	**1.318**
Health-Enhanced Milk	-0.706	-0.009	**0.510**	***-1.490***	-0.274	-1.092	**0.825**	**0.302**	**0.325**	-0.024	**1.634**
Lactose-Free Milk	-0.317	**-0.138**	**0.214**	-0.314	***-0.663***	-1.356	**0.702**	**0.201**	**0.164**	**0.021**	**1.486**
Juices	-0.083	**0.063**	-0.041	-0.092	-0.099	***-0.740***	**0.315**	**0.206**	**0.037**	**0.218**	**0.216**
Bottled Water	**0.152**	**0.050**	**0.060**	**0.066**	**0.049**	**0.302**	***-1.883***	**0.453**	**0.097**	**0.080**	**0.573**
Sports Drinks	-0.214	-0.216	**0.168**	**0.081**	**0.047**	**0.656**	**1.507**	***-1.712***	**0.118**	-0.235	-0.199
Protein Beverages	**0.955**	-0.004	**0.208**	**0.228**	**0.100**	**0.309**	**0.848**	**0.309**	***-2.148***	-0.016	-0.790
Alternative Beverages	**0.835**	**0.303**	-0.117	-0.013	**0.010**	**1.467**	**0.562**	-0.496	-0.013	***-1.306***	-1.231
Yogurt	**0.698**	**0.078**	**0.158**	**0.257**	**0.204**	**0.405**	**1.120**	-0.117	-0.177	-0.343	***-2.283***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 28. Compensated Own- and Cross-Price Elasticities for the Mid-South Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***0.205***	**0.069**	-0.295	-0.108	-0.102	**0.266**	-0.264	-0.137	**0.022**	**0.436**	-0.092
Organic Milk	**0.349**	***-0.298***	-0.209	**0.063**	-0.101	**0.773**	-0.038	-0.437	-0.140	**0.562**	-0.524
Traditional Flavored Milk	**-3.221**	-0.448	***-0.533***	**0.023**	**0.212**	-3.039	**2.217**	**1.690**	**0.789**	-0.528	**2.839**
Health-Enhanced Milk	-0.683	**0.079**	**0.013**	***-0.898***	-0.166	-1.428	**0.476**	**0.458**	**0.131**	**0.730**	**1.288**
Lactose-Free Milk	-0.826	-0.162	**0.158**	-0.213	***-1.386***	-1.890	**0.766**	**1.015**	**0.280**	**0.069**	**2.188**
Juices	**0.168**	**0.096**	-0.176	-0.142	-0.146	***-0.324***	-0.163	**0.025**	**0.116**	**0.438**	**0.108**
Bottled Water	-0.148	-0.004	**0.114**	**0.042**	**0.053**	-0.144	***-0.999***	**0.379**	**0.129**	-0.006	**0.584**
Sports Drinks	-0.228	-0.143	**0.257**	**0.120**	**0.207**	**0.067**	**1.123**	***-2.013***	**0.255**	-0.210	**0.565**
Protein Beverages	**0.103**	-0.129	**0.339**	**0.097**	**0.161**	**0.866**	**1.077**	**0.722**	***-1.988***	-0.384	-0.863
Alternative Beverages	**1.659**	**0.420**	-0.184	**0.438**	**0.032**	**2.640**	-0.039	-0.481	-0.312	***-1.523***	-2.651
Yogurt	-0.123	-0.138	**0.347**	**0.271**	**0.359**	**0.228**	**1.391**	**0.455**	-0.246	-0.930	***-1.613***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

South Central

Table 29. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the South Central Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		Quantity (millions[1])		Budget Share (%)	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**3.70**	**4.31**	**7.34**	**6.74**	**23.95**	**21.43**
Traditional White Milk	3.07	3.54	6.28	5.51	17.02	14.32
Organic Milk	7.68	7.97	0.35	0.38	2.37	2.23
Traditional Flavored Milk	6.12	6.70	0.26	0.27	1.39	1.30
Health-Enhanced Milk[3]	8.64	9.44	0.22	0.29	1.70	2.00
Lactose-Free Milk	7.29	7.32	0.23	0.29	1.47	1.58
Competitive Beverages & Yogurt						
Juices[4]	0.04	0.05	587.00	627.00	21.54	20.99
Bottled Water	1.30	1.43	25.46	29.43	28.91	30.58
Sports Drinks	0.03	0.04	319.00	363.00	9.50	10.91
Protein Beverages	19.46	20.21	0.22	0.28	3.67	4.12
Alternative Beverages[5]	6.35	6.49	0.53	0.69	2.94	3.28
Yogurt	2.19	2.27	4.92	5.22	9.49	8.67

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice.).

Table 30. Own-Price Elasticities and Expenditure Elasticities for the South Central Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		Expenditure Elasticity	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-0.809**	— [5]	**0.681**	**0.415**
Traditional White Milk	-0.931	— [5]	0.623	0.249
Organic Milk	-0.463	-0.463	0.760	0.464
Traditional Flavored Milk	-1.241	-0.410	0.729	2.591
Health-Enhanced Milk[2]	-1.140	-0.465	0.836	0.752
Lactose-Free Milk	-0.665	-0.087	0.741	0.240
Competitive Beverages & Yogurt				
Juices[3]	-0.562	— [5]	0.916	0.745
Bottled Water	-1.460	-0.429	1.298	1.285
Sports Drinks	-1.475	-1.331	1.482	1.733
Protein Beverages	-1.919	-1.537	0.805	1.107
Alternative Beverages[4]	-1.660	-0.806	0.875	0.809
Yogurt	-0.954	— [5]	0.761	1.046

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5] A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 15. Own-Price Elasticities for the South Central Region from the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

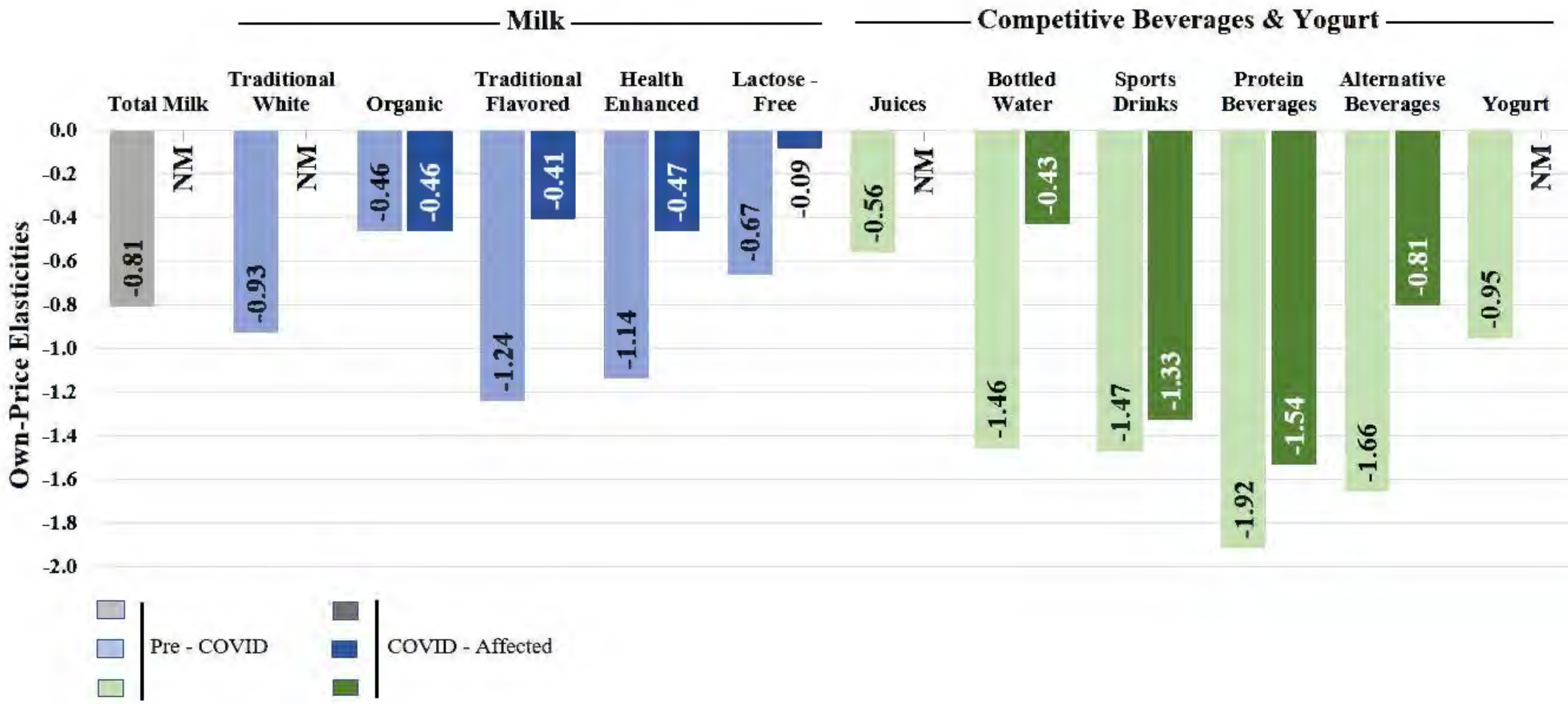


Table 31. Compensated Own- and Cross-Price Elasticities for the South Central Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

Compensated Price Elasticities	**Milk**					**Competitive Beverages & Yogurt**					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.825***	-0.073	-0.012	-0.099	-0.009	**0.456**	-0.061	-0.121	**0.243**	**0.265**	**0.237**
Organic Milk	-0.524	***-0.445***	-0.129	-0.663	-0.103	**0.057**	**0.514**	-0.350	**0.050**	**0.510**	**1.081**
Traditional Flavored Milk	-0.143	-0.220	***-1.231***	**0.362**	-0.066	**0.780**	**0.267**	**0.109**	-0.052	-0.490	**0.685**
Health-Enhanced Milk	-0.987	-0.924	**0.296**	***-1.125***	-0.346	-0.596	**0.026**	**0.288**	**0.240**	-0.071	**3.198**
Lactose-Free Milk	-0.106	-0.167	-0.063	-0.400	***-0.654***	**0.021**	**0.263**	-0.173	**0.220**	-0.098	**1.157**
Juices	**0.360**	0.006	**0.050**	-0.047	0.001	***-0.365***	**0.291**	**0.185**	-0.091	**0.074**	-0.465
Bottled Water	-0.036	**0.042**	**0.013**	0.002	**0.013**	**0.217**	***-1.085***	**0.382**	**0.082**	**0.121**	**0.248**
Sports Drinks	-0.218	-0.087	**0.016**	**0.052**	-0.027	**0.419**	**1.164**	***-1.334***	**0.078**	-0.061	0.000
Protein Beverages	**1.127**	**0.032**	**-0.020**	**0.111**	**0.088**	-0.537	**0.648**	**0.201**	***-1.889***	-0.023	**0.262**
Alternative Beverages	**1.534**	**0.411**	-0.232	-0.041	-0.049	**0.543**	**1.193**	-0.198	-0.029	***-1.634***	-1.498
Yogurt	**0.424**	**0.270**	**0.100**	**0.573**	**0.179**	-1.056	**0.755**	0.000	0.101	-0.464	***-0.882***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 32. Compensated Own- and Cross-Price Elasticities for the South Central Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

Compensated Price Elasticities	**Milk**					**Competitive Beverages & Yogurt**					
	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***0.950***	**0.143**	-0.726	-0.056	**0.231**	**0.087**	-1.039	-0.040	**0.178**	**0.448**	-0.175
Organic Milk	**0.917**	***-0.453***	-0.811	**0.347**	-0.619	-0.290	-0.704	-0.566	**0.072**	**1.074**	**1.033**
Traditional Flavored Milk	-7.972	-1.389	***-0.377***	-0.807	-0.282	-2.726	**2.998**	**3.054**	**3.552**	-0.152	**4.101**
Health-Enhanced Milk	-0.402	**0.387**	-0.526	***-0.450***	**0.182**	**0.361**	-0.143	-0.562	-0.009	-0.409	**1.571**
Lactose-Free Milk	**2.091**	-0.875	-0.232	**0.230**	***-0.083***	-2.230	-2.058	-0.958	-0.346	**1.310**	**3.151**
Juices	**0.059**	-0.031	-0.169	**0.034**	-0.168	***0.211***	-0.069	**0.253**	**0.048**	**0.100**	-0.270
Bottled Water	-0.486	-0.051	**0.128**	-0.009	-0.106	-0.047	***-0.036***	**0.473**	**0.037**	**0.078**	**0.021**
Sports Drinks	-0.053	-0.116	**0.365**	-0.103	-0.139	**0.487**	**1.326**	***-1.142***	-0.020	0.008	**-0.613**
Protein Beverages	**0.617**	**0.039**	**1.124**	-0.004	-0.133	**0.244**	**0.276**	-0.054	***-1.492***	-0.323	-0.295
Alternative Beverages	**1.954**	**0.730**	-0.061	-0.249	**0.631**	**0.641**	**0.728**	**0.028**	-0.406	***-0.780***	-3.217
Yogurt	-0.289	**0.266**	**0.617**	**0.362**	**0.574**	-0.653	**0.073**	-0.771	-0.140	-1.218	***1.179***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Southeast

Table 33. Summary Statistics Associated with Prices, Quantities, and Budget Shares of the Eleven Product Categories for the Southeast Region by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Price ($/volume)		**Quantity (millions[1])**		**Budget Share (%)**	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[2]	**4.18**	**4.65**	**9.24**	**8.72**	**25.02**	**21.90**
Traditional White Milk	3.43	3.77	7.67	6.97	17.07	14.20
Organic Milk	8.06	8.29	0.52	0.53	2.71	2.37
Traditional Flavored Milk	6.05	6.48	0.33	0.33	1.30	1.16
Health-Enhanced Milk[3]	9.39	9.71	0.34	0.44	2.09	2.30
Lactose-Free Milk	7.64	7.62	0.37	0.45	1.84	1.87
Competitive Beverages & Yogurt						
Juices[4]	0.04	0.05	853.00	925.00	24.45	24.70
Bottled Water	1.46	1.59	26.82	31.66	25.08	26.98
Sports Drinks	0.03	0.04	386.00	435.00	8.41	9.74
Protein Beverages	19.50	20.42	0.23	0.29	2.85	3.21
Alternative Beverages[5]	6.58	6.75	0.87	1.12	3.70	4.07
Yogurt	2.30	2.37	7.05	7.36	10.50	9.39

[1]Unit of volume for juices and sports drinks is 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]Alternative beverages refer to plant-based alternatives (almond, oat, soy, coconut, cashew, and rice).

Table 34. Own-Price Elasticities and Expenditure Elasticities for the Southeast Region Estimated Using the Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

	Own-Price Elasticity		**Expenditure Elasticity**	
	Pre-COVID	COVID-Affected	Pre-COVID	COVID-Affected
Total Milk[1]	**-1.220**	**-0.750**	**0.524**	**0.427**
Traditional White Milk	-0.955	-0.285	0.483	0.303
Organic Milk	-0.895	-1.359	0.633	0.603
Traditional Flavored Milk	-1.538	—[5]	0.711	0.498
Health-Enhanced Milk[2]	-1.518	-0.923	0.489	0.851
Lactose-Free Milk	-0.634	-0.525	0.501	0.652
Competitive Beverages & Yogurt				
Juices[3]	-1.407	-1.497	0.707	0.924
Bottled Water	-1.777	-1.510	1.965	1.348
Sports Drinks	-2.242	-1.978	1.316	1.408
Protein Beverages	-2.176	-1.856	0.842	1.127
Alternative Beverages[4]	-1.269	-1.177	0.724	0.883
Yogurt	-1.143	-1.488	0.427	1.106

[1]Total milk includes all five sub-categories of milk.
[2]Health-enhanced milk (products with added protein, calcium, or other health benefits).
[3]Juices include refrigerated juices and drinks and shelf-stable bottled juices.
[4]Alternative beverages refer to plant-based alternatives (almond, oat, soy, cashew, coconut, and rice).
[5] A blank entry indicates a positive own-price elasticity, inconsistent with demand theory.

Figure 16. Own-Price Elasticities for the Southeast Region from Eleven-Product Demand Model by Pre-COVID Period (January 8, 2017-March 15, 2020) and COVID-Affected Period (June 28, 2020-May 15, 2022)

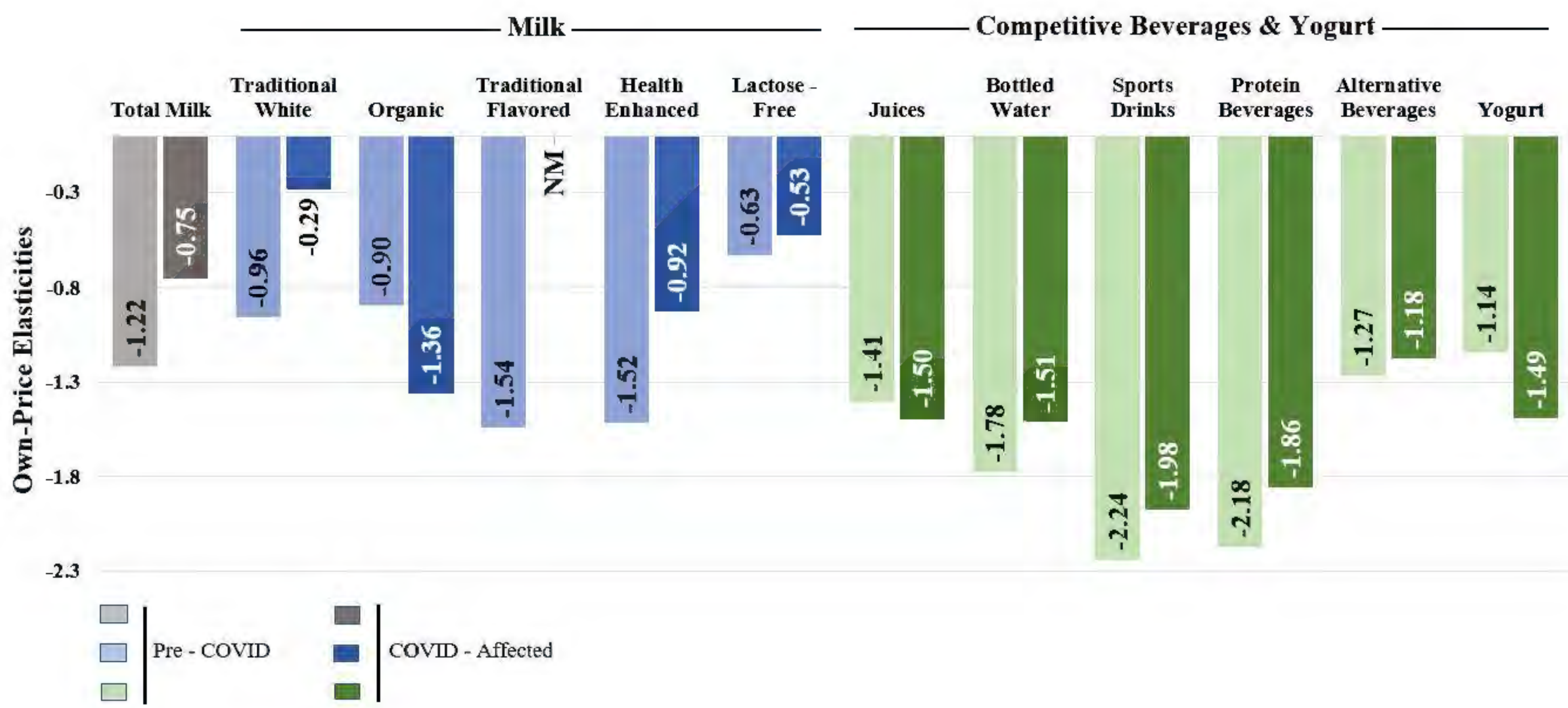


Table 35. Compensated Own- and Cross-Price Elasticities for the Southeast Region, Pre-COVID Period (January 8, 2017-March 15, 2020)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.873***	**0.049**	-0.060	**0.027**	**0.035**	**0.108**	-0.016	**0.192**	**0.222**	**0.154**	**0.163**
Organic Milk	**0.306**	***-0.878***	-0.108	**0.155**	**0.035**	**0.307**	**0.130**	**0.130**	**0.121**	**0.049**	-0.248
Traditional Flavored Milk	-0.795	-0.227	***-1.529***	**0.808**	**0.065**	-0.096	**0.212**	**0.226**	**0.131**	**0.043**	**1.162**
Health-Enhanced Milk	**0.219**	**0.200**	**0.500**	***-1.508***	-0.538	**0.382**	**0.149**	**0.076**	**0.069**	**0.097**	**0.355**
Lactose-Free Milk	**0.320**	**0.052**	**0.046**	-0.611	***-0.625***	**0.145**	**0.042**	**0.016**	**0.162**	**0.071**	**0.382**
Juices	**0.075**	**0.034**	-0.005	**0.033**	**0.011**	***-1.234***	**0.546**	**0.219**	**0.031**	**0.077**	**0.213**
Bottled Water	-0.011	**0.014**	**0.011**	**0.012**	**0.003**	**0.532**	***-1.284***	**0.411**	**0.069**	**0.040**	**0.203**
Sports Drinks	**0.390**	**0.042**	**0.035**	**0.019**	**0.004**	**0.638**	**1.224**	***-2.131***	-0.027	**0.016**	-0.209
Protein Beverages	**1.332**	**0.116**	**0.060**	**0.051**	**0.105**	**0.270**	**0.609**	-0.079	***-2.151***	**-0.069**	-0.242
Alternative Beverages	**0.711**	**0.036**	**0.015**	**0.055**	**0.035**	**0.507**	**0.272**	**0.037**	-0.053	***-1.243***	**-0.372**
Yogurt	**0.265**	-0.064	**0.144**	**0.071**	**0.067**	**0.496**	**0.484**	-0.168	-0.066	-0.131	***-1.098***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Table 36. Compensated Own- and Cross-Price Elasticities for the Southeast Region, COVID-Affected Period (June 28, 2020-May 15, 2022)

	Milk					Competitive Beverages & Yogurt					
Compensated Price Elasticities	Traditional White	Organic	Traditional Flavored	Health-Enhanced	Lactose-Free	Juices	Bottled Water	Sports Drinks	Protein Beverages	Alternative Beverages	Yogurt
Traditional White Milk	***-0.242***	**0.120**	-0.158	**0.057**	**0.140**	-0.185	-0.027	**0.083**	**0.099**	**0.069**	**0.046**
Organic Milk	**0.715**	***-1.345***	-0.117	**0.322**	**0.071**	**0.072**	**0.186**	**0.014**	**0.144**	**0.139**	-0.202
Traditional Flavored Milk	-1.932	-0.239	***1.417***	-0.657	-0.625	**0.529**	-0.011	**0.539**	**0.601**	-0.066	**0.444**
Health-Enhanced Milk	**0.353**	**0.332**	-0.332	***-0.903***	-0.600	-0.024	**0.691**	**0.089**	**0.165**	**0.154**	**0.075**
Lactose-Free Milk	**1.062**	**0.090**	**-0.389**	-0.738	***-0.513***	-0.100	**0.268**	**0.045**	**0.099**	-0.024	**0.201**
Juices	-0.106	0.007	**0.025**	-0.002	-0.008	***-1.268***	**0.599**	**0.273**	**0.081**	**0.082**	**0.318**
Bottled Water	-0.014	**0.016**	0.000	**0.059**	**0.019**	**0.549**	***-1.146***	**0.269**	**0.058**	**0.056**	**0.135**
Sports Drinks	**0.120**	0.003	**0.064**	**0.021**	0.009	**0.692**	**0.746**	***-1.840***	**0.015**	**0.048**	**0.122**
Protein Beverages	**0.436**	**0.106**	**0.217**	**0.118**	**0.057**	**0.619**	**0.490**	**0.047**	***-1.819***	-0.129	-0.142
Alternative Beverages	**0.240**	**0.081**	-0.019	**0.087**	-0.011	**0.497**	**0.369**	**0.114**	-0.102	***-1.141***	-0.115
Yogurt	**0.070**	-0.051	**0.055**	**0.018**	**0.040**	**0.836**	**0.389**	**0.126**	**-0.049**	-0.050	***-1.385***

Bolded diagonal entries are the compensated own-price elasticities. Bold off-diagonal elements are reflective of Hicksian substitutes and non-bolded off-diagonal elements are reflective of complements.

Analysis of the USDA Data from the Agricultural Marketing Service (AMS)

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). The primary motivation for the consideration of the USDA, AMS data is to draw comparisons to the IRI analysis, and to shed light on the **non-retail component** of fluid milk sales. In doing so, IDFA and MilkPEP is in position to highlight the impacts of pricing policy on fluid milk sales.

Unlike the IRI data, these sales 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 products** in the 11 Federal Milk Orders in Figure 17. (Northeast (Order Number 001), Appalachian (Order Number 005), Florida (Order Number 006), Southeast (Order Number 007), Upper Midwest (Order Number 030), Central (Order Number 032), Mideast (Order Number 033), California (Order Number 051), Pacific Northwest (Order Number 124), Southwest (Order Number 126), and Arizona (Order Number 131)).[9]

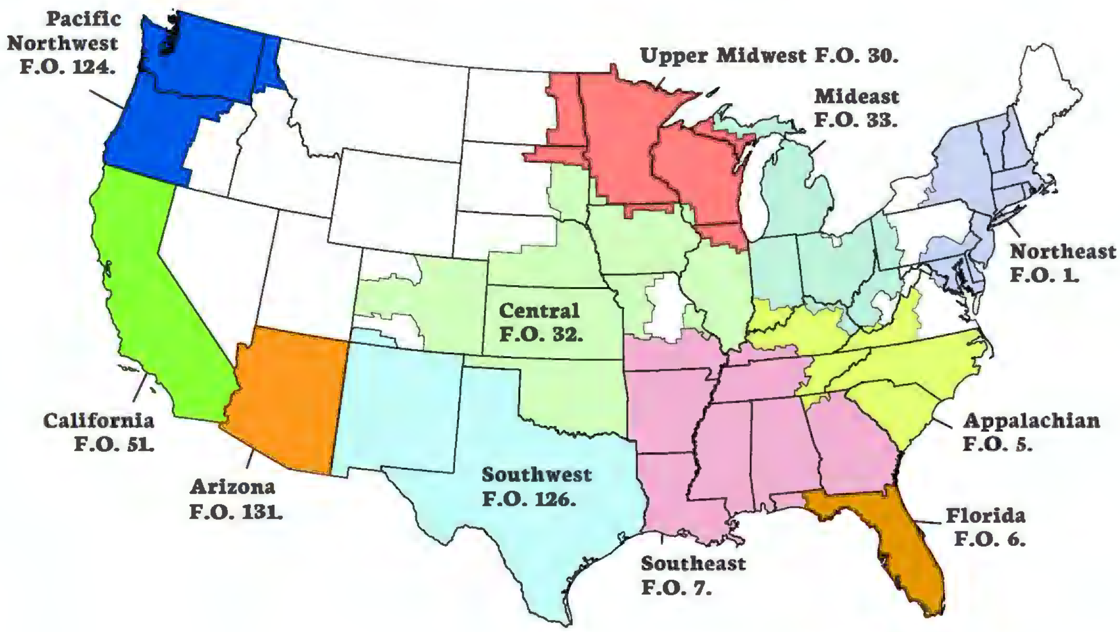
At the national level only, total milk products may be disaggregated into total conventional products and total organic products. Additionally, total conventional products and total organic products may further be decomposed into: (1) whole milk; (2) flavored whole milk; reduced fat milk (2%); (4) low fat milk (1%); (5) fat free milk (skim); (6) flavored far-reduced milk; (7) buttermilk; and (8) other fluid milk products. Again, this decomposition is only possible at the national level. For this analysis, we center attention on **traditional flavored milk, traditional white milk, organic milk, and total milk.**

The USDA does not currently collect data on volumes of plant-based milk alternatives. Hence the USDA, AMS volume data are devoid of any sales of plant-based milk alternatives.

To be consistent with the previously discussed IRI national and regional analyses, the AMS data span the period from January 2017 to August 2022 in this analysis. To estimate own-price elasticities based on the estimated fluid milk sales reports, it was necessary to align price data to shadow the volume sales information. For the analysis of total milk products by Federal Milk Marketing Order, we use the Class I prices associated with each order. For the national analysis, we use prices from IRI channels for the U.S. market for traditional flavored milk, traditional white milk, organic milk, and total milk due to the unavailability of corresponding price information from AMS. Because the prices based on the IRI data indigenous to the U.S. market were available weekly, the weekly prices were aggregated to form monthly prices for the purposes of this analysis. To support this proxy for the use of the monthly IRI prices for the four products in question, the correlation of monthly Class I prices for total milk and the monthly prices of total milk based on the IRI data for the United States was nearly 0.70.

[9] California became a Federal Milk Marketing Order in November 2018.

Figure 17. The Eleven Federal Milk Marketing Order Areas



The depiction of Class I milk prices by Federal Milk Marketing Order in terms of dollars/cwt over the period January 2017 to August 2022 is given in Figure 18. The respective Class I prices move together without question, in lockstep fashion. On average, these respective prices by marketing order ranged from $19.08/cwt (Upper Midwest) to $22.68 (Florida). Over this period, the lowest Class I price was $13.22/cwt (Upper Midwest), and the highest Class I milk price was $31.27 (Florida).

The depiction of total milk product sales in terms of millions of pounds over the period January 2017 to August 2022 is presented in Figure 19. On average, total milk product sales by market order ranged from 84 million pounds (Arizona) to 632 million pounds (Northeast). The lowest total milk product sales over this period were 71 million pounds (Arizona) to 724 million pounds (Northeast).

Descriptive statistics for organic milk, traditional flavored milk, traditional white milk, and total milk from the estimates of fluid milk products sales reports over the period January 2017 to August 2022 are exhibited in Table 37. On average, total milk sales were 3,829 million pounds over this period, ranging from 3,298 million pounds to 4,259 million pounds. Similarly, on average traditional white milk sales were 3,254 million pounds, ranging from 2,876 million pounds to 3,656 million pounds. Further, traditional flavored milk sales were on average 348 million pounds over this period, ranging from 194 million pounds to 454 million pounds. Finally, organic milk sales were on average 227 million pounds, ranging from 188 million pounds to 264 million pounds.

The monthly prices of organic milk, traditional flavored milk, traditional white milk, and total milk are expressed in terms of dollars per gallon, for clarity prices in terms of volume sales not unit sales. The monthly data for the respective prices based on the use of the IRI data for the U.S. market cover the period January 2017 to March 2022.

Figure 18. Class I Milk Prices by Federal Milk Marketing Order, January 2017 to August 2022, $/cwt

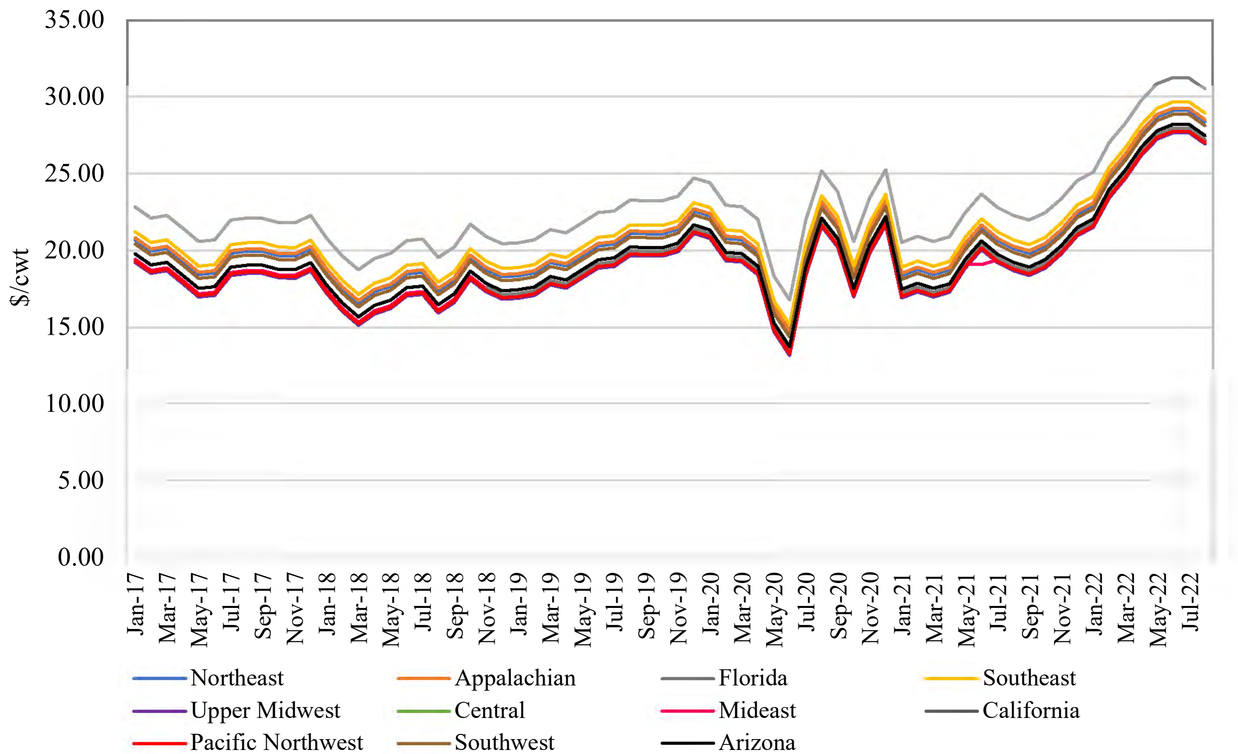


Figure 19. Total Milk Product Sales by Federal Milk Marketing Order, January 2017 to August 2022, millions of pounds

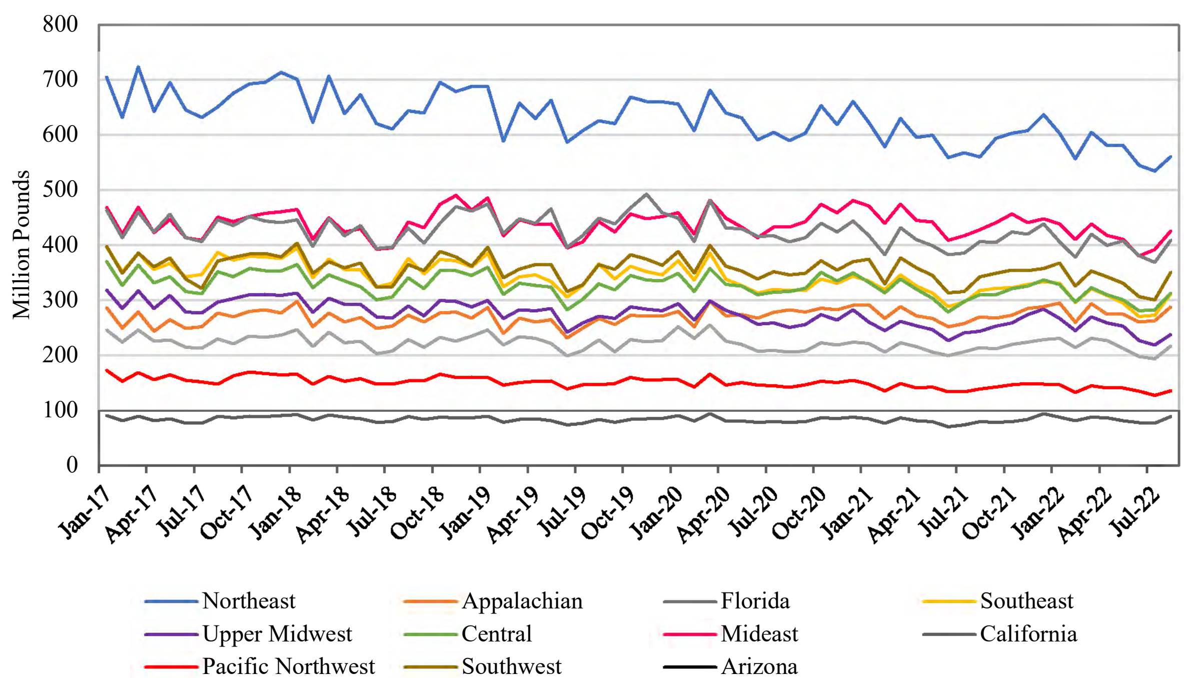


Table 37. Descriptive Statistics for Organic Milk, Traditional Flavored Milk, Traditional White Milk, and Total Milk from the Estimated Fluid Milk Products Sales Reports, AMS, USDA, January 2017 to August 2022, millions of pounds

	Organic Milk	Total Milk	Traditional Flavored Milk	Traditional White Milk
Mean	227	3,829	348	3,254
Median	229	3,813	369	3,261
Maximum	264	4,259	454	3,656
Minimum	188	3,298	194	2,876
Standard Deviation	17	230	75	193

Source: AMS, USDA

The descriptive statistics associated with prices of organic milk, traditional flavored milk, traditional white milk, and total milk are exhibited in Table 38. On average, the price of organic milk was $8.09 per gallon, ranging from $7.89 per gallon to $8.52 per gallon. The price of traditional flavored milk on average was $5.23 per gallon, ranging from $4.88 per gallon to $5.84 per gallon. Moreover, on average, the price of traditional white milk was $3.20 per gallon, ranging from $2.96 per gallon to $3.77 per gallon over this period. Finally, the price of total milk was $3.94 per gallon on average, ranging from $3.60 per gallon to $4.60 per gallon over this period.

Taken together, with the USDA AMS volume data and with appropriate price data, we estimate own-price elasticities for total milk, conventional milk (flavored milk and white milk), and organic milk at the national level. As well, we estimate own-price elasticities for total milk for each of the Federal Milk Marketing Orders. We hypothesize that the impacts attributed to price (i.e., the own-price elasticities) are likely to be greater on retail sales than on sales to schools, the military, and for industrial purposes. Bottom line, we expect that the own-price elasticities based on the use of the IRI data will be larger than the own-price elasticities derived from the estimated fluid milk products sales based on the use of the AMS data. Another explanation for this hypothesis is that the AMS data are devoid of prices of either substitute and/or complementary products. According to economic theory, own-price elasticities are larger given the availability of substitute /complementary products.

To carry out the respective estimations of the various own-price elasticities, we employ the use of two seemingly unrelated regression (SUR) models (Zellner, 1962). These models account for not only prices but also seasonality and the pandemic. The vetting of seasonality is done using monthly indicator of dummy variables. The base or reference category is arbitrarily chosen as the month of December to avoid the euphemistic dummy variable trap econometrically. To shed light on the impact of COVID-19, indicator or dummy variables are constructed as follows: (1) March 2020 lone; (2) April 2020 alone; (3) May 2020 alone; and (4) for the remaining months June 2020 to

Table 38. Descriptive Statistics Associated with Volume-Based Prices of Organic Milk, Traditional Flavored Milk, Traditional White Milk, and Total Milk, January 2017 to March 2022, $/gallon

	Organic Milk Price	Total Milk Price	Traditional Flavored Milk Price	Traditional White Milk Price
Mean	8.09	3.94	5.23	3.20
Median	8.06	3.80	5.15	3.19
Maximum	8.52	4.60	5.84	3.77
Minimum	7.89	3.60	4.88	2.96
Standard Deviation	0.16	0.29	0.27	0.21

Source: Information Resources, Inc. (IRI).

August 2022. The base or reference category is the period January 2017 to February 2020.[10] Further, to explore dynamics, we also entertain volume sales twelve months ago as a potential exogenous factor. This latter consideration allows for habit persistence or inventory behavior. Importantly, the SUR modeling approach accounts for the correlation of the respective error terms. These error terms represent inadvertently omitted explanatory variables (e.g., prices of competing or complementary products, disposable income, advertising, and population dynamics) which are common to all equations in the system. Consequently, in the ensuing applied econometric analyses, the estimated standard errors of the respective estimated coefficients are guaranteed to be lower than if the estimation occurred one equation at a time (via ordinary least squares (OLS)). Finally, we adopt the use of logarithmic transformation on the continuous variables in the SUR models. With this transformation, the estimated coefficients associated with the respective price variables are the own-price elasticities.

[10] The World Health Organization formally declared COVID-19 a pandemic on March 11, 2020. Two days later March 13, 2020, the Trump Administration declared COVID-19 a national emergency. We adopt this period to indicate the start of market disruption attributed to COVID-19. That said, we acknowledge that initial consumer reaction to the pandemic could have happened before March 11, 2020, given that the first COVID-19 case in the United States could be traced back to January 21, 2020, and given that the CDC expressed a warning of a looming pandemic on February 25, 2020.

See also: Zhao, S., L. Wang, W. Hu, and Y. Zheng. 2022. Meet the Meatless: Demand for New Generation Plant-Based Meat Alternatives. *Applied Economic Perspectives and Policy*, 2022:1-18.

SUR Model for Conventional Flavored Milk, Conventional White Milk, Organic Milk, and Total Milk

Parameter estimates, standard errors, t-statistics, and p-values associated with the coefficients of the seemingly unrelated regression model dealing with sales of organic milk, traditional flavored milk, traditional white milk, and total milk are exhibited in Appendix D.

A summary of the econometric results for the United States concerning the fluid milk product sales for total milk, organic milk, traditional flavored milk, and traditional white milk is exhibited in Table 39.

The goodness-of-fit statistics (R^2) indicate that the SUR model captures roughly 80 to 90 percent of the variability in U.S. sales of the respective products. Seasonality as expected was a statistically significant factor affecting product sales. The seasonal pattern was the same for organic milk, traditional white milk, and total milk sales, wherein sales were highest in December and January. But the seasonal pattern was different for flavored milk sales, wherein sales were lowest in June, July, and August. This patten reflects the availability of flavored milk in schools. COVID-19 was not a statistically significant driver of sales for total milk, traditional white milk, or organic milk. However, COVID-19 was a statistically significant factor affecting traditional flavored milk sales. Sales in March 2020, April 2020, May 2020, and beyond (June 2020 to March 2022) were lower by 34 percent, 55 percent, 54 percent, and 25 percent relative to the pre-COVID period. Again, this pattern reflects the importance of schools concerning flavored milk.

Further, sales in the previous 12 months were a factor affecting current product sales of total milk, organic milk, and traditional white milk. A 1 percent change in total milk sales 12 months ago resulted in a 0.21 percent change in current total milk sales. A 1 percent change in organic milk sales 12 months ago resulted in a 0.19 percent change in current organic milk sales. A 1 percent change in traditional white milk sales 12 months ago resulted in a 0.23 percent change in current traditional white milk sales. This finding was not evident for traditional flavored milk, wherein a 1 percent change in traditional flavored milk 12 month ago resulted in a 0.02 percent change in current traditional flavored milk sales. Holding all other factors constant, the dynamics indicate habit persistence over inventory behavior for sales of the respective milk products.

The own-price elasticities were estimated to be -0.24 for total milk, -0.37 for traditional white milk; -0.74 for organic milk; and 1.54 for traditional flavored milk. The respective own-price elasticities except for traditional flavored milk were consistent with the extant literature and economic theory. Further, the own-price elasticities for total milk, traditional white milk, and organic milk were in the inelastic range. As such, as expected, not much price sensitivity was evident concerning these three fluid milk products. A possible explanation for the anomalous positive own-price elasticity for traditional flavored milk may be attributed to deliveries in packages from processing (bottling) plants predominantly to schools. As such, we may argue that price sensitivity was not a prime consideration for schools.

Table 39. Summary of Econometric Results for Total Milk, Organic Milk, Traditional White Milk, and Traditional Flavored Milk for the United States

	Total Milk	Organic Milk	Traditional White Milk	Traditional Flavored Milk
Own-Price Elasticity	-0.2372	-0.7418	-0.3700	*1.5384*
Seasonality Base Month; December				
January	0.0038	0.0208	0.0006	0.1364
February	-0.0824	-0.0781	-0.0864	0.0682
March	-0.0150	-0.0156	-0.0239	0.1747
April	-0.0595	-0.0903	-0.0717	0.1449
May	-0.0432	-0.0380	-0.0528	0.1168
June	-0.1086	-0.0816	-0.0883	-0.3410
July	-0.0907	-0.0655	-0.0652	-0.4116
August	-0.0512	-0.0491	-0.0462	-0.0476
September	-0.0570	-0.0562	-0.0691	0.1438
October	-0.0019	-0.0216	-0.0208	0.2230
November	-0.0068	-0.0262	-0.0155	0.1106
COVID Periods Base Period: PreCOVID				
March 2020	0.0683	0.1646	0.1056	-0.3402
April 2020	0.0196	0.2317	0.0624	-0.5462
May 2020	-0.0172	0.1589	0.0209	-0.5415
June 2020 To March 2022	-0.0119	0.1175	-0.0046	-0.2545
Sales Volume Previous 12 Months	0.2111	0.1915	0.2301	0.0206
R2	0.8889	0.8167	0.8410	0.9291
Adjusted R2	0.8469	0.7475	0.7809	0.9022
SER	0.0218	0.0392	0.0256	0.0718
Durbin-Watson Statistic	1.7583	1.7707	1.2809	1.0780

Source: Estimated Fluid Milk Product Sales from Monthly AMS Reports,
Data from January 2017 to March 2022

SUR Model for Total Milk Products by Federal Milk Marketing Order

Parameter estimates, standard errors, t-statistics, and p-values associated with the coefficients of the seemingly unrelated regression model dealing with sales of total milk by Federal Milk Marketing Order are exhibited in Appendix E.

A summary of the econometric results for the United States concerning the total milk product sales by marketing order is exhibited in Table 40.

The goodness-of-fit statistics (R^2) also indicate that the SUR model captures roughly 80 to 90 percent of the variability in U.S. total milk deliveries to food stores, convenience stores, warehouse stores/wholesale clubs, non-food stores, schools, food service industry, and home delivery. Seasonality as expected was a statistically significant factor affecting total milk sales. Total milk sales were highest in December and January across the respective marketing orders.

COVID-19 was a statistically significant driver of total milk sales beginning in May 2020 and beyond for all Federal Milk Marketing Orders except for the Appalachian Order and the Mideast Order. Except for these two orders, sales in May 2020 and beyond (June 2020 to March 2022) were lower by two to nine percent (depending on the affected Order) than in the pre-COVID period.

Further, sales in the previous 12 months were a factor affecting current product sales of total milk but for the Southwest Order, the Central Order, and the California Order. A 1 percent change in total milk sales 12 months ago resulted in a 0.12, 0.22, 0.25, and 0.28 percent change in current total milk sales in the Upper Midwest Order, the Southeast Order, the Pacific Northwest Order, and the Northeast Order respectively. These findings indicate habit persistence over inventory behavior for sales of total milk in the previously mentioned orders. On the other hand, a 1 percent change in total milk sales 12 months ago led to a -0.12, -0.16, -0.19, and -0.25 percent change in current total milk sales in the Mideast Order, the Appalachian Order, the Arizona Order, and the Florida Order. These findings indicate inventory behavior of sales of total milk over habit persistence in the Federal Milk Marketing Orders.

The own-price elasticities for total milk across the respective marketing orders were estimated to be in the inelastic range. In addition, the respective own-price elasticities were not unform across marketing orders. The lowest own-price elasticity was in the Appalachian Order (-0.0020), while the highest own-price elasticity was in the Southeast Order (-0.1559). As expected, not much price sensitivity was evident concerning total milk by Federal Milk Marketing Order. This result is consistent with the extant economic literature.

Table 40. Summary of Econometric Results for the Eleven Federal Milk Marketing Orders

	Appalachian	Arizona	California	Central	Florida	Mideast
Own-Price Elasticity	-0.0020	-0.0458	-0.0823	-0.1111	-0.0311	-0.1182
Seasonality (Base Month; December)						
January	0.0480	-0.0015	-0.0339	0.0123	0.0489	0.0027
February	-0.1070	-0.1279	-0.1242	-0.1016	-0.0718	-0.1132
March	0.0104	-0.0189	-0.0316	-0.0192	0.0276	-0.0212
April	-0.0726	-0.0748	-0.0735	-0.0685	-0.0370	-0.0872
May	-0.0446	-0.0961	-0.0384	-0.0797	-0.0657	-0.0722
June	-0.1249	-0.1911	-0.1127	-0.1626	-0.1495	-0.1677
July	-0.0947	-0.1725	-0.1104	-0.1321	-0.1315	-0.1397
August	-0.0160	-0.0580	-0.0477	-0.0480	-0.0490	-0.0607
September	-0.0502	-0.1019	-0.0557	-0.0708	-0.1009	-0.0695
October	-0.0037	-0.0451	-0.0063	-0.0028	-0.0128	-0.0066
November	0.0053	-0.0394	-0.0023	-0.0124	-0.0284	-0.0103
COVID Periods (Base Period: PreCOVID)						
March 2020	0.0706	0.0630	0.0505	0.0383	0.0567	0.0605
April 2020	0.0547	-0.0406	-0.0201	-0.0020	-0.0077	0.0484
May 2020	0.0360	-0.0366	-0.0782	-0.0247	-0.0215	-0.0288
June 2020 To August 2022	0.0453	-0.0375	-0.0803	-0.0388	-0.0535	0.0113
Sales Volume Previous 12 Months	-0.1579	-0.1911	0.0475	-0.0282	-0.2498	-0.1214
R2	0.8489	0.7969	0.8806	0.8441	0.8688	0.8445
Adjusted R2	0.7975	0.7165	0.8081	0.7911	0.8243	0.7916
SER	0.0246	0.0335	0.0301	0.0303	0.0252	0.0260
Durbin-Watson Statistic	1.4998	1.4169	2.0436	1.1651	1.8110	1.5639

	Northeast	Pacific Northwest	Southeast	Southwest	Upper Midwest
Own-Price Elasticity	-0.0891	-0.0688	-0.1559	-0.0989	-0.0940
Seasonality (Base Month; December)					
January	-0.0194	0.0004	0.0233	0.0509	-0.0021
February	-0.0952	-0.0785	-0.0704	-0.0814	-0.0947
March	-0.0184	-0.0198	-0.0130	-0.0024	-0.0177
April	-0.0701	-0.0424	-0.0403	-0.0339	-0.0577
May	-0.0353	-0.0255	-0.0503	-0.0289	-0.0406
June	-0.0927	-0.0690	-0.1093	-0.1299	-0.1275
July	-0.0878	-0.0727	-0.0825	-0.1254	-0.1139
August	-0.0693	-0.0569	-0.0083	-0.0231	-0.0701
September	-0.0560	-0.0325	-0.0362	-0.0311	-0.0672
October	-0.0172	0.0049	-0.0029	0.0203	-0.0171
November	-0.0247	-0.0038	-0.0051	0.0048	-0.0122
COVID Periods (Base Period: PreCOVID)					
March 2020	0.0184	0.0689	0.0828	0.0734	0.0180
April 2020	0.0165	-0.0430	-0.0307	0.0012	-0.0037
May 2020	-0.0649	-0.0431	-0.0770	-0.0496	-0.0796
June 2020 To August 2022	-0.0618	-0.0553	-0.0785	-0.0320	-0.0911
Sales Volume Previous 12 Months	0.2785	0.2450	0.2203	-0.0022	0.1163
R2	0.9123	0.8730	0.9067	0.8709	0.8318
Adjusted R2	0.8824	0.8298	0.8750	0.8271	0.7746
SER	0.0246	0.0272	0.0305	0.0273	0.0408
Durbin-Watson Statistic	1.4932	1.1543	1.2597	1.7051	1.0105

Notes: Seemingly Unrelated Regression; Monthly data from January 2017 to August 2022; California became a Federal Milk Marketing Order in November 2018.

Systematic Review of the Existing Literature

A literature review was conducted to examine and summarize existing research on milk elasticities. Four electronic databases (CAB Abstracts, Econlit, Academic Search Ultimate, and Agricola) were systematically searched using a combination of keywords that include milk OR dairy AND demand OR elastic OR purchase OR expenditure OR consumption OR scanner data OR budget shares for studies related to the United States and **published after 1990**. The database search was complemented with additional references from a personal digital library on the topic and search of the list of the references of the identified studies. Studies were included in this review if they reported own-price elasticity estimates for any type of milk product or category. Studies reporting supply elasticities or simulated elasticities were excluded. In Appendix F Figure F1, we describe the study screening and selection steps.

The body of the literature accumulated over time on the U.S. demand for fluid milk products was quite large. Sixty-four studies reported in sixty-eight documents were included in the review. Most of the studies were published in academic journals (48), followed by working papers and reports (12), PhD. dissertations (3), and book chapters (1). In Appendix F Table F1, we provide detailed information from included studies regarding location/region, year of data, data source, data aggregation level, sample size, objective, statistical design and procedures, main results, and the reported milk elasticities. Out of sixty-four studies, thirty-two reported elasticities and their standard error, which allowed us to conduct univariate random-effects meta-analysis and obtain an overall elasticity estimate. As can be seen from this table, the existing research produced a wide range of milk elasticity estimates, and these elasticities differed with respect to number of products used in the estimation, time period covered, data used (household level data vs. time-series), model specification, and estimation technique (single-equation vs. multiple-equation).

In Table 41, we provide the summary of the data extracted from existing studies. Although there was a considerable range of elasticities found from the literature, some generalization can be drawn from this review. Most of the studies reported inelastic own-price elasticities of demand for white milk and elastic own-price elasticities of demand for flavored and organic milk. That is to say, the demand for traditional white milk was less responsive to price changes than the demand for traditional flavored milk. Own-price elasticity estimates for specialty milk (rBST free milk, goat milk, and lactose-free milk) and alternative plant-based beverages were mixed. All elasticities reported in the extant economic literature covered the pre-COVID period only. As such, our study adds measurable to the existing literature regarding own-price elasticities for milk products.

Table 41. Summary of Data Extracted from the Literature

Milk category	Number of Studies in Meta-Analysis	Number of observations		Range of Elasticities
		Retrieved	Used in the Analysis	
White milk	18	76	66	[-2.411, 0.000]
Flavored Milk	4	11	11	[-3.820, -1.390]
Organic Milk	7	18	18	[-4.220, -0.634]
Specialty Milk (rBST free milk, goat, lactose free)	5	22	22	[-9.192, -0.002]
Alternative Beverages (Plant-Based)	6	22	16	[-6.266, -0.059]

Insights on Own- Price Elasticities Associated with Traditional White Milk

All elasticities reported as fluid milk, cow's milk, white milk, and generic milk other than the elasticities by fat content, flavor, and specialty milk, were included in traditional white milk category. Thirty-seven studies reported such estimations. Uncompensated own-price elasticities ranged from -7.061 (Badruddoza 2020) to 0.150 (Lenz et al. 1998). After removing outliers, elasticities for white milk ranged from -2.41 (Hovhannisyan and Gould 2012) to 0 (Kaiser and Chung 2002), with a median value of -0.24 among 66 elasticities reported.

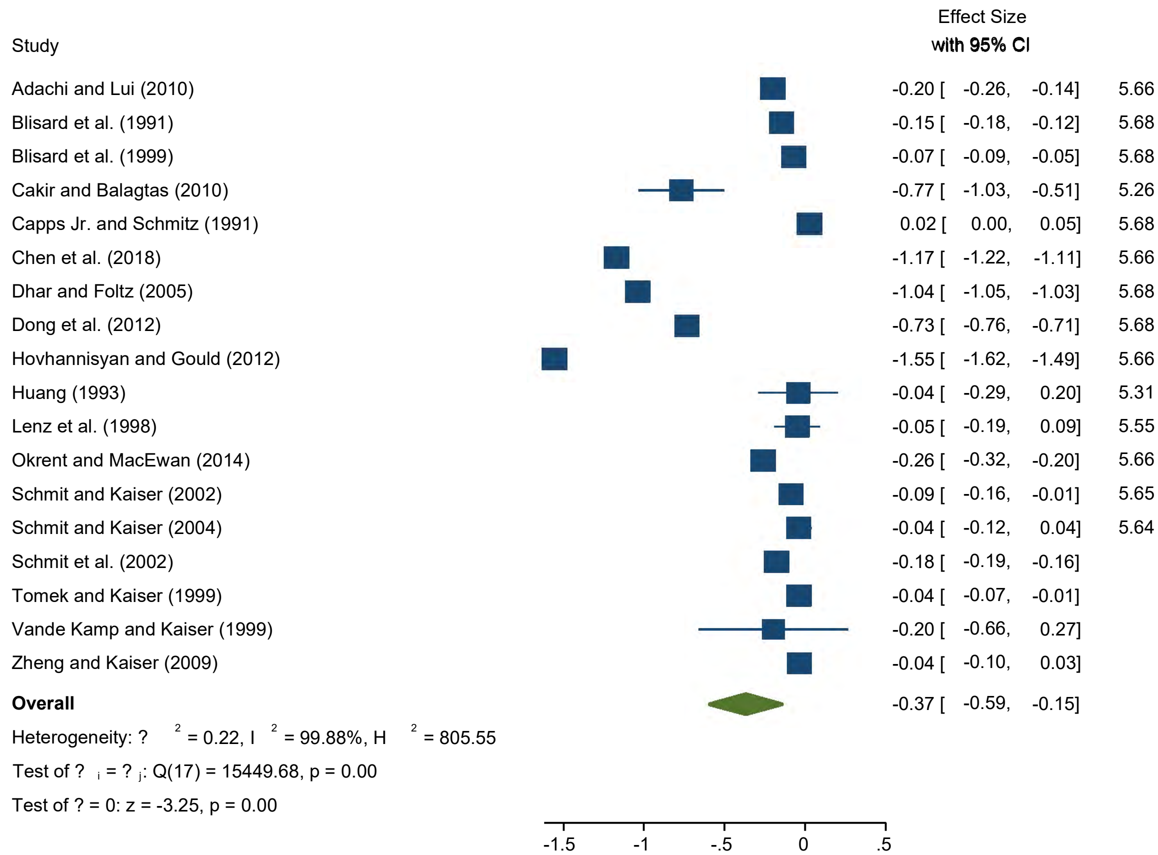
Figure 20 presents the forest plot from meta-analysis for white milk elasticities. This figure shows the range of elasticities estimated by the authors of existing studies. Several studies reporting milk elasticities were not included in meta-analysis due to missing standard errors.

Own-price elasticities for white milk from the meta-analysis of the 18 studies reporting both elasticities and their standard errors was estimated to be -0.37. The 95% confidence interval of for the respective own-prices for white milk is given as [-0.59, -0.15].

Most frequently, studies concentrated on types of milk, namely whole milk, reduced fat milk (2%), low fat milk (1%) and fat-free milk (skim). Although not within the scope of this report, a summary of studies on milk by fat content is provided below.

Whole Milk: Twenty-seven studies report elasticity estimates for whole milk ranging from -9.79 (Chidmi and Murova 2011) to a non-significant own-price positive elasticity of 0.032 (Capps and Schmitz 1991). Most of the reported elasticities fall in the interval (-0.75, -0.65) with the median value among 28 elasticities reported of -0.76. The median own-price elasticity from the meta-analysis of the 12 studies was estimated to be -0.54 (with a 95% confidence interval given as [-0.80, -0.27]).

Figure 20. Meta-Analysis Results for Milk



Reduced-fat Milk: Twenty-two studies reported elasticities of reduced-fat milk. Own-price elasticities ranged from -5.88 (Chidmi and Murova 2011) to 0 (Kiesel et al. 2004) with a median value of -0.87 among 32 reported elasticities. The median own-price elasticity from the meta-analysis of the 8 studies reporting both the elasticities and their standard error was estimated to be -0.87 (with a 95% confidence interval given as [-1.15, -0.59]).

Low-fat Milk: Twenty-two studies reported own-price elasticities for low-fat milk. The own-price elasticities ranged from -2.55 (Lopez and Lopez 2009) to -0.0002 (Kiesel et al. 2004) with a median value of -0.70 among the 30 reported estimations. The median own-price elasticity from the meta-analysis of the 11 studies reporting both elasticities and their standard error was estimated to be -0.47 (with a 95% confidence interval given as [-0.74, -0.21]).

Fat-free Milk: Twenty studies reported own-price elasticities of fat-free milk. These own-price elasticities ranges from -3.24 (Davis et al. 2012) to 1.44 (Ueda and Frechette 2002) with a median value of -0.68 among the 30 reported estimations. These respective elasticities fell in the interval [-0.65, 0.45]. The median own-price elasticity from the meta-analysis of the 9 studies reporting both elasticity estimation and its standard error was estimated to be -0.57 (with a 95% confidence interval given as [-0.76, -0.39]).

Insights on Own-Price Elasticities Associated with Traditional Flavored Milk

Four studies reported own-price elasticities of flavored milk (Davis et al. 2012, Dharmasena and Capps 2014, Hu et al. 2020, Maynard and Liu 1999) providing a total of 11elasticity estimates. Unconditional own-price elasticities ranged from -3.82 (Davis et al. 2012) to -1.39 (Dharmasena and Capps 2014), while conditional own-price elasticities were estimated to be -0.62 (Hu et al. 2020) and -0.32 (Dharmasena and Capps 2014). Except for conditional own-price elasticities, the demand for traditional flavored milk was very sensitive to changes in prices.

Insights on Own-Price Elasticities Associated with Organic Milk

Seven studies reported own-price elasticities for organic milk (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). These own-price elasticities ranged from -4.22 to -0.63, the latter being the only inelastic measure among the 18 reported. This elasticity corresponded to organic whole milk bought from natural stores, while the same product bought from food, drug, and mass merchandizer stores had an estimated elasticity of -1.20 (Li et al. 2018). Most own-price elasticities for organic milk were observed in the interval (-1.45, -1.25).

Insights on Own-Price Elasticities Associated with Specialty Milk

Five studies reported elasticities for specialty milk including products labeled as rBST free milk, goat milk, and lactose free milk (Badduddoza 2020, Dhar and Foltz 2005, Kiesel et al. 2004, Lopez and Lopez 2009, Scott 2013). Except for Kiesel et al. (2004), all studies reported highly elastic demands for specialty milks, with own-price elasticities ranging from -9.19 to -2.09. The own-price elasticities for rBGH-free labelled milk varied depending on fat content and the container size. ranging from -0.95 to -0.002 (Kiesel et al. 2004).

Insights on Own-Price Elasticities Associated with Plant-Based Beverages

Plant-based beverages considered in the literature included soy milk, almond milk, coconut milk, and rice milk. Six studies reported own-price elasticities for these alternative beverages. Most of the studies observed highly elastic demands for these plant-based alternative beverages to milk (Badruddoza 2020, Dharmasena and Capps 2014, Okrent and MacEwan 2014, Scott 2013) reporting elasticities ranging from -6.27 to -1.68. In contrast, two studies (Chen 2021, and Yang and Dharmasena 2021) reported inelastic demands for plant-based beverages with own-price elasticity estimates ranging from -0.50 to -0.02.

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Appendices

Appendix A. Description of the Barten Synthetic Model

Appendix B. Parameter Estimates, Standard Errors, t-Statistics, and p-values from the Eleven Product Barten Synthetic Model for the United States

Appendix C. Parameter Estimates, Standard Errors, t-Statistics, and p-values from the Eleven Product Barten Synthetic Model for each of the Eight IRI Regions

Appendix D. Parameter Estimates, Standard Errors, t-Statistics, and p-values from the Seemingly Unrelated Regression (SUR) Model Dealing with Sales of Organic Milk, Traditional Flavored Milk, Traditional White Milk, and Total Milk

Appendix E. Parameter Estimates, Standard Errors, t-Statistics, and p-values from the Seemingly Unrelated Regression (SUR) Model Dealing with Sales of Total Milk by Federal Milk Marketing Order

Appendix F. Details Associated with the Review of the Extant Economic Literature Concerning the Demand for Milk Products