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The effects of retail concentration on retail dairy product prices in the United States

V. Hovhannisyan*[1] and M. Bozic†
*Department of Agricultural and Applied Economics, University of Wyoming, Laramie 82071
†Department of Applied Economics, University of Minnesota, St. Paul 55108

ABSTRACT

This study provides an empirical investigation of the relationship between grocery retail concentration and retail dairy product prices in the United States. The analysis was performed based on a unique data set on store-level retail prices provided by the Information Resources Inc. Further, alternative measures of retail concentration were considered, which included revenue and store selling space-based Herfindahl-Hirschman Index that were computed based on a Nielsen TDLinx data set on store characteristics. Results from a reduced-form empirical framework estimated via panel data techniques indicated that grocery retail concentration had a positive statistically significant effect on retail dairy product prices in the analyzed locations during the analyzed period of time. Specifically, a 10% increase in concentration was found to lead to a 0.46% rise in retail dairy product prices. This central result was robust to the way in which retail concentration was measured and was consistent with broader empirical evidence in the literature on retail market power.
Key words: retail concentration, retail price, dairy food products, market power

INTRODUCTION

Market power is one of the central themes of economics of US dairy markets and policy (Balagtas, 2010; Bozic and Novakovic, 2014). Traditionally, market power was examined in the context of regulating bargaining power of dairy processors. The Agricultural Marketing Agreement Act of 1937 set the legal framework for the system of Federal Milk Marketing Orders, established to provide orderly marketing of milk and increase bargaining power of dairy producers and milk marketing cooperatives. Recent market power analyses centered on market conduct in wholesale spot market for cheese, with concerns that thin markets may be prone to occasional market manipulations by large dairy buyers (Mueller and Marion, 2000; US Government Accountability Office, 2009; US Department of Justice, 2011). Another line of inquiry focused on asymmetries in farm-to-retail price transmission process (e.g., Awokuse and Wang, 2009; Stewart and Blayney, 2011; Kim and Ward, 2013; Fitzsimmons et al., 2015).

Extensive research effort was devoted to studying retail market power when marketing a variety of dairy products (e.g., Cohen and Cotterill, 2011; Hovhannisyan and Gould, 2012; Hovhannisyan et al., 2014). This was mostly driven by significant structural changes in the US food retailing sector over the past 3 decades. One such change was the rising retail concentration with the 4 largest grocery chains accounting for 36% of US total market share in 2005 as opposed to only 16% in 1982 (Hovhannisyan and Bozic, 2013). Rising retail concentration has the potential to reshape not only the horizontal competitive landscape, but also the vertical relationships along the entire supply chain. This carries important welfare implications for US farmers, processors, consumers, and so on (US Government Accountability Office, 2009). Given the importance of the matter, through joint workshops the USDA and the US Department of Justice aimed at providing policymakers with an improved understanding of market conditions that determine farm and consumer prices (US Department of Justice, 2011).

Previous studies predominantly relied on a structural approach to analyzing retail market power when marketing dairy products (e.g., Hovhannisyan et al., 2014). Another important pattern that emerged from this literature was that the research focus was largely confined to a specific dairy category such as milk, cheese, yogurt, and sub-categories therein (e.g., Cohen and Cotterill, 2011; Hovhannisyan and Gould, 2012; Hovhannisyan et al., 2014). The current study provides new evidence on the effects of retail concentration by extending the scope of the analysis to a wider range of dairy products. The main objective is to inform the discussion concerning retail concentration and market

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[1]Corresponding author: vhovhann@uwyo.edu

power in dairy markets that has been at the center of recent public debates. The analysis was based on a novel Information Resources Inc. (**IRI**) data that provide retail price information on a detailed list of dairy products from several US retail markets (IRI Infoscan, 2008–2011). Further, panel data econometric techniques were employed, which allowed to account for store- and product-level unobserved heterogeneity (e.g., Evans et al., 1993; Biscourp et al., 2013). These methods relieve some of the important limitations imposed by the lack of information that is an intrinsic characteristic of economic environments. Specifically, this approach obviates the need for imposing nontestable assumptions concerning the behavioral aspects of economic agents and market competition.

The IRI data are supplemented by the Nielsen TDLinx data set containing detailed information on store characteristics such as the annual revenue, selling space, and so on. This information was used to compute the Herfindahl-Hirschman index (**HHI**), a measure of market concentration that was calculated as the sum of squared market shares of all the firms in a given market. (The theoretical HHI maximum is 10,000. Markets with an HHI index between 1,500 and 2,500 are considered moderately concentrated, and an HHI index above 2,500 is characteristic of highly concentrated markets.) This measure provides a more complete representation of firm size distribution vis-à-vis the k-firm concentration ratio (typically k is the 4 or 8 largest firms on market), which was used extensively in early studies on market concentration and firm performance (e.g., Kwoka, 1979). In addition to the revenue-based HHI, the store selling area-based HHI estimates were used as a robustness check. It is generally believed that the space-based estimates are less prone to an econometric issue of endogeneity relative to the revenue-based index and the number of firms in a market, given that it takes time (time lag to obtain permit, construction lag, and so on) for retailers to expand (contract) store selling space in response to a changing economic environment (Biscourp et al., 2013). Hence, the space-based regression was the preferred specification in the empirical analysis.

MATERIALS AND METHODS

Retail Data

Empirical analysis was performed based on data compiled from several sources: (1) IRI data set that contains information on retail-level dollar sales and physical volume of dairy products marketed, (2) Nielsen TDLinx data set that provided information on characteristics of retail stores from across the United States, and (3) US Department of Commerce, Bureau of Economic Analysis data on market characteristics such as population and per capita income. Details concerning the data along with a short discussion of summary statistics are presented below.

IRI Data on Retail Dairy Product Prices. Retail-level unit prices were obtained using unique IRI Infoscan data over the period 2008–2011. The IRI collects information on all items scanned at cash registers from more than 11,000 local grocery stores from across the United States on a weekly basis. The data are then scaled up to reflect all sales from stores with annual revenues of $2 million and higher. The IRI data set contains information on dollar sales and physical volumes for a large groups of food products from 5 departments (dairy, deli, bakery, frozen food, fresh produce) at the brand, UPC, or item level. It mostly includes the stores that belong to a grocery retail chain. The remaining nonchain/independent stores are chosen by the IRI using random stratified sampling method. Rotating panel design is employed where a fraction of stores are dropped each month and replaced by others (see Ward et al., 2002, for more detail).

Empirical analysis was conducted using a large number of dairy products widely marketed through retail stores. The IRI data set contains information on more than 40 dairy products, which were combined into 11 product groups based on certain common characteristics (Table 1). For example, milk comprises all types of drinkable white milk regardless of fat content, brand name, and special attributes (e.g., organic, lactose-free, and so on). Similarly, all natural and processed cheeses were aggregated into 2 separate groups irrespective of the product form such as chunks, slices, crumbles, loaf, and so on. It should be mentioned that these product categories vary considerably in their degree of homogeneity. For example, milk and sour cream comprise relatively more homogeneous products vis-à-vis natural cheeses.

For empirical feasibility, the research setting was designed to comprise 20 retail markets that were represented by metropolitan areas or cities located in different geographical areas of the United States. The major market selection criterion was the annual variability of the number of retailers in the sample period. This variability reflects retailer entry and exit, and is essential from the perspective of identifying the effects of concentration on retail price changes. Table 2 provides the retail markets included in the study along with the basic statistics describing the variability in the number of stores over the sample period.

The final data used in the analyses were aggregated from the weekly to monthly basis and contained monthly prices for 11 dairy product groups in 20 US retail

Table 1. Composition of dairy product groups included in the analysis[1]

Product groups	Products
Butter	Refrigerated butter, butter blends
Coffee creamer	Refrigerated coffee creamer
Cottage cheese	Cottage cheese
Cream cheese	Cream cheese balls, bricks, soft, whipped, all other forms
Dairy cream	Refrigerated dairy cream, half and half cream
Margarine	Margarine, spreads
Milk	Milk, refrigerated skim/low-fat and whole milk
Natural cheese	Natural cheese chunks, crumbles, cube, shreds, slices, string/sticks and all other forms, Ricotta cheese
Processed cheese	Processed/imitation cheese loaf, shred, slices, and other forms, refrigerated grated cheese
Sour cream	Sour cream
Yogurt	Refrigerated yogurt

[1]Source: IRI Infoscan, 2008–2011.

markets over 2008–2011. The result was an unbalanced panel of retail stores representing a wide range of retail channels (i.e., convenience stores, mass merchandisers, groceries, and so on) and contained 1,190,858 observations.

Appendix Table A1 presents the descriptive statistics concerning the retail format of the stores in our sample (i.e., both number and fraction), and the product price. Drug stores and convenience stores appeared to be the most heavily represented retail formats in our study (1,020 and 831, respectively, in 2008). They are followed by dollar stores (632) and supermarkets (458) and mass merchandisers (187). Further, the composition of retail formats manifested considerable variability across the retail markets (top panel). For example, the average share of convenience stores made up 41.7% in 2008 with the associated standard deviation being 65.9%. In regard to prices, natural cheese appeared to be the most expensive dairy product with the price per ounce amounting to $0.445. By contrast, milk represented the least expensive dairy product in our sample ($0.035 per liquid ounce).

Table 2. The number of stores by market over the period 2008–2011[1]

State	City	Minimum	Maximum	SD
NC	Charlotte	3,744	5,332	663
IL	Chicago	14,544	16,598	1,234
OH	Cincinnati	3,744	5,332	663
OH	Columbus	7,482	9,549	808
TX	Dallas	5,634	7,453	704
TX	El Paso	4,231	6,386	875
TX	Houston	18,770	19,841	412
IN	Indianapolis	6,833	11,695	1,893
FL	Jacksonville	12,398	13,612	507
KY	Lexington	4,170	5,576	599
KY	Louisville	6,292	8,635	928
WI	Milwaukee	3,269	5,244	822
MN	Minneapolis	1,920	4,429	1,228
NY	New York	10,970	12,013	408
AZ	Phoenix	15,207	16,883	717
NY	Rochester	5,039	6,538	619
CA	Sacramento	3,077	4,626	732
TX	San Antonio	10,982	11,999	388
CA	San Diego	2,839	5,631	1,229
MA	Springfield	7,080	8,960	754

[1]Source: IRI Infoscan, 2008–2011.

Nielsen TDLinx Data on Store Characteristics. Retail grocery competition is a local phenomenon limited to certain geographic markets; nevertheless, delineation of markets may be a challenging task (Biscourp et al., 2013). The common approach to defining markets is based on the identification of competing stores within certain areas/radius (Barros et al., 2006). Retail formats used in the current study were supermarkets, dollar stores, drug stores, convenience stores, and mass merchandisers, whereas other retail formats and establishments such as military stores were excluded. These included retail formats are discussed in more detail, which will prove useful when interpreting the major findings:

(a) *Supermarkets* are large grocery stores based on self-service that offer a wide range of food and household products. The typical supermarket selling area varies from 4,000 to 27,000 square feet. The basic appeal of supermarkets are proximity to residential areas (city centers or outskirts), availability of wide variety of products (mostly food) at relatively more affordable prices, and convenient shopping hours.

(b) *Dollar stores*, also known as variety stores, offer a variety of inexpensive food and drink products in addition to personal hygiene, garden tools, and other household consumables. They offer predominantly generic brands or private label products that are normally priced above traditional retailers but lower than convenience stores.

(c) *Drug stores* are retail stores that carry pharmaceutical products along with some other products such as groceries, cosmetics, books and magazines, and so on. For some drugstores, these additional products constitute a major source of revenue.
(d) *Convenience stores* have an average selling area of 2,800 square feet, are usually closer to consumers, and charge much higher prices relative to supermarkets. Merchandise varies widely from store to store; however, they typically offer everyday items such as groceries, snack food, soft drinks, and so on.
(e) *Mass merchandisers* carry staple goods sold in high volume and quick turnover for less than conventional prices. They can have a selling area of up to 100,000 square feet. The best known mass merchandisers are Wal-Mart, K-Mart, and Target.

The revenue and store selling space-based HHI estimates were computed for the markets in our sample based on the Nielsen TDLinx store characteristics data (Appendix Table A2). The revenue-based HHI estimates were on a steady rise from an average of 1,043 in 2008 to 1,233 in 2011; nevertheless, these estimates fell behind space-based HHI estimates in the sample period with the latter growing from an average of 1,272 in 2008 to 1,497 in 2011. The average estimates of both revenue and space-based HHI measures were indicative of markets being moderately competitive; however, individual markets were rather diverse. For example, the space-based HHI estimate for New York is only 336, whereas markets at the other end of the spectrum such as San Antonio had an estimate of 3,729 in 2011. One reason why markets might appear less concentrated as measured by the HHI may be that US metro areas represent the retail markets in the current study. A better alternative would probably be to further disaggregate markets to ZIP code level or even neighborhood level. Nevertheless, the explanatory variables used here were measured at the metro level (e.g., consumer income by city), which would bring about identification issues.

US Department of Commerce Data on Market Characteristics. Several descriptors were used to characterize retail markets in this study. Specifically, population and per capita income data were compiled from the US Department of Commerce, Bureau of Economic Analysis (2008–2011). These were market-specific data and varied annually for a given market. The goal with the inclusion of the population and income variables was to account for the potential effects of demand-related factors on retail prices.

The markets under study varied considerably in terms of population with Lexington having a population of 479,000 as opposed to New York with more than 19 million population in 2011 (Appendix Table A3). Another important fact to note is that all markets in question had seen a steady rise in population in our study period. Markets also manifested considerable heterogeneity in terms of consumer income. Specifically, per capita income varied from as low as $29,600 in El Paso to as high as $56,900 in New York in 2011. A general tendency that stood out is that per capita income declined in most markets following the great recession in 2008. Nevertheless, this effect was predominantly felt in 2009, and starting the following year income reverted back to a rising trend in most markets, eventually surpassing the pre-recession levels.

Literature Review

The relationship between retail market structure and retail performance has been a focal issue among economists, policymakers, and various stakeholders alike. Early studies in this literature relied on the structure-conduct-performance (**SCP**) paradigm whereby market structure was predicated to lead to certain types of firm behavior, which in turn determines firm performance (e.g., Schmalensee, 1989; Martin, 2002; Pepall et al., 2005; Ellickson, 2015). In early empirical applications, market structure was typically represented by a k-firm concentration ratio as discussed above, or by HHI that reflected firm size distribution in a given market. Firm performance, on the other hand, was usually represented by some measure of profitability computed from accounting data (e.g., Porter, 1979). More recent studies shifted their focus from profitability to price to sidestep potential issues related to the computation of firm profit (e.g., Cotterill, 1999; Biscourp et al., 2013).

An important characteristic of the previous literature was that empirical analyses was usually conducted at an aggregate level or the study scope was confined to certain geographical location, a specific product category, or both. For example, Cotterill (1999) examined market power in the US food retailing using a price index constructed from a basket of 115 products. Similarly, Aalto-Setälä (2002) relied on an aggregate price index based on a basket of 345 grocery products to analyze retail market power in Finland. Hovhannisyan et al. (2014) adopted a structural approach to investigate retail behavior in the United States when marketing a single dairy category (i.e., yogurt). In the same vein, Cohen and Cotterill (2011) studied retail market conduct in the sale of cheese. It is also worth

noting that many previous studies used cross-section survey data, given the lack of store and product-level panel data until recently. A fundamental drawback of this approach is that unobserved store heterogeneity (e.g., quality of service, store amenities, service hours, and so on) cannot be accounted for, which may prove central to retail price determination. Biscourp et al. (2013) represented an important exception, which applied panel data estimation techniques to empirically examine price-concentration relationship in food retailing in France using a wide range of food products.

In this study, new evidence is provided on the relationship between retail concentration and dairy food prices in the United States. The study has several distinguishing features. First, an extensive list of dairy products that were marketed through a large number of retail stores from across the United States are analyzed based on novel IRI data (IRI Infoscan, 2008–2011). Second, panel data econometric techniques were adopted to account for store and product-level unobserved heterogeneity. This particular approach obviated the need to impose nontestable assumptions on the behavioral aspects of food retailers and retail competition. Third, both revenue and selling space-based HHI estimates for market concentration were computed using the Nielsen TDLinx data set on store characteristics. This latter measure of concentration is less prone to the econometric issue of endogeneity vis-a-vis the revenue-based estimate and the number of firm, given the time lags required for the retailers to respond to changes in their economic environment (Biscourp et al., 2013). Hence, the space-based regression was our preferred specification that was used to examine the effects of retail concentration on retail dairy product prices. The major hypothesis to be tested was whether increased retail concentration and consolidation had resulted in higher prices because of enhanced market power or lower prices on the account of cost efficiencies passed on to consumers.

Methodology

Panel data econometric techniques were used to empirically investigate the relationship between grocery retail concentration and dairy prices. Let $p_{i,j}^{y,m}$ denote the price (in logarithm) of product i in store j in month m of year y. Further, let $\theta(i)$ represent the product type (national brand or store brand), $\varphi(i)$ is the type of store (supermarket, mass merchandiser, and so on), and $c(j)$ denotes the city where store j is located. The following reduced-form price equation represents the base specification in this study:

$$p_{i,j}^{y,m} = \delta^{y} HHI_{c(j)}^{y} + \lambda^{y} X_{c(j)}^{y} + \alpha_{i}^{y,m} + \beta_{\theta(i)}^{y} + \gamma_{\varphi(i)}^{y} + \varepsilon_{i,j}^{y,m}, \quad [1]$$

where $HHI_{c(j)}^{y}$ is index of market concentration, $X_{c(j)}^{y}$ is a vector of market-specific characteristics other than concentration (e.g., population and income), $\alpha_{i}^{y,m}$ represents an interaction of product, year, and month dummies, $\beta_{\theta(i)}^{y}$ and $\gamma_{\varphi(i)}^{y}$ capture product and store-type effects, respectively. It is worth noting that all the continuous explanatory variables were expressed in logarithm for ease of interpretation of the respective coefficients.

Two variations of the model (1) were estimated based on the HHI calculated in the traditional way, and, alternatively, using the HHI computed as a space-based measure of concentration, as discussed above. The number of firms and the 2 HHI measures (revenue based and store space based) were used to reflect the effects of market concentration on retail dairy product price changes in our econometric models. These latter estimates of revenue and space-based HHI index were computed using store-specific information obtained from the Nielsen TDLinx data. The IRI data set contained no information on store characteristics such as revenue and selling space.

In addition to the simple cross-section regression, a more conservative model (i.e., the within or fixed-effects model) was estimated via the inclusion of store fixed effects. This estimation technique relies upon store-level variation and accounts for time-invariant unobserved store characteristics such as quality of management, network effects, location, amenities, and so on. An important advantage of this approach is that it accounts for unsuspected correlation between unobserved store fixed effects and observed explanatory variables such as consumer income, population, and so on. This correlation may be present, for example, when retail stores located in areas with relatively more affluent consumers offer higher quality service, better amenities, and so on. Further, this econometric method enables the researcher to account for certain aspects of unobserved product effects on dairy product price changes. Specifically, product, year, month, and product, retail format interaction dummy variables were included in the econometric analysis, which accounted for certain aspects of unobserved product heterogeneity such as seasonality effects and other unobserved product-level shocks that vary annually. Further, this particular specification recognized the fact that certain items may have been priced differently depending on store type

(e.g., convenience store vs. discount store) through the inclusion of dummy variables accounting for interaction effects among dairy products and retail formats.

RESULTS AND DISCUSSION

Estimation results from alternative model specifications are presented in Appendix Tables A4, A5, and A6. Appendix Table A4 presented the parameter estimates from the cross-section (i.e., ordinary least squares, **OLS**) and within models (panel data fixed effects) that used the number of retail stores as a proxy for retail competition. Based on the R^2 (0.931) and adjusted R^2 statistic values (0.930), the cross-section specification provided a good fit of the data (left panel). Importantly, mass merchandisers were confirmed to constitute the least expensive retail outlets sampled. Moreover, convenience stores were found to be the most expensive retail outlets with the estimated coefficients varying from 0.375 to 0.431. They were followed by drug and dollar stores with the associated coefficients falling in the ranges of 0.073 to 0.098 and 0.081 to 0.117, respectively. Supermarkets offered the second most affordable dairy product prices with the estimated coefficients ranging from 0.019 to 0.064. Further, the price gap between mass merchandisers and dollar stores appeared to have increased during the sample period, whereas the price gap between mass merchandisers on the one hand, and supermarkets and convenience stores on the other hand, was found to rise until 2010, followed by a decrease afterward. Results also showed that supermarket and mass merchandiser prices converged until 2011 with this trend being reversed afterward. These cross-section estimates also indicated that the market size and consumer purchasing power had positive effects on retail dairy product prices with the respective coefficients falling in the ranges of 0.120 to 0.124 and 0.082 to 0.106, respectively. Because the estimating equation was in double-log form, these coefficients could be interpreted as elasticity estimates (i.e., percentage change in prices associated with 1% change in market concentration). Specifically, the HHI coefficients indicated that concentration had negative significant effects on retail dairy product prices in year 2008, which was reversed afterward with the effect increasing in magnitude from 0.004% in 2010 to 0.007% in 2011. The cross-section specifications might well suffer from a bias stemming from the correlation between unobserved store characteristics and included explanatory variables, as discussed above. Parameter estimates from the fixed-effects model were presented next (right panel). As the computed R^2 (0.956) and adjusted R^2 statistic values (0.955) indicated, this panel data model provided a better fit of the data vis-à-vis the OLS model. In line with the OLS model, the general finding was that mass merchandisers represent the most affordable retail format. However, it should be kept in mind that the coefficients in this specification reflected not only the price difference across the formats, but also the change in retail-specific prices relative to year 2008. This was done to make our results comparable to other similar studies such as Biscourp et al. (2013). Most importantly, retail concentration was found to have positive and significant effects on price changes with the effect intensifying steadily during the sample period (from 0.007% in 2008 to 0.017% in 2011). These findings might be indicative of the HHI coefficients being biased in the OLS model owing to the correlation between unobserved store characteristics and HHI.

Appendix Table A5 provides the estimation results from the cross-section and within models that use the revenue-based HHI. Despite marginal differences in magnitude, overall, the estimated coefficients appeared to be qualitatively similar to those from the previous model presented above (left panel). By contrast, the HHI coefficients were found positive, statistically significant, and of greater magnitude relative to the previous model (that relies on the number of firms to represent market concentration). Specifically, the HHI coefficients were found to decline from 0.027% in 2008 to 0.012% in 2010, followed by an increase to 0.017% in 2011. Hence, the effects of market concentration on price changes for retail dairy products did not appear to be large. Similarly, the results from the fixed-effects model showed that the effect of concentration declined from 0.030% in 2008 to 0.021% in 2010, followed by an increase to 0.023% in 2011. These results generally concurred with findings from other similar studies both in terms of the direction and the magnitude of the effects of concentration on retail price (see, for example, Biscourp et al., 2013). Importantly, concentration coefficients from the within model manifested a similar dynamics and fall in the same range of magnitude. This finding might be a result of food demand becoming more elastic in the aftermath of the 2008 recession, thus intensifying retail competition. Finally, the explanatory power of the revenue-based specifications were the same as that for the previous models that rely on firm number to represent market concentration.

Results from a specification using space-based HHI are reported in Appendix Table A6. The model provided a good fit of the data. Appendix Table A7 provides a summary of interaction terms for each dairy category from both the cross-section and within models. In line with the previous model, the coefficients for the concentration measure were positive and statisti-

cally significant. This finding may be interpreted as the concentration affecting retail dairy product prices positively. In regard to the magnitude of the effect in the cross-section estimation, a 10% rise in retail concentration resulted in 0.36% price increase in 2008 with the effect diminishing across years to be only 0.15% in 2011 (left panel). Results from the fixed-effects panel (within model) estimation that should be more reliable largely concurred with these findings in terms of the direction of the effect of concentration on price change, the magnitude, and the dynamics of the effect (right panel). Specifically, a 10% rise in retail concentration was found to result in 0.46% price increase in 2008 and only 0.31% price increase in 2011. These coefficients were greater in magnitude as compared with those from the previous 2 models. This finding might be reflective of the downward bias in the HHI coefficients resulting from the endogeneity of the number of firms and revenue-based HHI (see, for example, Evans et al., 1993). However, the estimated effects were economically very modest even for the model that used the space-based HHI measure that was less prone to the endogeneity issue, given the information inefficiencies and the time lag between changing food prices and store response (Aalto-Setälä, 2002). This could be due to the fact that concentration slowed down in early to mid-2000s after an initial rapid increase in the late 20th century.

The major findings emerging from this study concurred with the empirical evidence emerging from the United States (see, for example, Cotterill, 1999; Hovhannsiyan and Bozic, 2013), as well as other countries such as France (Gohin and Guyomard, 2000; Biscourp et al., 2013) and Finland (Aalto-Setälä, 2002), despite these studies differing vastly in methodology, types, and number of products included in the analyses, the study period, and so on.

CONCLUSIONS

The current study contributes to the discussion of the relationship between grocery market structure and retail performance. Specifically, it offers an empirical investigation of the effects of rising retail concentration on dairy food products in a large number of diverse local markets from across the United States. The analysis was conducted on a unique store-level data set for a period of 2008 through 2011 provided by Information Resources Inc. It covered a large number of retail grocery stores representing a variety of retail formats. The IRI data were supplemented by a Nielsen TDLinx data set on retail store characteristics that formed the basis for the computation of retail market concentration across the markets under study. The empirical analysis relied on panel data econometric methods, which were powerful techniques to account for unobserved store and product effects. The major findings indicated that retail concentration had positive significant effects on dairy retail prices with the effect diminishing in the aftermath of the great recession of the 2008. More specifically, a 10% increase in retail concentration was found to result in an average effect of 0.31 to 0.46% rise in retail dairy product prices in the United States. This central result was robust to the various measures of market concentration (i.e., number of retailers, revenue and space-based HHI) used in the analysis and was in accord with the empirical evidence from the United States, as well as other countries such as France and Finland.

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APPENDIX

Table A1. Descriptive statistics for the major variables in the analysis

	2008		2009		2010		2011	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fraction of stores by format								
Convenience	0.417	0.659	0.398	0.598	0.404	0.599	0.419	0.621
Dollar	0.209	0.407	0.230	0.421	0.237	0.425	0.231	0.421
Drug	0.125	0.330	0.122	0.327	0.128	0.334	0.143	0.350
Supermarket	0.364	0.481	0.354	0.478	0.352	0.478	0.349	0.477
Mass merchandiser	0.225	0.418	0.215	0.411	0.203	0.403	0.199	0.399
Number of stores by format								
Convenience	831		1,129		1,200		1,202	
Dollar	632		638		659		688	
Drug	1,020		1,038		1,050		1,059	
Supermarket	458		459		449		437	
Mass merchandiser	187		187		184		185	
Price ($US/ounce)								
Butter	0.210	0.059	0.205	0.066	0.216	0.068	0.238	0.067
Coffee creamer	0.130	0.026	0.132	0.029	0.132	0.029	0.138	0.029
Cottage cheese	0.165	0.033	0.164	0.044	0.158	0.044	0.171	0.045
Cream cheese	0.258	0.078	0.260	0.076	0.263	0.081	0.289	0.086
Dairy cream	0.104	0.029	0.101	0.026	0.104	0.025	0.114	0.028
Margarine	0.118	0.031	0.134	0.034	0.133	0.035	0.143	0.039
Milk	0.035	0.008	0.030	0.008	0.031	0.009	0.035	0.010
Natural cheese	0.445	0.165	0.492	0.207	0.508	0.212	0.517	0.210
Processed cheese	0.306	0.091	0.297	0.098	0.300	0.094	0.307	0.094
Sour cream	0.153	0.032	0.153	0.035	0.160	0.035	0.169	0.035
Yogurt	0.154	0.043	0.162	0.048	0.171	0.055	0.180	0.056

[1]Source: IRI Infoscan, 2008–2011. Prices for milk and dairy cream are based on liquid ounce, and prices for the other dairy categories are based on net weight ounce.

Table A2. Revenue and space-based Herfindahl-Hirschman index (HHI) by market, 2008–2011[1]

		Space-based HHI				Revenue-based HHI			
City	State	2008	2009	2010	2011	2008	2009	2010	2011
Charlotte	NC	1,467	1,412	1,377	1,580	1,211	1,079	1,099	1,230
Chicago	IL	1,956	1,685	1,494	1,534	1,390	1,476	1,651	1,491
Cincinnati	OH	944	1,184	1,124	1,512	949	1,135	1,090	1,372
Columbus	OH	1,383	1,584	1,656	1,826	807	922	980	1,037
Dallas	TX	718	590	558	522	502	500	472	417
El Paso	TX	1,058	1,149	1,033	1,228	1,116	1,217	1,134	1,346
Houston	TX	1,490	1,409	1,465	1,589	1,295	1,282	1,287	1,444
Indianapolis	IN	1,178	1,395	1,421	1,676	795	904	940	1,059
Jacksonville	FL	1,968	1,984	1,889	2,196	1,635	1,640	1,755	1,971
Lexington	KY	522	589	661	641	561	625	693	696
Louisville	KY	1,084	1,232	1,327	1,560	1,188	1,337	1,408	1,613
Milwaukee	WI	868	1,115	1,056	1,588	605	745	695	900
Minneapolis	MN	313	551	548	588	223	405	388	399
New York	NY	265	297	361	336	280	338	386	381
Phoenix	AZ	2,958	2,726	2,486	3,086	2,124	1,926	1,853	2,122
Rochester	NY	1,483	1,555	1,704	2,227	1,361	1,343	1,433	1,787
Sacramento	CA	372	384	379	382	266	270	277	286
San Antonio	TX	3,163	3,039	2,966	3,729	2,928	2,938	2,863	3,621
San Diego	CA	399	381	321	404	400	393	411	432
Springfield	MA	1,842	1,770	1,712	1,736	1,225	1,297	1,030	1,047

[1]Source: own calculations based on Nielsen TDLinx data, 2008–2011.

Table A3. Population and per capita income by market, 2008–2011[1]

		Population (thousand)				Income (thousand)			
City	State	2008	2009	2010	2011	2008	2009	2010	2011
Charlotte	NC	2,152	2,196	2,224	2,257	38.5	36.6	37.3	38.8
Chicago	IL	9,385	9,429	9,470	9,491	46.1	43.8	44.2	46.3
Cincinnati	OH	2,095	2,108	2,117	2,123	40.0	38.7	39.1	41.6
Columbus	OH	1,866	1,888	1,906	1,925	38.2	37.6	38.4	40.9
Dallas	TX	6,211	6,342	6,453	6,571	43.7	40.4	41.4	44.5
El Paso	TX	773	790	807	822	27.2	27.5	28.6	29.6
Houston	TX	5,676	5,826	5,949	6,054	48.4	43.1	44.3	48.4
Indianapolis	IN	1,850	1,873	1,892	1,910	39.1	37.7	38.3	40.4
Jacksonville	FL	1,323	1,335	1,349	1,361	40.7	38.4	39.5	40.9
Lexington	KY	460	467	473	479	38.0	36.4	37.0	38.8
Louisville	KY	1,217	1,228	1,238	1,245	38.2	36.9	37.6	39.1
Milwaukee	WI	1,538	1,550	1,557	1,561	43.7	43.2	43.4	45.4
Minneapolis	MN	3,301	3,331	3,355	3,389	47.3	44.9	46.0	48.8
New York	NY	19,339	19,469	19,596	19,732	54.9	52.8	54.3	56.9
Phoenix	AZ	4,106	4,154	4,209	4,253	37.6	35.4	35.4	37.2
Rochester	NY	1,075	1,078	1,080	1,082	39.8	39.3	40.3	42.6
Sacramento	CA	2,108	2,133	2,154	2,175	42.1	40.8	41.1	43.3
San Antonio	TX	2,061	2,106	2,153	2,193	35.7	34.6	35.5	38.3
San Diego	CA	3,022	3,061	3,104	3,139	46.9	44.9	45.5	48.3
Springfield	MA	620	621	623	625	38.7	38.7	39.2	41.1

[1]Source: US Department of Commerce, Bureau of Economic Analysis, 2008–2011.

Table A4. Cross section and within estimates based on the number of retail stores for concentration[1]

	Cross section				Within			
Item	2008	2009	2010	2011	2008	2009	2010	2011
Convenience	0.375	0.431	0.423	0.402	Ref.	0.092	0.069	0.036
	(0.002)	(0.002)	(0.001)	(0.002)		(0.003)	(0.003)	(0.003)
Dollar	0.073	0.078	0.090	0.098	Ref.	0.033	0.024	0.015
	(0.002)	(0.001)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Drug	0.081	0.117	0.100	0.092	Ref.	0.049	0.033	0.012
	(0.002)	(0.002)	(0.003)	(0.001)		(0.002)	(0.002)	(0.002)
Supermarket	0.064	0.041	0.019	0.040	Ref.	0.002	−0.022	−0.007
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Mass merchandiser	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
HHI	−0.010	0.003	0.004	0.007	0.007	0.008	0.011	0.017
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
Population	0.124	0.122	0.120	0.121	Ref.	−0.004	−0.003	0.003
	(0.017)	(0.017)	(0.016)	(0.017)		(0.001)	(0.001)	(0.001)
Income	0.082	0.092	0.106	0.104	Ref.	0.011	0.020	0.021
	(0.002)	(0.002)	(0.002)	(0.002)		(0.001)	(0.001)	(0.001)
R^2	(0.931)				(0.956)			
Adjusted R^2	(0.930)				(0.955)			
Additional controls	(product × year × month)				(product × year, year × month, product × store type, store effect)			
No. of observations	261,570	276,458	280,352	290,082	261,570	276,458	280,352	290,082

[1]Ordinary least squares (OLS) estimates are under cross section, estimates from fixed-effects panel regression are under within, standard errors are in parentheses. HHI = Herfindahl-Hirschman index. Ref. = reference.

Table A5. Cross section and within estimates using revenue-based Herfindahl-Hirschman index (HHI) for concentration[1]

	Cross section				Within			
Item	2008	2009	2010	2011	2008	2009	2010	2011
Convenience	0.370	0.432	0.423	0.403	Ref.	0.076	0.060	0.037
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Dollar	0.072	0.078	0.089	0.098	Ref.	0.005	0.008	0.011
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Drug	0.08	0.117	0.101	0.093	Ref.	0.048	0.031	0.019
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Supermarket	0.066	0.041	0.018	0.04	Ref.	−0.013	−0.041	−0.019
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Mass merchandiser	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
HHI	0.027	0.014	0.012	0.017	0.030	0.021	0.021	0.023
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population	0.101	0.103	0.101	0.108	Ref.	−0.010	−0.013	−0.004
	(0.016)	(0.016)	(0.016)	(0.017)		(0.001)	(0.001)	(0.001)
Income	0.084	0.084	0.097	0.095	Ref.	0.007	0.022	0.023
	(0.002)	(0.002)	(0.002)	(0.002)		(0.001)	(0.001)	(0.001)
R^2	(0.931)				(0.956)			
Adjusted R^2	(0.930)				(0.955)			
Additional controls	(product × year × month)				(product × year, year × month, product × store type, store effect)			
No. of observations	261,570	276,458	280,352	290,082	261,570	276,458	280,352	290,082

[1]Ordinary least squares (OLS) estimates are under cross section, estimates from fixed-effects panel regression are under within, standard errors are in parentheses. Ref. = reference.

Table A6. Cross-section and within estimates using store space-based HHI index for concentration[1]

	Cross section				Within			
Item	2008	2009	2010	2011	2008	2009	2010	2011
Convenience	0.371	0.432	0.423	0.403	Ref.	0.074	0.057	0.034
	0.002	*0.002*	*0.002*	*0.002*		*0.002*	*0.002*	*0.002*
Dollar	0.072	0.078	0.089	0.098	Ref.	0.005	0.008	0.011
	0.002	*0.002*	*0.002*	*0.002*		*0.002*	*0.002*	*0.002*
Drug	0.080	0.117	0.101	0.092	Ref.	0.048	0.030	0.018
	0.002	*0.002*	*0.002*	*0.002*		*0.002*	*0.002*	*0.002*
Supermarket	0.066	0.041	0.018	0.040	Ref.	−0.014	−0.041	−0.021
	0.002	*0.002*	*0.002*	*0.002*		*0.002*	*0.002*	*0.002*
Mass merchandiser	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
HHI	0.036	0.020	0.020	0.015	0.046	0.035	0.034	0.031
	0.003	*0.003*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*	*0.002*
Population	0.018	0.022	0.021	0.023	Ref.	−0.007	−0.010	−0.005
	0.016	*0.016*	*0.016*	*0.016*		*0.001*	*0.001*	*0.001*
Income	0.084	0.084	0.096	0.092	Ref.	0.007	0.020	0.020
	0.002	*0.003*	*0.002*	*0.003*		*0.001*	*0.001*	*0.001*
R^2	*0.931*				*0.956*			
Adjusted R^2	*0.930*				*0.955*			
Additional controls	(product × year × month)				(product × year, year × month, product × store type, store effect)			
No. of observations	261,570	276,458	280,352	290,082	261,570	276,458	280,352	290,082

[1]Ordinary least squares (OLS) estimates are under cross-section, estimates from fixed-effects panel regression are under within, standard errors are italicized. HHI = Herfindahl-Hirschman index. Ref. = reference.

Appendix Table A7. Summary of interaction terms for the cross-section and within models[1]

	Cross section (product × year × month)		Within	
Product	Number of significant coefficients	Number of insignificant coefficients	Number of significant coefficients (product × year)	Number of insignificant coefficients (product × retail format)
Butter	42	6	3	4
Coffee creamer	48	0	4	3
Cottage cheese	48	0	3	4
Cream cheese	48	0	4	4
Cream cheese	48	0	4	4
Margarine	48	0	4	4
Milk	48	0	4	4
Natural cheese	48	0	4	4
Processed cheese	48	0	4	4
Sour cream	48	0	4	4
Yogurt	48	0	4	4

[1]There are a total of 48 interaction coefficient for each product in the cross-section model. Further, there are 4 product × year and product × retail format interaction terms for each product, with the exception of product × year interaction for butter.