**Foaming up a milk empire?**

**Projected effects of a dairy merger**

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Running head: Projected effects of a dairy merger

Abstract

The recent bankruptcy of Dean Foods (DF) and subsequent acquisition of a major share by Dairy Farmers of America (DFA) raised an anti-trust complaint which led to DF divesting some assets. The current article empirically analyzes the economic impact of a hypothetical merger between DF and DFA. We use retail scanner data of 2008-2018 under a random-coefficient discrete choice framework. Assuming a constant marginal cost, we find that the hypothetical merger may slightly increase retail prices of cow milk products—especially organic ones—across the market and the hypothetical market power of DFA in the long run.

## Introduction

With U.S. milk consumption falling 40% per capita since 1975, the dairy industry is facing significant challenges. Americans are drinking less cow's milk than before; and milk alternatives sales have been growing (Stewart, Dong and Carlson 2013; Welsh et al. 2019; Badruddoza 2020; Stewart et al., 2021). The economy-wide transitions adversely affected thousands of farmers along with big firms (Smith 2018). For example, Dean Foods (DF)—formerly, the largest U.S. milk processor that marketed about one-third of the milk in the country and sold dairy products under 50 popular labels including Dean's, TruMoo, Dairy Pure, Land O'Lakes, and Tuscan—struggled in recent years primarily because consumers started seeking less sugary or plant-based alternatives (Valinsky 2019). The average price of the dairy products marketed by DF fell from seven cents per ounce to 5 cents per ounce over the period 2008-18. Between 2016 to 2019, DF's stock prices fell by 95% from $20 to $1, eventually pushing the company to file for voluntary Chapter 11 bankruptcy protection (Business Insider 2021). After three months of negotiation, Dairy Farmers of America (DFA)—a Kansas-based farmer-owned cooperative—reached an agreement with DF to acquire 44 of DF's fluid and frozen facilities, including the real estate, inventory, equipment, and all other assets in processing facilities (Bloomberg 2020), and won the bid to buy a substantial part of DF for $433 million in April 2020 (Businesswire 2020). Other bidders like Prairie Farms Dairy won smaller parts of DF's facilities (Dorsett 2020)

Dairy farmers benefit from higher milk prices, while milk processors benefit from lower milk prices. A dairy cooperative that buys milk-processing operations—implying that it buys some of the milk its own marketing arm sells—may create a conflict of interest. The primary concern was DFA's capability to wield market power at two levels of the supply chain, thereby thwarting the competition in the dairy market. Not surprisingly, many farm groups were concerned about an excessive concentration of milk buyers in different parts of the country (Bunge 2020). There were two reasons. First, DF was the largest milk processor and DFA is the largest dairy cooperative, and their products together would cover about 50% of cow's milk sold (see Figure 1). Second, both firms were accused of anticompetitive conduct before, e.g., for the high prices in 2008-09 by dairy farmers in the U.S. Southeast and Northeast regions (Bolotova 2018; Astley 2014; Yaffe-Bellany 2019). In May of 2020 the State of Wisconsin and the Commonwealth of Massachusetts filed an anti-trust complaint against DF acquiring certain milk processing plants, and in October of 2020 DF was ordered to divest of three processing plants in Wisconsin and Massachusetts. Subsequently in December 2020, DF was allowed to keep the plant in Massachusetts because a suitable buyer could not be found for the plant as it required substantial investments to make the plant profitable. DF agreed to make the investments (U.S. Department of Justice, 2020a). This was noted as important by the Department of Justice (DOJ) because the COVID-19 pandemic caused the demand for milk by schools and restaurants to collapse (Kaberline 2020). While the acquisition of the DF processing plants by DFA was found to have an was anti-competitive impact in two geographic areas, it is yet unknown if, and to what extent, the merger affects the U.S. dairy market.

The current article measures the economic impact of a hypothetical merger between Dean Foods (DF) and Dairy Farmers of America (DFA). We use prices, sales, and attributes of cow's milk products from the scanner data (2008-2018)--that cover about half of the retail food sales in the United States--to analyze this issue. A random-coefficient discrete-choice framework was used to estimate the demand for cow's milk and then to evaluate the effects of a hypothetical merger on prices and market power. Own- and cross-price elasticities indicate that consumers are less likely to substitute away from DF products compared with how much they substitute away from other companies' products. Assuming marginal costs are constant, we find that the retail prices increase by 29% on average (1.27 cents per ounce of milk) in the long run, not only for the merged companies, but also for the entire market. The hypothetical merger also slightly increases DFA's market power.

The Lerner Indices for DF and DFA before merging were 44.6 and 13.1 respectively, which became 46.1 after the hypothetical merger.

**Modeling the effects of a merger**

We adopt a random utility discrete choice approach (Berry, Levinsohn, and Pakes 1995; Nevo 2001) to project the impact of the hypothetical merger between DF and DFA on the market for cow's milk products in the United States. The idea is to derive the demand curve, predict the post-merger prices and use the prices to calculate the gap between price and marginal cost. This section summarizes the approach. For a detailed technical discussion, see Appendix 1.

For the demand side, we assume that a consumer's indirect utility is a function of price and other product attributes, and the parameters follow Normal distribution to accommodate consumer heterogeneity. A consumer chooses a milk product when her indirect utility from that product exceeds other options. Thus, the probability of purchasing a product depends on its attributes and the consumer's tastes. Aggregating probabilities for each product across consumers in a market gives the theoretical market share of that product. Market shares of products and product attributes are observable in the data. We can thereby estimate the parameters with product attributes by minimizing the gap between theoretical market shares and observed market shares. Own and cross-price elasticities and consumer welfare are calculated from the derived relationship between market shares and prices.

For the supply side, we define that each company has a range of milk products that differ by attributes. Maximizing the profit function, we get an expression where the gap between price and the marginal cost of milk products (price-cost markup) depends on the price elasticities of demand and an ownership matrix. The ownership matrix is a square matrix and its dimension is equal to the number of milk products. An element of the ownership matrix is 1 if the product is marketed by the company listed on the row of the matrix, and zero otherwise. We use observed product prices, the ownership matrix, and price elasticities obtained from the demand side to calculate the price-cost markup. We also calculate the Lerner Index (=100×(price - marginal cost)/price) that provides an estimate of the market power. Finally, we change the ownership matrix to check the effects of the merger on prices and the Lerner Index. For example, milk product *j* of DF has DF equal to 1before the hypothetical merger, and DFA is equal to 0. After the merger, the revers is true (DF=0 and DFA=1. Post-merger prices are numerically solved using the new ownership matrix and previous marginal cost and elasticities, under the assumption that the costs and elasticities did not change. An increase in the price and markup for DFA after the merger indicates a greater level of concentration in the cow's milk market.

**Data and estimation**

We use retail-scanner data from IRI's InfoScan that cover about 51% of the retail food sales in the United States (Muth et al. 2016; Levin et al. 2018). Each product is identified via a unique universal product code (UPC). As customers purchase a product, its price, quantity, and locational information are scanned and recorded against the UPC. InfoScan reports the weekly purchases for each store or group of stores by location. Product dictionaries provide product characteristics, including organic, milkfat, added flavor, and package volume. However, retail scanner data do not include consumers' demographic information.

For the empirical estimation, we selected all products in the "milk" category in the "dairy" aisle, that are fluid, and had "cow's milk" claimed on the label. The product labels were searched using a Structural Query Language (SQL) program. Our selection includes various types of cow's milk and some value-added products that are close substitutes to cow's milk, e.g., a chocolate milkshake made from cow's milk. These beverages were included in the model in order to comprehensively analyze the products marketed by Dean Foods. Selecting a greater range of products reduces the chance of omitting a feature that is related to cow's milk, and thereby estimates the impact of a merger more accurately. The process generated about 387 unique products under 22 parent companies, including DF and DFA. DF has over 40 products whereas DFA has two.

Table 1 presents the key terms and variables used in the analysis with their means and standard deviations. Table A1 in Appendix S1 shows the summary statistics by year. The data set spans eleven years from 2008 to 2018. We define each state-year combination as the market, where states include all contiguous U.S. States and the District of Columbia. The average market share of a cow's milk product is 0.006 (0.6%) that varies from 0.008 to 0.005 in the studied years— indicating considerable competition among products. The market share was calculated by $s_{jt} = \frac{Q_{jt}}{\sum_{j=1}^{J} Q_{jt}}$, where $Q_{jt}$ is the quantity sold of product *j* in market *t*, such that *J* is the total number of products available in the market. Since the raw data are in weekly form, we convert the quantity sold into a yearly form using $Q_{jt} = \text{package size}_j \times \sum_1^{52} \text{Units sold a week}_j$—where package size means the amount of beverage in fluid ounces in a bottle or pack. The mean price revolves around seven cents per ounce. The mean price of a product is $p_j = \frac{\sum_1^{52} \text{Cents}_j}{Q_{jt}}$, where the numerator is the sum of weekly revenue in cents reported in the IRI data. Prices rose during 2013-14 as international demand increased. Milk-attribute variables include milkfat, organic, no-sugar, private label, flavor, and drink. All of these variables are binary, except for milkfat. Whole milk usually implies 3.5% milkfat, as per cow's milk equivalent. Zero fat (skim) generally indicates about 0.2% milkfat.

Figure 1 plots the aggregated market shares by the parent company. DF covers more than 40% of the beverage ounces sold with leading milk products such as Dean's, TruMoo, Dairy Pure, and Tuscan. In comparison, DFA shares in cow's milk are around 15% of the sales, dominated by Borden and Kemps. The figure suggests that a merger between the two companies might have substantial changes in the market. We compare the pre-merger and post-merger scenarios in the following section.[1]

**Results**

The derived estimates capture the overall pattern of 2008-2018, thus show the long-run effects of the hypothetical merger. Table 2 presents the BLP estimates. The top part shows the mean components ($\hat{\delta}_{jt}$) of the utility, and the bottom part presents the random ones ($\hat{\mu}_{ijt}$). Milk attribute variables are not statistically significant, possibly due to considerable variations in consumer tastes in the sampled eleven years (Badruddoza 2020). However, the linear and random coefficients with the variable of interest, price, are statistically significant respectively at 1% and 10% levels. A negative coefficient implies marginal disutility of spending money on cow's milk. Greater consumer heterogeneity increases the disutility. Among others, a negative coefficient with milkfat is noticeable but not statistically significant (p-value=0.19).

The price coefficients are used to calculate elasticities. The average own-price elasticities for DF, DFA, and other companies are -3.8, -7.86, and -5.39, respectively, whereas the cross-price elasticities are 0.028, 0.039, and 0.033. An increase in the price of a DF's product would decrease its share by 3.8% on average, but a similar increase will decrease DFA's share by 7.86%. Moreover, the increase in the price of a DF's product would result in an increase in the share of non-DF products by 0.028%. This implies that the substitutability of DF's products is lower than that of DFA or other companies. As a result, the degree of market power should differ across companies.

Before comparing market powers, we evaluate whether consumer valuations of the products are similar across companies. If consumers value DF's products, DFA's products, and their

[1] Some of the organic brands formerly owned by DF were merged with other companies between 2008 and 2018. This does not affect our analysis because we use a balanced panel.

competitors' products differently, then market powers should differ across companies. Figure 2 plots the empirical densities of consumer valuations ($\hat{\delta}_{jt}$) by companies. The densities appear similar. Recall that the mean utility from all omitted beverages is normalized to zero. Therefore, cow's milk products have a negative mean utility. We conduct a two-sample Kolmogorov-Smirnov test—a nonparametric test that checks for distributional similarities. The test was conducted in three pairs: (1) DF vs. others, (2) DFA vs. others, and (3) DF vs. DFA. The estimated p-values are 0.00, 0.08, and 0.05, so we reject the null hypothesis of distributional differences at the 10% level. This implies that parent companies themselves do not influence consumer utility, i.e., given product attributes, consumers receive similar utilities from products regardless of the parent companies. This allows us to compare the degree of market power across firms.

Figures 3 and 4 show the effects of a hypothetical merger between DF and DFA on market prices and the Lerner Index for 2018. Each dot on the scatterplot represents a cow's milk product. Simple visual inspection indicates that the merger appears to have a mixed impact on price and market power. The average price of products from DF, DFA, and other companies before the merger respectively were 5.59, 12.6, and 9.44 cents per ounce. These prices changed to 10.3, 13.9, and 9.65 after the hypothetical merger. The average changes are 4.76 (82.6%), 1.23 (10.4%), and 0.21 (12.9%) cents per ounce of milk. The prices of most DF's products are likely to increase after the hypothetical merger. In a relatively competitive market, an increase of 10 cents appears to be large (Figure 3). However, there are two reasons for this jump: (1) our model is based on consumer valuation of attributes given the ownership of the product, and (2) an econometric prediction tends to revolve around the observed means. Since the average price of DF's products was falling in 2008-2018 and was already lower compared to those of DFA and other companies, our model predicts that their prices would be higher given the attributes and the change of ownership—to a level that is closer to the means of other products. The hypothetical merger not only increases the prices of DF and DFA products, but also pushes the overall market prices up by around 29% (1.27 cents per ounce). Such an increase in price may decrease the mean consumer welfare by an estimated 19.769% from a cow's milk product.

The hypothetical merger also affects market power. The Lerner Index before the merger for DF, DFA, and other companies were 44.6, 13.1, and 39.8 respectively. Holding marginal costs constant, the post-merger Lerner Index for DF and DFA becomes 46.1, compared to 44.5 for the other companies. Due to the change in ownership, pre-merger DF products show heterogeneous changes in the Lerner index but lose their market power by 8.26% on average, but products from DFA and other companies gain by 60.3% and 36.5% on average.

Since the distributions of price and Lerner Index are unknown, we employ a Wilcoxon signed-rank test to evaluate if the changes are statistically significant. The test does not impose any distributional assumptions and assumes dependency between pre- and post-merger prices—a realistic condition in this context. The market-wide change in retail prices is significant and has a p-value of less than 0.01. A separate test with DF and DFA prices also confirms the rise at the 1% level of significance ($p\text{-value}<0.01$). Similarly, the change in overall market power and in the market power of merging companies are both significant at 1%. In short, the merger between DF and DFA significantly affects the prices and market powers of cow's milk products.

At this point, we are interested in testing whether the changes estimated so far are similar for organic and non-organic products. One could ideally repeat the exercise for organic and non-organic products. However, many organic products have market shares that are too small for model convergence, so we repeat the analysis for non-organic products only. A comparison between overall market outcomes and non-organic outcomes should help us infer the outcomes for organic products. The BLP estimates for non-organic products are provided in the Appendix. An increase in price decreases the market share of a non-organic product more (-0.688) than it does for the overall market (-0.635). That is, non-organic products are more substitutable than organic ones in case of a price increase. The mean change in the market price for non-organic products after the merger is about -0.32 cents (an 8.38% drop). Due to the price decrease, consumer surplus from non-organic products increases by 1.59%. These results suggest that the price increase found for the entire market above is primarily driven by the post-merger expansion of organic products in the long run. The average market power of non-organic products does not change after the merger—increases by merely 0.69%. The estimated organic expansion can be influenced by an event in 2016 when DF entered a cooperative venture with CROPP (Organic Valley) to have DF plants process and distribute their products (Dean Foods, 2016).

## Concluding remarks and policy implications

In the last few decades, dairy production has been shifting from small farms to larger, fewer farms (Hoppe and Banker 2006; MacDonald and Newton 2014), but food prices and market power frequently miss the antitrust debate due to the complex and diverse nature of consumer preferences and supply chains (Bolotova 2007; Watson and Winfree 2021). Antitrust authorities are mandated to break up giant, market-dominating producers to enhance fair competition and consumer welfare. However, U.S. antitrust statutes in agriculture support producer welfare as well by the Capper-Volstead Act (1922), which provides a limited antitrust exemption for agricultural marketing associations. Under this act, qualifying cooperatives can collaborate on prices and other terms of sale, marketing activities, and agree on common marketing practices with other cooperatives, thus achieve substantial market share (USDA 2002). The underlying logic is to enhance the bargaining power of small agricultural producers. Although a greater concentration of firms seems anti-competitive, the reason for allowing the concentration is to enhance efficiency and reduce costs through shared research and marketing (Sproul 1993; Crandall and Winston 2003).

Before 1982, post-merger concentration ratios and market powers were assessed in order to control the monopolization of an industry. The Reagan administration's interpretation of the Sherman Act in 1982 approves mergers that have a promise of scale efficiency, therefore lowering price and improving consumer welfare. From the supply side, if the fixed and marginal costs are changing, then the optimal farm size is changing as well. If farms are not allowed to produce at a larger scale, then equilibrium prices will be higher (Watson and Winfree 2021). Appelbaum and Gaby-Biegel (2020) point out that the 1982 guidelines enable investor-owned corporations and farmer-owned cooperatives to buy up smaller dairy producers, vertically integrate, and consolidate their operations. Consequently, dominant processors in local markets can set low prices for the raw milk, which makes farms increase the number of cows to reduce average costs, e.g., the median herd size has grown from 80 in 1987 to 1,300 in 2017 (MacDonald 2020). The supply of dairy milk goes up as a result amid already falling demand, and eventually pushes prices below the marginal costs for many small farms. Not surprisingly, the number of family dairy farms decreased from 650 thousand in 1970 to under 40 thousand in 2019 (Douglas 2017). Although lower prices seem attractive to improve consumer welfare, such consolidation and concentration affects smaller local farms, and undermines the resilience of the supply chain (e.g., MacDonald 2020; Thilmany et al. 2020). For example, farmers were dumping milk during the pandemic whereas supermarkets were rationing dairy products to limit hoarding by consumers (Brandt and Sanchez 2020).

Hence, the hypothetical merger of DF and DFA laid out in this study is interesting from a policy perspective. Our results suggest that the hypothetical merger would increase the price and market power, and decrease consumer surplus in the long run. However, an economic theory may not provide complete directions of changes in market outcomes due to the complex and dynamic nature of the interactions among various parties in the industry. Our analysis predicts the effect of the hypothetical merger on market prices, which is later used in calculating market power and consumer welfare under *ceteris paribus* assumptions. It is possible that an actual merger would result in a reduction of costs or some other sort of efficiency gain in the supply chain, which may potentially increase social welfare. As U.S. Department of Justice (2020b) points out, many DF plants were financially struggling and DF bankruptcy statements indicate that they would have closed their operations if the bankruptcy sale of assets did not occur quickly, which might have had a substantial effect on the dairy industry and the local economy. In fact, one of the plants that DFA was ordered to sell in the anti-trust lawsuit was in such financial state that a suitable buyer could not be identified. DFA expressed intent to make the necessary investments (U.S. Department of Justice, 2020b). One of the major limitations of our study is assuming the same marginal cost after the hypothetical merger. If the merger reduces production costs, then prices may go down and consumer surplus may increase. However, in the absence of elaborate firm-level data, we limit the policy discussion to aggregated market-level observations.

There are several implications of our study. First, there can be "winners" and "losers" from the hypothetical merger like any other redistributive economic event. An increase in average milk prices across the market can financially benefit dairy farmers who have been struggling from low prices, as long as the gain is evenly distributed. DFA is vertically integrated downstream with a milk-processing company with some market power. If operating across the entire supply chain from farms to marketing enhances efficiency, and if the benefits of higher prices are properly transferred to farmers, the hypothetical merger would raise the margin for DFA's farmer members. Non-members on the other hand may have limited or no options to get their raw milk to market if they reject DFA's offer. The possibility cannot be ruled out because the company currently handles 30% of the national raw milk supply and faced lawsuits in 2013 and 2015 for collusion and monopolization of the raw milk market (Astley 2014; Yaffe-Bellany 2019). In January 2017, DFA was planning to stop marketing the milk of around 900 independent dairy producers with an intention to address oversupply (Douglas 2017), leaving them with a sole alternative of selling to dairy processors on their own. Moreover, higher prices after the merger do not guarantee a homogenous gain among co-op members. The voting power in cooperatives is not homogenous and it tends to depend on the amount a farmer produces, which might bias the co-op's decisions in favor of larger farmers.

Second, the hypothetical merger increases the market power of DFA and hence furthers the consolidation and concentration of dairy production—a similar process has pushed small local dairy farmers out of the business in past decades. Technological innovations have increased the overall milk production, and vertical integration has proliferated by large retailers for supply stabilization (Guebert 2019). For example, Walmart opened its own dairy plants in Indiana to better control its supply (Laca 2018). Although many farms produce milk, fluid milk processing has become increasingly dominated by the top four largest firms, including DFA (MacDonald 2017; 2020). Appelbaum and Gaby-Biegel (2020) point out that the market power of a virtually integrated dairy cooperative hurts two supply chains: one serving commercial markets for institutional customers, and another serving the retail markets for consumers. The growing market power of a cooperative also indicates that independent, small farmers may end up with disadvantageous terms and become more vulnerable to collusion among cooperatives. If market concentration increases further, the literature suggests that prices may increase for all producers, but greater market power in processing can be used to influence prices and acquire financially weakening rivals. Similarly, a significant increase in the market power of DFA may increase the entry barriers in the future.

Finally, the hypothetical merger may reduce consumer welfare since higher prices decrease consumer surplus, *ceteris paribus*, and eventually curb the demand for cow's milk further. Our results imply that consumers do not get any additional utility when purchasing a DFA-owned product, hence cow's milk sales are less likely to improve after the merger.

Our findings are consistent with MacDonald (2017) and Appelbaum and Gaby-Biegel (2020), that the approach of anti-trust guidelines to mergers like above may not necessarily ensure sectoral resilience. It is likely that consolidation, concentration, and monopolization will lower consumer welfare and impair the resilience of the sector in the long run if the Reagan administration 1982 guidelines of anti-trust are followed.

The study examines the potential, not observed, long-term effects of a hypothetical dairy merger and reviews the influence of the antitrust law on the current transition of the dairy industry. Further discussion on the effect of the merger and antitrust in the U.S. dairy sector will be possible once the ex-post data become available. We have limited our study to cow's milk to reduce the noise in the identification of milk and generate results that relate to the dairy farmers. Future research will explore the observed effects of the merger in the market for dairy and non-dairy milk.

## References


Appelbaum, Eileen, and Jared Gaby-Biegel. 2020. Spilt milk: COVID-19 and the dangers of dairy industry consolidation. *Institute for New Economic Thinking Working Paper Series*, no. 134. Center for Economic and Policy Research.

Astley, Mark. 2014. DFA to Pay $50m to settle Northeast US milk price lawsuit. Dairy Reporter. July 16., Available https://www.dairyreporter.com/Article/2014/07/16/DFA-to-pay-50m-to-settle-Northeast-US-milk-price-lawsuit. Accessed December 15, 2021.

Badruddoza, Syed. 2020. *Impacts of Social Influence, Organic, and Plant-Based Milks on the U.S. Dairy Market*. Doctoral dissertation. School of Economic Sciences. Washington State University.

Berry, Steven, James Levinsohn, and A. Pakes. 1995. Automobile prices in market equilibrium. *Econometrica* 63(4): 841-890.

Bloomberg. 2020. Bankrupt Dean agrees to $425 million asset bid from Dairy co-op. February 17. Available https://www.bloomberg.com/news/articles/2020-02-17/dean-foods-in-asset-purchase-pact-with-dairy-farmers-of-america. Accessed December 15, 2021.

Bolotova, Yuliya. 2007. Agricultural contracting: A legal and economic analysis of selected problems. Agricultural Economics Research Series, 07-03(May). Moscow: University of Idaho.

Bolotova, Yuliya. 2018. An analysis of milk pricing in the Eastern United States. Selected paper presented at the Southern Economic Association's Annual Meeting. SEA: Florida.

Brandt, Tyler, and Dan Sanchez. 2020. Dairies are dumping millions of gallons of milk while stores are rationing it due to the coronavirus. What's going on? Foundation for Economic Education. April 6. Available https://fee.org/articles/dairies-are-dumping-millions-of-gallons-of-milk-while-stores-arerationing-it-due-to-the-coronavirus-what-s-going-on/. Accessed December 15, 2021.

Bunge, Jacob. 2020. Regulators probe potential Dean Foods Merger. *Wall Street Journal*. January 27. Available https://www.wsj.com/articles/regulators-probe-potential-dean-foods-merger-11580147236. Accessed Aug 30, 2021.

Business Insider. 2021. Market Insider: Dean Foods Co. Available https://markets.businessinsider.com/stocks/dfodq-stock. Accessed July 18, 2021.

Businesswire. 2020. Dean foods announces Dairy Farmers of America as winning bidder for substantially all of its assets. March 31. Available https://www.businesswire.com/news/home/20200331005673/en/Dean-Foods-Announces-Dairy-Farmers-America-Winning. Accessed December 15, 2021.

Crandall, Robert, and Clifford Winston. 2003. Does antitrust policy improve consumer welfare? Assessing the evidence. *Journal of Economic Perspectives*. 17(4): 3-26.

Dean Foods. 2016. Dean Foods and CROPP Cooperative Form Joint Venture to Grow the Organic Valley Milk Brand. press release November 15. https://www.deanfoods.com/newsroom/news/dean-foods-and-cropp-cooperative-form-joint-venture-to-grow-the-organic-valley-milk-brand (accessed December 14, 2021)

Dorsett, Jennifer. 2020. DFA wins bid for big portion of Dean Foods. Texas Farm Bureau. Available http://www.texasfarmbureau.org/dfa-wins-bid-big-portion-dean-foods/. Accessed August 29, 2021.

Douglas, Leah. 2017. Milk monopolist moves to increase power over dairy farmers. Food and Power. Open Markets Institute. February 23. Available https://www.foodandpower.net/latest/2017/02/23/milk-monopolist-moves-to-increase-power-over-dairy-farmers%E2%80%8B. Accessed May 10, 2020.

Guebert, Alan. 2019. Costco, Walmart want ag control. *Farm and Dairy Columns*. March 21, 2019. https://www.farmanddairy.com/columns/costco-walmart-want-ag-control/542531.html. Accessed December 15, 2021.

Hoppe, Robert, and David Banker. 2006. Structural and Financial Characteristics of U.S. Farms: 2006 *Family Farm Report*. Washington DC: U.S. Department of Agriculture.

Kaberline, Brian. 2020. DFA completes $433M acquisition, with feds' blessing. Kansas City Business Journal. May 4. Available https://www.bizjournals.com/kansascity/news/2020/05/04/dfa-completes-433m-dean-foods-acquisition.html. Accessed August 29, 2021.

Laca, Anna-Lisa. 2018. Walmart opens Indiana milk plant. Dairy Herd Management. June 13. Available https://www.dairyherd.com/walmart. Accessed December 15, 2021.

Levin, David, Danton Noriega, Chris Dicken, Abigail M. Okrent, Matt Harding, and Michael Lovenheim. 2018. *Examining Food Store Scanner Data*. Washington D.C.: US Department of Agriculture.

MacDonald, James M. 2020. Tracking the consolidation of U.S. agriculture. *Applied Economic Perspective and Policy*, 42(3): 361-379.

MacDonald, James M. 2017. *Consolidation, Concentration, and Competition in the Food System*. Kansas City: Federal Reserve Bank of Kansas City.

MacDonald, James .M. and Doris Newton. 2014. Milk production continues shifting to large-scale farms. *Amber Waves*, December. Washington DC: U.S. Department of Agriculture.

Muth, Mary K., Megan Sweitzer, Derick Brown, Kristen Capogrossi, Shawn A. Karns, David Levin, Abigail Okrent, Peter Siegel, and Chen Zhen. 2016. *Understanding IRI household-based and store-based scanner data*. May TB-1942, Economic Research Service, Washington D.C.: U.S. Department of Agriculture.

Nevo, Aviv. 2001. Measuring market power in the ready-to-eat cereal industry. *Econometrica,* 69(2): 307-342.

Smith, Tovia. 2018. As milk prices decline, worries about dairy farmer suicides rise. *NPR National*, February 27. Available https://www.npr.org/2018/02/27/586586267/as-milk-prices-decline-worries-about-dairy-farmer-suicides-rise. Accessed December 15, 2021.

Sproul, Michael F. 1993. Antitrust and prices. *Journal of Political Economy*. 101:741-754.

Stewart, Hayden, Diansheng Dong, and Andrea Carlson. 2013. Why are Americans consuming less fluid milk? A look at generational differences in intake frequency. *Economic Research Report*. U.S. Department of Agriculture. ERR 149(35).

Stewart, Hayden, Fred Kuchler, Diansheng Dong, and Jerry Cessna. 2021. Examining the decline in U.S. per capita consumption of fluid cow's milk. *Economic Research Report.* U.S. Department of Agriculture. ERR 300 (October):1-34.

Thilmany, Dawn, Elizabeth Canales, Sarah A. Low, and Kathryn Boys. 2020. Local food supply chain dynamics and resilience during COVID-19. Applied Economic Perspectives and Policy. 43:86-104. doi: 10.1002/aepp.13121.

U.S. Department of Agriculture. 2002. Antitrust status of farmer cooperatives: The story of the Capper-Volstead act. *Cooperative Information Report* 59, September. Washington DC: USDA.

U.S. Department of Justice. 2020a. Justice Department Requires Divestitures as Dean Foods Sells Fluid Milk Processing Plants to DFA Out of Bankruptcy. *Justice News.* May 1, 2020. Available https://www.justice.gov/opa/pr/justice-department-requires-divestitures-dean-foods-sells-fluid-milk-processing-plants-dfa, Accessed August 29, 2021.

U.S. Department of Justice. 2020b. *U.S. and Plaintiff States v. Dairy Farmers of America, Inc and Dean Foods Company* Available: https://www.justice.gov/atr/case/us-and-plaintiff-states-v-dairy-farmers-america-inc-and-dean-foods-company Accessed December 20, 2021

Valinsky, Jordan. 2019. America's largest milk producer files for bankruptcy. *CNN Business*, November 12. Available https://www.cnn.com/2019/11/12/business/dean-foods-bankruptcy/index.html. Accessed August 29, 2021.

Watson, Philip, and Jason Winfree. 2021. Should we use antitrust policies on big agriculture? *Applied Economic Perspectives and Policy.* (June):1-14. https://doi.org/10.1002/aepp.13173.

Welsh, Jean A., Hayley Braun, Nicole Brown, Caroline Um, Karen Ehret, Janet Figueroa, and Dana B. Barr. 2019. Production-related contaminants (pesticides, antibiotics and hormones) in organic and conventionally produced milk samples sold in the USA. *Public Health Nutrition*. (16): 2972-2980.

Yaffe-Bellany, David. 2019. America's dairy farmers are hurting: A giant merger could make things worse. December 11. New York Times. Available https://www.nytimes.com/2019/12/11/business/dean-foods-dairy-farmers-antitrust.html. Accessed December 15, 2021.

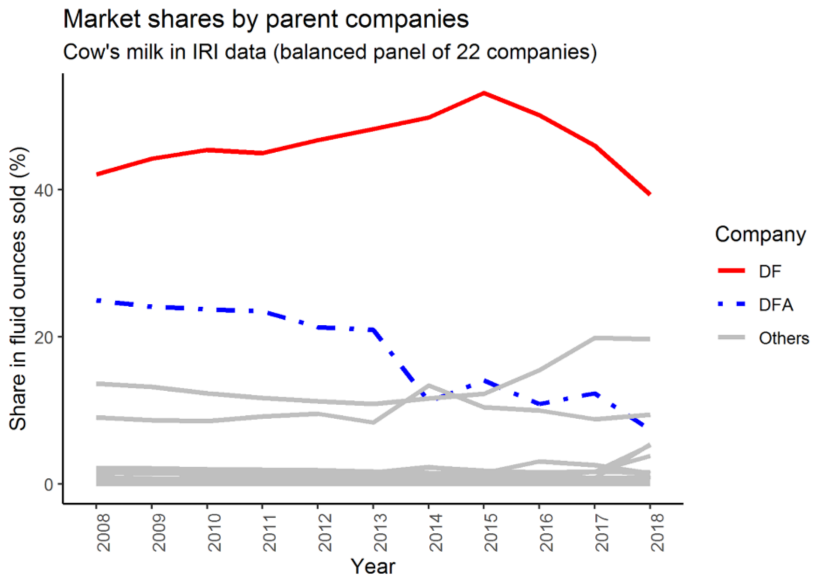


**Figure 1. Market shares of companies in cow's milk products sold**

*Source:* Authors' calculation using IRI data 2008-18.

*Note:* DF=Dean Food. DFA=Dairy Farmers of America. Others include all other cow's milk products. See Table 1 for variable description.

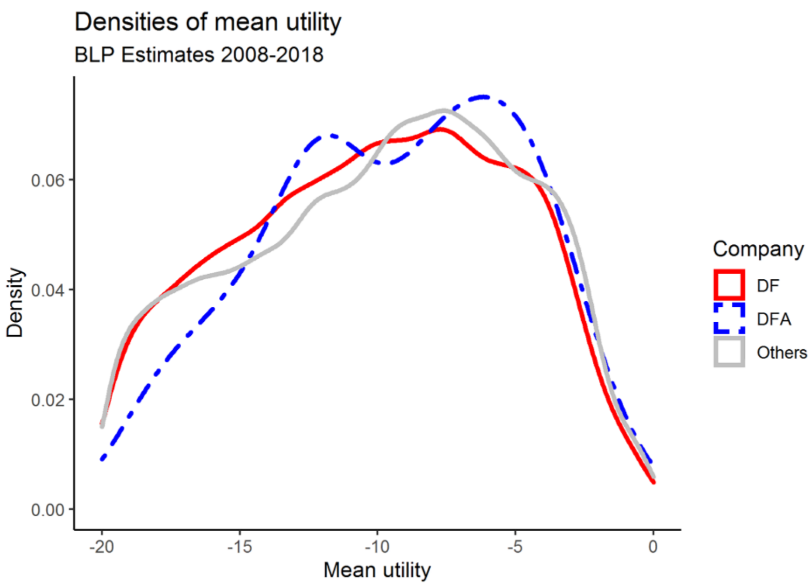


**Figure 2. Densities of mean utilities estimated by BLP model**

*Source:* Authors' estimate using IRI data 2008-18.

*Note:* DF=Dean Food. DFA=Dairy Farmers of America. Others include all other cow's milk products.

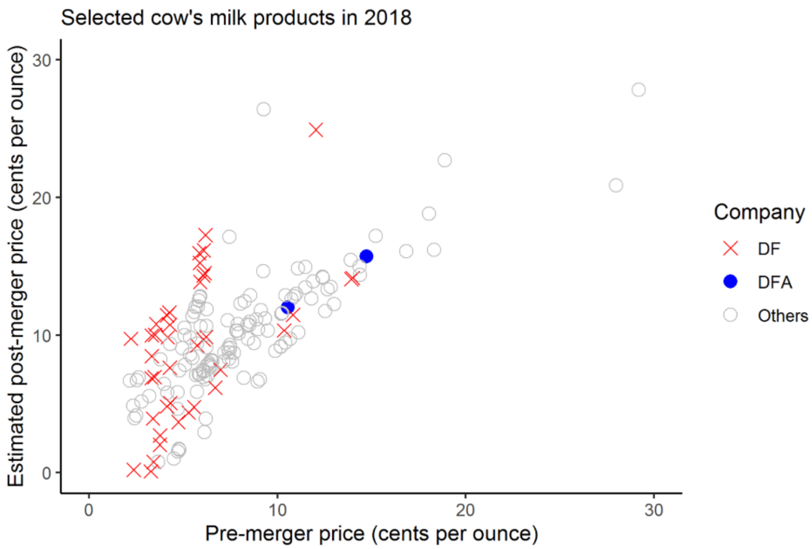


**Figure 3. Effects of a hypothetical merger on retail prices of cow's milk.**

*Source:* Authors' calculation using IRI data 2008-18.

*Note:* DF=Dean Food. DFA=Dairy Farmers of America. Others include all other cow's milk products.

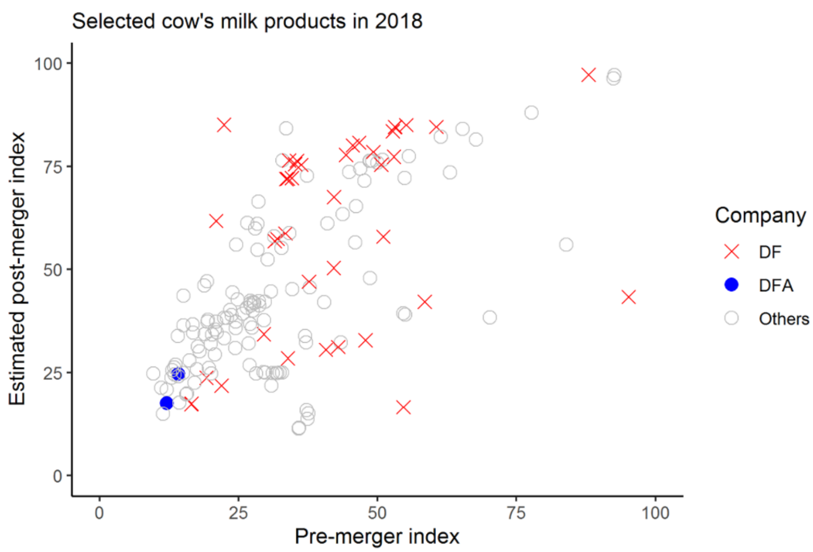


**Figure 4. Effects of a hypothetical merger on Lerner Index of cow's milk**

*Source:* Authors' calculation using IRI data 2008-18.

*Note:* DF=Dean Food. DFA=Dairy Farmers of America. Others include all other cow's milk. Lerner Index is 100×(price-marginal cost)/price.

**Table 1. Description of key terms and variables**

| Variable | Description | Mean (SD) |
|---|---|---|
| Year | Calendar year: January 1-December 31. Total number of years is 11 (2008-2018). | |
| Market | A state and year combination. Total number of markets is 539 (= 48 contiguous states plus Washington DC times 11 years). | |
| Company | Parent company, e.g., Dean Foods (DF). A parent company may have several products marketed. The data include 22 parent companies, including DF and DFA. | |
| Product | A product sold in the "dairy" aisle is fluid, included in the "milk" category and labeled as "cow's milk" in the IRI data. The data include 387 products. | |
| Share | Market share of a product. Calculated by dividing the quantity sold of a product at a certain market over the sum of all products sold. | 0.006 (0.018) |
| Price | Average price per ounce of the product in cents. | 7.690 (4.750) |
| Milkfat | Fat content reported on the product label. Usually labeled between 0.2% (zero fat) to 3.5% (whole milk). | 2.070 (1.280) |
| Organic | Binary variable, takes 1 if organic claimed on the product label, 0 otherwise. | 0.339 (0.473) |
| No-sugar | Binary variable, takes 1 if 'no-sugar-added' or 'no artificial sweetener' or 'unsweetened' is claimed on the label, 0 otherwise. | 0.021 (0.143) |
| Pvt. Label | Binary variable, takes 1 if the product is a store brand, 0 otherwise. | 0.261 (0.439) |
| Flavor | Binary variable, takes 1 if the product has a flavor, e.g., chocolate, strawberry, vanilla, added artificially, 0 otherwise. | 0.263 (0.440) |
| Drink | Binary variable, takes 1 if the product is milkshake, chai milk, or fermented milk, 0 if plain milk. | 0.257 (0.437) |
| Instruments | Instrumental variables. Contemporaneous prices in other markets. | |

*Note:* Authors' estimates using IRI Infoscan data (2008-2018). DF=Dean Foods, DFA=Dairy Farmers of America. Total observations=69,708.

**Table 2. Random coefficient discrete choice (BLP) model estimates**

| Variable | Estimate | Robust Std. Error | t-value | p-value |
|---|---|---|---|---|
| *Mean components* | | | | |
| Price | -0.635 | 0.184 | -3.450 | 0.001 |
| Milkfat | -0.761 | 0.583 | -1.305 | 0.192 |
| Organic | -3.126 | 6.118 | -0.511 | 0.609 |
| No-sugar | -33.363 | 70.667 | -0.472 | 0.637 |
| Pvt. label | -3.251 | 8.656 | -0.376 | 0.707 |
| Flavor | -9.289 | 26.19 | -0.355 | 0.723 |
| Drink | -0.700 | 2.606 | -0.268 | 0.788 |
| *Random components* | | | | |
| Price | -0.252 | 0.153 | -1.647 | 0.098 |
| Milkfat | 1.215 | 1.626 | 0.747 | 0.455 |
| Organic | 5.545 | 8.326 | 0.666 | 0.505 |
| Nosugar | 17.387 | 30.322 | 0.573 | 0.566 |
| Pvt. label | -3.315 | 16.264 | -0.204 | 0.838 |
| Flavor | 8.122 | 16.187 | 0.502 | 0.616 |
| Drink | 1.097 | 7.360 | 0.149 | 0.882 |
| Markets | | 539 | | |
| Observations | | 69,708 | | |

*Source:* Authors' estimates using IRI Infoscan data (2008-2018).
*Note:* Log of market share is the dependent variable. Estimates are numerically generated using nonlinear instrumental variable Generalized Method of Moments. Contemporaneous prices from other markets were used as instrumental variables that are not reported. Company dummies were also used but not reported. See Table 1 for variable description.

**Appendix 1.**

**Modeling the effects of a hypothtical merger**

This appendix provides the technical framework to empirically address the impact of a merger on the market. We adopt a random utility discrete choice approach proposed by Berry, Levinsohn, and Pakes (1995) (BLP), and augmented by Nevo (2001). Random coefficient models are often applied in food market analysis to capture consumer heterogeneity and market power (e.g., de Magistris and Gracia 2008). Empirical estimations with the BLP approach have attractive features as they allow for heterogeneity in consumer preferences and product-level unobservable characteristics (Berry and Haile 2016). The model is particularly relevant in our context because it accommodates a large number of differentiated products.

Assume there are $i = 1, \dots, I$ consumers in $t = 1, \dots, T$ markets. Each market is a year-state combination, e.g., Washington 2008 is a separate market from Washington 2018. A consumer chooses between $j = 1, \dots, J$ mutually exclusive alternatives of cow's milk. The products are strictly defined in terms of characteristics to cover product differentiation as much as possible and avoid the omission of relevant features. For example, Company X's whole white cow's milk 128 ounces and Super Power Milk's whole chocolate cow's milk 128 ounces are two different products. A product has *K* characteristics that can be binary or continuous, such as being organic or amount of milkfat. Let $\mathbf{x}_{j,t} = (x_{jt,1}, \dots, x_{jt,K})'$ be the $K \times 1$ vector of characteristics for product $j$ in market $t$. Assume consumer $i$ buys a unit of $j$ product in the market $t$ and receives indirect utility $u_{ijt}$.

$$u_{ijt} = \alpha_i(y_{it} - p_{jt}) + \mathbf{x_j}\boldsymbol{\beta}_\mathbf{i} + \xi_{jt} + \epsilon_{ijt} \quad (1)$$

where, $y_{it}$ represents consumer income, and $p_{jt}$ is observed per-unit price of the product $j$ at market $t$, and has a coefficient denoting the marginal utility of money $\alpha_i$. A *K*-dimensional (row) vector, $\mathbf{x_j}$, includes observed attributes of $j$, $\boldsymbol{\beta}_i$ is a *K*-dimensional (column) vector of marginal utilities from product attributes. Scalar $\xi_{jt}$ refers to heteroscedastic characteristics of product $j$ that affect consumer utility but are unobserved by the researcher, $\epsilon_{ijt}$ is the mean zero homoscedastic error.

Notice the *i* subscript with parameters accounts for consumer heterogeneity in taste, such that $\alpha_i, \boldsymbol{\beta}_i$ are Normal random variables with constant and diagonal variance-covariance matrix within the market.

$$\begin{bmatrix} \alpha_i \\ \boldsymbol{\beta}_i \end{bmatrix} = \begin{bmatrix} \alpha \\ \boldsymbol{\beta} \end{bmatrix} + \boldsymbol{\Sigma}\mathbf{v}_\mathbf{i} \tag{2}$$

where, $\alpha, \boldsymbol{\beta}$ are respectively the means of $\alpha_i, \boldsymbol{\beta}_i$, and $\mathbf{v}_\mathbf{i}$ is a $(K+1)$ column vector of consumer $i$'s unobservable characteristics that affect the parameters, and $\boldsymbol{\Sigma}$ is a $(K+1)^2$ matrix of how parameters depend on the unobservable consumer characteristics. Vector $\mathbf{v}_\mathbf{i}$ is multivariate standard normal by assumption.

Plug the values of $\alpha_i, \boldsymbol{\beta}_i$ in the indirect utility function and write it in matrix form.

$$u_{ijt} = \begin{bmatrix} (y_{it} - p_{jt}) & \mathbf{x}_\mathbf{j} \end{bmatrix} \begin{bmatrix} \alpha \\ \boldsymbol{\beta} \end{bmatrix} + \begin{bmatrix} (y_{it} - p_{jt}) & \mathbf{x}_\mathbf{j} \end{bmatrix} \boldsymbol{\Sigma} \mathrm{v}_i + \xi_{jt} + \epsilon_{ijt} \tag{3}$$

For notational simplicity, let $\delta_{jt} = \begin{bmatrix} (y_{it} - p_{jt}) & \mathbf{x}_\mathbf{j} \end{bmatrix} \begin{bmatrix} \alpha \\ \boldsymbol{\beta} \end{bmatrix} + \xi_{jt}$ and $\mu_{ijt} = \begin{bmatrix} (y_{it} - p_{jt}) & \mathbf{x}_\mathbf{j} \end{bmatrix} \boldsymbol{\Sigma} \mathrm{v}_i$. Therefore,

$$u_{ijt} = \delta_{jt} + \mu_{ijt} + \epsilon_{ijt} \tag{4}$$

The first part of the expression (3) stands for the means utility from the product $j$ that remains the same across consumers in the market $t$, and the second part represents the heterogeneity in the utility due to the heterogeneity in consumer tastes, and the last part is the homoscedastic disturbance.

When consumer *i* chooses brand *j*, it implies that the consumer receives greater utility from product *j* than all other products. Imagine there are only two products, $j$, and $\bar{j}$. The probability of one choice being preferred to another is,

$$s_{ijt} = P(u_{ijt} > u_{i\bar{j}t}) = P(\delta_{jt} + \mu_{ijt} + \epsilon_{ijt} > \delta_{\bar{j}t} + \mu_{i\bar{j}t} + \epsilon_{i\bar{j}t}) \tag{5}$$

$$= P(\epsilon_{i\bar{j}t} - \epsilon_{ijt} < \delta_{jt} - \delta_{\bar{j}t} + \mu_{ijt} - \mu_{i\bar{j}t}) \tag{6}$$

$$= \int_{\epsilon} I(\delta_{\bar{j}t} - \delta_{jt} + \mu_{i\bar{j}t} - \mu_{ijt})\, F_{\tilde{\epsilon}} d\tilde{\epsilon} \tag{7}$$

where $I(.)$ is an indicator function that generates 1 when $\epsilon_{i\bar{j}t} - \epsilon_{ijt} = \tilde{\epsilon} < \delta_{jt} - \delta_{\bar{j}t} + \mu_{ijt} - \mu_{i\bar{j}t}$ and zero otherwise; and $F_{\tilde{\epsilon}}$ is the distribution of the error. Assuming $\epsilon$ independently and identically distributed as Gumbel makes $\tilde{\epsilon}$ Logistic (Train 2003). Consumer income, $y_{it}$, cancels out since it is on both sides of the equation. Assume an outside brand if the consumer decides not to purchase any of the milk brands. The outside brand gives the indirect utility of,

$$u_{i0t} = \delta_{0t} + \mu_{i0t} + \epsilon_{ijt} \tag{8}$$

The mean utility $\delta_{0t}$ cannot be identified and is normalized to zero (Nevo 2001). Further assume the distributional independence of $\boldsymbol{\nu}$ and $\epsilon$. The market share of a product is the sum of the individual preferences across the observed and unobserved features. Assume the ties between the two milk products occur with zero probability, which implies that the consumer is not indifferent at the point of transaction and selects only one product at the time of purchase, the market share of the $j$th product is,

$$s_{jt} = \int_{\mathbf{v}} s_{ijt}\, dF_{\nu}(\mathbf{v}) \tag{9}$$

where $s_{ijt}$ is as defined in equation 7, and $F_{\nu} \sim \text{MVNormal}(0,1)$ for generality. The expression can be used to numerically solve for the parameters that minimize the distance between the predicted market shares and observed shares. That is, first assume the initial values of parameters and use market data to calculate the term on the right-hand side, then compare the calculated market share with the observed one. If they are approximately equal, stop and report the estimated parameters, else repeat until convergence.

The price of the product is typically endogenous to market share as both are affected by the latent demand shocks. Estimation of the model hence requires setting a population moment condition that is a product of instrumental variables and a structural error term. Following Nevo (2001), we use a nonlinear Generalized Method of Moments (GMM) estimator.

$$\widehat{\boldsymbol{\theta}} = \arg\min_{\boldsymbol{\theta}} \omega(\boldsymbol{\theta})'\boldsymbol{Z}\boldsymbol{A}^{-1}\boldsymbol{Z}'\omega(\boldsymbol{\theta}) \tag{10}$$

where, $\omega$ is a function of model parameters that represents the error in numerical estimation of equation 9 above, $\boldsymbol{Z}$ is a set of instruments, $\boldsymbol{A}$ is a consistent estimate of $E(\boldsymbol{Z}'\omega\omega'\boldsymbol{Z})$, such that for true values of parameters $E(\boldsymbol{Z}'\omega) = 0$. Common BLP instruments include cost shifters and characteristics of competing products (BLP 1995; Berry and Haile 2016). Following Hausman (1996) and Nevo (2001), we use prices of the same product in other contemporaneous markets as instruments.

The own- and cross-price elasticity of demand for a product is, respectively,

$$\eta_{j\bar{j}t} = \begin{cases} -\dfrac{p_{jt}}{s_{jt}} \displaystyle\int_{\mathbf{v}} \alpha_i s_{ijt}\left(1 - s_{ijt}\right) dF_v(\mathbf{v}) & \text{if } j = \bar{j} \\ \dfrac{p_{\bar{j}t}}{s_{jt}} \displaystyle\int_{\mathbf{v}} \alpha_i s_{ijt} s_{i\bar{j}t}\, dF_v(\mathbf{v}) & \text{if } j \neq \bar{j} \end{cases} \tag{11}$$

where, $\alpha_i = \frac{\partial s_{jt}}{\partial p_{\bar{j}t}}$ and $s_{ijt}$ can be estimated using equation 10 above, and the price to market share ratio is directly observable in the data.

We use the above information to predict price-cost margins for different products. It is important to keep in mind that most producers sell more than one product, and some even more than one type of milk. Suppose producer $r, (r = 1, \dots, R)$ produces milk products, $J_r \subseteq J$. Producer $r$ chooses the range of prices for $J_r$ differentiated products to maximize their total profit,

$$\sum_{j \in J_r} (p_j - c_j) s_j(\boldsymbol{p}) \sum_t \sum_j Q_{jt} - \text{Fixed Cost} \tag{12}$$

where $p_j, c_j, s_j(\boldsymbol{p})$ are respectively the price, marginal cost, market share of product $j$, and $Q$ is quantity—hence $\sum_t \sum_j Q_{jt}$ is the total size of the market. The market share is a function of all prices and consumers in the market. Assume the pure-strategy Bertrand-Nash equilibrium exists (Nevo 2001): firms compete in milk prices and there is no uncertainty associated with the equilibrium. The profit-maximizing first-order condition for firm $r$ with respect to price is,

$$s_j(\boldsymbol{p}) + \sum_{\bar{j} \in J_r} (p_{\bar{j}} - c_{\bar{j}}) \frac{\partial s_{\bar{j}}}{\partial p_j} = 0 \tag{13}$$

where, $j, \bar{j} = 1, \dots, J$. There is one first order conditions for each of $J$ brands. In vector form for $J$ product type,

$$\boldsymbol{s}(\boldsymbol{p}) + \boldsymbol{\Omega}(\boldsymbol{p} - \boldsymbol{c}) = \boldsymbol{0} \tag{14}$$

where, $\boldsymbol{\Omega}$ is $J \times J$ ownership matrix containing the partial derivatives of shares with respect to prices only if $j$ and $\bar{j}$ are sold by the same firm, and zero otherwise. Hence, we obtain a price-cost markup equation,

$$\boldsymbol{p} - \boldsymbol{c} = -\boldsymbol{\Omega}^{-1} \boldsymbol{s}(\boldsymbol{p}) \tag{15}$$

Equation 15 allows us to calculate the price-cost margin using the previously estimated $\frac{\partial s_{jt}}{\partial p_{\bar{j}t}}, \forall j, \bar{j} \in J$. That is, the markup for a product can be expressed in terms of own- and cross-price elasticities. Most large firms tend to be multi-product in the milk industry, so margins may arise from portfolio diversification to cater to the taste of consumers (Nevo 2001). We also define the Lerner Index from the equation above to obtain a standard measure of market power.

$$\text{Lerner Index} = 100 \times \frac{\boldsymbol{p} - \boldsymbol{c}}{\boldsymbol{p}} \tag{16}$$

A counterfactual effect on price-cost margin can be estimated by changing the ownership matrix. One can adjust the ownership matrix such that the products of two companies are both considered products of a single firm. Let 'pre' stand for pre-merger and 'post' indicate post-merger equilibrium. First, we estimate,

$$\boldsymbol{p}_{\text{pre}} - \hat{\boldsymbol{c}} = -\boldsymbol{\Omega}_{\text{pre}}^{-1} \hat{\boldsymbol{s}}(\boldsymbol{p}_{\text{pre}}) \tag{17}$$

We assume the marginal costs and consumer valuations of product attributes remain unchanged. After the merger, the firms achieve a new equilibrium at prices where the first-order condition of the profit function holds,

$$\boldsymbol{p}_{\text{post}} - \hat{\boldsymbol{c}} = -\boldsymbol{\Omega}_{\text{post}}^{-1} \hat{\boldsymbol{s}}(\boldsymbol{p}_{\text{post}}) \tag{18}$$

Estimation of post-merger prices becomes a problem of solving nonlinear equations. Given the new ownership matrix and marginal costs, we need to find a set of prices such that equation 18 is satisfied. We solve for the post-merger prices numerically.

**Table A1. Summary statistics of major variables by year**

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Share | 0.008 | 0.007 | 0.007 | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 | 0.005 | 0.004 | 0.005 |
| | (0.022) | (0.02) | (0.018) | (0.018) | (0.018) | (0.02) | (0.02) | (0.018) | (0.017) | (0.015) | (0.016) |
| Price | 7.337 | 7.343 | 7.224 | 7.232 | 7.416 | 8.229 | 8.238 | 7.898 | 7.814 | 7.864 | 7.680 |
| | (3.531) | (3.65) | (3.558) | (3.584) | (3.719) | (5.444) | (5.13) | (5.379) | (5.173) | (5.408) | (5.286) |
| Milkfat | 2.046 | 2.058 | 2.059 | 2.036 | 2.067 | 2.106 | 2.076 | 2.042 | 2.092 | 2.086 | 2.09 |
| | (1.306) | (1.305) | (1.3) | (1.287) | (1.301) | (1.29) | (1.289) | (1.271) | (1.27) | (1.276) | (1.265) |
| Organic | 0.405 | 0.383 | 0.366 | 0.359 | 0.365 | 0.372 | 0.355 | 0.301 | 0.299 | 0.308 | 0.301 |
| | (0.491) | (0.486) | (0.482) | (0.48) | (0.482) | (0.483) | (0.479) | (0.459) | (0.458) | (0.462) | (0.459) |
| No-sugar | 0.029 | 0.028 | 0.023 | 0.022 | 0.021 | 0.024 | 0.023 | 0.019 | 0.017 | 0.016 | 0.017 |
| | (0.167) | (0.165) | (0.15) | (0.147) | (0.143) | (0.153) | (0.15) | (0.136) | (0.128) | (0.126) | (0.131) |
| Pvt. Label | 0.161 | 0.167 | 0.216 | 0.258 | 0.262 | 0.198 | 0.194 | 0.300 | 0.324 | 0.327 | 0.322 |
| | (0.368) | (0.373) | (0.411) | (0.438) | (0.44) | (0.398) | (0.396) | (0.458) | (0.468) | (0.469) | (0.467) |
| Flavor | 0.227 | 0.252 | 0.248 | 0.241 | 0.232 | 0.275 | 0.297 | 0.260 | 0.285 | 0.282 | 0.267 |
| | (0.419) | (0.434) | (0.432) | (0.428) | (0.422) | (0.446) | (0.457) | (0.439) | (0.451) | (0.45) | (0.443) |
| Drink | 0.218 | 0.243 | 0.24 | 0.234 | 0.225 | 0.269 | 0.292 | 0.253 | 0.279 | 0.277 | 0.262 |
| | (0.413) | (0.429) | (0.427) | (0.423) | (0.418) | (0.443) | (0.455) | (0.435) | (0.449) | (0.447) | (0.44) |
| Obs. | 4,450 | 4,765 | 5,348 | 5,707 | 5,925 | 5,534 | 5,879 | 7,083 | 8,530 | 8,657 | 7,830 |

*Source:* Authors' calculation using IRI Infoscan data.

*Note:* Standard deviations are reported in the parentheses. Total observation is 69,708. See Table 1 for variable description.

**Table A2. Random coefficient discrete choice (BLP) model estimates (non-organic products)**

| Variable | Estimate | Robust Std. Error | t-value | p-value |
|---|---|---|---|---|
| *Mean components* | | | | |
| Price | -0.688 | 0.263 | -2.618 | 0.009 |
| Milkfat | -1.012 | 1.051 | -0.962 | 0.336 |
| No-sugar | -1.281 | 12.288 | -0.104 | 0.917 |
| Pvt. label | -4.018 | 5.304 | -0.758 | 0.449 |
| Flavor | -0.761 | 7.110 | -0.107 | 0.915 |
| Drink | -1.881 | 2.392 | -0.786 | 0.432 |
| *Random components* | | | | |
| Price | 0.166 | 0.342 | 0.484 | 0.628 |
| Milkfat | -1.142 | 1.580 | -0.723 | 0.470 |
| Nosugar | 1.532 | 11.942 | 0.128 | 0.898 |
| Pvt. label | -3.189 | 8.647 | -0.369 | 0.712 |
| Flavor | 2.569 | 5.742 | 0.447 | 0.655 |
| Drink | -1.195 | 4.670 | -0.256 | 0.798 |
| Markets | | 539 | | |
| Observations | | 46,060 | | |

*Source:* Authors' estimates using IRI Infoscan data (2008-2018).
*Note:* Log of market share is the dependent variable. Estimates are numerically generated using nonlinear instrumental variable Generalized Method of Moments. Contemporaneous prices from other markets were used as instrumental variables that are not reported. Company dummies were also used but not reported. See Table 1 for variable description.

**References:**

Berry, Steven, and Philip Haile. 2016. Identification in Differentiated Products Markets. *Annual Review of Economics* 8: 27-52.

De Magistris, Tiziana, and Azucena Gracia. 2008. The Decision to Buy Organic Food Products in Southern Italy. *British Food Journal* 110(9): 929-47.

Hausman, Jerry. 1996. Valuation of New Goods Under Perfecet and Imperfect Competition. In *The Economics of New Goods, Studies in Income and Wealth,* Timothy Bresnahan and Robert Gordon (eds.) 56:207-48. Chicago, IL: National Bureau of Economic Research.

Train, Kenneth. 2003. *Discrete Choice Methods with Simulation.* Cambridge, UK: Cambridge University Press.