Grocery Retail Configuration and Markups*

Donghoon Kim

Job Market Paper

Click here for the most recent version.

Abstract

This study examines how evolving retail formats in the U.S. grocery retail industry impact productivity and markups, using a production function approach and establishment-level data from 2004 to 2020. Empirical results indicate that both increased scope of services within a single store and network economies across stores, measured by the number of stores operated by a company, significantly increase retail markups. In addition, the results confirm that economies of size results in increased markups. Overall, I attribute increased markups to increases in efficiency rather than increases in prices as evolving retail configuration gain production and distribution efficiencies that primarily lower cost and enable stores to tap related markets and shopping convenience through increased services. I further checked the heterogeneity of markups across the U.S. to identify trends, geographic patterns, and the effects of grocery store formats.

JEL: L10; L81; Q18

Keywords: Retail configuration, markups, food retail industry, production-function approach

---

*Donghoon Kim, Corresponding Author, Department of Agricultural and Resource Economics, University of Connecticut, email: donghoon.kim@uconn.edu; Rigoberto Lopez, Department of Agricultural and Resource Economics, University of Connecticut, email: rigoberto.lopez@uconn.edu; Sandro Steinbach, Department of Agribusiness and Applied Economics, North Dakota State University, email: sandro.steinbach@ndsu.edu. This work was supported by the National Institute of Food and Agriculture through the Agriculture and Food Research Initiative Award 2019-67023-29343, the Economic Research Service Cooperative Grant Agreement 58-4000-0-0018, and the Richard DelFavero Fund for Agricultural and Resource Economics at the University of Connecticut. Any opinions, findings, conclusions, or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the United States Department of Agriculture. Copyright 2023 by Donghoon Kim, Rigoberto A. Lopez, and Sandro Steinbach. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

1. Introduction

The U.S. food retail industry has undergone considerable changes with the emergence of big-box retailers such as Walmart and the rise of small format networks like Aldi during the last four decades (Chenarides et al., 2021; Holmes, 2011). At the same time, market concentration in the grocery retail industry has increased by more than 458 percent between 1990 and 2019 while traditional grocery retailers have experienced a decline in their market share (Dong et al., 2023; Zeballos et al., 2023). A mechanism to respond to increased competition is adjusting the retail configuration, allowing incumbent firms to increase efficiency and remain competitive (Bonanno & Lopez, 2009; Ellickson, 2016; Hanner et al., 2015). One factor that incumbent firms can use to adjust the retail configuration and remain competitive in the changing U.S. food retail industry is through markups. This is because markups are crucial for businesses in that they enable themselves to cover their operational costs and generate profit, while also accounting for the level of competition in the market. Additionally, markups can be adjusted to reflect changes in consumer demand, allowing businesses to stay responsive to the evolving needs and preferences of their customers. In this context, emerging retail outlet formats are taking advantage of network economies and the scope of services.

A growing literature studies the association between retail configuration and market power. For instance, Ellickson (2006) finds that firms with the broadest scope of services are more profitable. In a follow-up study, Ellickson (2007) constructed a supermarket competition model that relies on the framework introduced by Sutton (1991). This model shows that the desire to offer a wider range of products at each store encourages firms to increase their investment in advanced distribution systems. Previous studies have also examined the impact of the scope of services on market power, finding that businesses offering full services exhibit twice the market power than those offering a single service, leading to significant price discrimination in the industry (Bonanno & Lopez, 2009; Jia, 2008; Ellickson, 2007; Shepard, 1991). Limited studies have found a positive association between the economies of scope and market concentration in the food and drink industry (Sutton, 2007). More recently, Maican & Orth (2021) analyzed the role of economies of scope, finding that high-productivity firms improve the intensive and extensive margins by offering a wider variety of products in Swedish retail manufacturing. However, there is a lack of systematic knowledge regarding the impact of the retail configuration on markups. Our study aims to fill this gap by structurally examining the association between retail configuration and markups while accounting for network economies, the scope of services, and types of retail formats. At the same time, a preponderance of the industrial organization (IO) literature finds that markups are rising in the U.S. (Döpper et al., 2021; De Loecker et al., 2020).[1] The phenomenon of rising markups can lead to inflation, reducing both competition and consumer welfare. However, the reasons behind this phenomenon are unclear, and limited evidence is available to understand how markups are evolving in the retail sector and how they are affected by retail configuration.[2]

This study investigates the impact of evolving retail formats on production efficiency and markups in the U.S. grocery retail industry. The research employs a production function approach and establishment-level data spanning 2004 to 2020. To achieve this, I define retail configuration as

[1] See Smith and Ocampo (2022), who find that the local level of concentration does not affect the increasing markups in retail, and Decker et al. (2014, 2020) for the dominance of large firms. De Loecker and Eeckhout (2021) find that rising market power is due to a decrease in the employment reallocation rate and changes in the cost structure of firms. De Loecker et al. (2020) and Hall (2018) document increasing markups.

[2] See Chenarides et al. (2021), who find that entry by discount-stores (e.g.,Aldi) decreases similar retail stores' markups by about 7.3 percent compared to stores in non-entry markets. Chidmi and Lopez (2007) is one of the few studies estimating markups for U.S. grocery stores using BLP framework with detailed price and quantity data at the product/market level.

the principal components of the scope of services, network economies, and retail formats[3]. Specifically, we create the scope of services index using Principal Component Analysis (PCA) following Bonnano & Lopez's (2009) approach to reduce the dimensionality problem of the parameters to be estimated. This index will be used for food and non-food services provided on-site at the store level. Next, I measure network economies as the number of stores operated by the same parent company, identified by the parent company indicator. Lastly, retail formats are categorized variables within the grocery sector, used to compare store markups and productivity.

The study has three main findings by investigating the impact of retail configuration on markups and revenue per square footage in the U.S. food retail industry. First, this study finds that the increased scope of retail services within a single store allows grocery stores to significantly increase markup, likely by exploiting convenience shopping and optimizing markups in related markets. Second, increased network economies, as measured by the number of stores operated by a company, allow grocery stores to increase markups by gaining distribution efficiency and generating cost savings not fully passed on to consumers at each store. Specifically, the effect of the scope of services increasing productivity is two times larger (3.7%) than the effect of network economies (1.8%). Third, economies of size also increase markups by lowering marginal costs for large grocery stores rather than raising retail prices. For example, Walmart markups are found to be higher than those of supermarkets (6.3%), with an average of 16.2%, not due to higher prices but thanks to lower costs not passed on to consumers from efficiencies gained through store size, company network economies, and higher scope of services relative to supermarkets. Moreover, high-quality supermarkets (natural/gourmet stores) have higher markups than conventional

[3] Supermarket limited assortment, natural/gourmet foods, warehouse grocery, superette, conventional, supercenters. The formats are further discussed in data section.

supermarkets, suggesting that they cater to high-income consumers with limited product categories but higher prices and quality. The findings indicate that retailers can improve their market power by leveraging network economies and the scope of services and catering to high-income consumers with higher prices and quality.

The contributions of this paper are three-fold. First, this paper provides a detailed account of the association between the retail configuration (network economies,[4] the scope of services, and retail formats) and markups in the U.S. grocery retail industry retailers. I applied the production function approach (De Loecker and Warzynski 2012, hereafter DLW)[5] in order to estimate store-level markups in grocery retail industry, which are lacking in current studies. This is particularly relevant given the changing nature of the retail industry, as discussed in Berry et al. (2019) and Hortacsu & Syverson (2015), where emerging retail formats are saving costs due to the network economies (Ellicskon, 2013; Homles, 2011) and to capitalize on consumer preferences for shopping convenience and time-saving services (Bonnano & Lopez, 2009; Kinsey & Senauer, 1996). Estimating markups and how they are affected by retail configuration can help policymakers and practitioners identify inefficiencies across the different sectors and design policies to improve competition and efficiency (Gauri, 2013).

Second, this study documents the markups by formats that are both horizontally (location) and vertically (size) differentiated and counties over 17 years for the first time. It assesses the level of market power held by retailers in the grocery retail industry. Besides it shows the evolving trends

---

[4] Traditionally, economies of size have been used as a proxy for quality (Shaked and Sutton, 1987; Ellickson, 2006).

[5] Recent work using production function approach (PFA) includes Lee and Cayseele (2022) (Italian cooperatives); Chenarides et al., (2021) (cross-sectional markups for US supermarkets); Lowrey et al., (2020) (cross-sectional markups for US food bank retailers); Koppenberg and Hirsch, (2022) (EU dairy processing); Hirsch and Koppenberg, (2020) (French food retailing).

that are useful to provide information to policymakers about understanding the level of competition to protect consumers. Third, the study sheds light on answering the question of rising markups associated with the retail configuration. Even though there has been documented evidence of rising markups in other industries (Döpper, 2022; De Loecker et al., 2020; Hall, 2018), the magnitude and the cause of increasing markups have not been addressed fully, particularly grocery retail industry (Berry et al., 2019).

Hence, this study fills the above gaps by using network economies, the scope of services, and retail formats as determinants of rising markups in grocery retail research. Overall, this study contributes to the literature on retail economics and provides insights into the dynamics of the grocery retail industry by comparing the effect under different formats and regions over time.

2. Background and Data

The US grocery retail industry is primarily composed of brick-and-mortar stores, with over 38,000[6] operating across the country and total sales surpassing $700 billion in 2018. Despite a diverse range of ownership structures, a few large, vertically integrated chains dominate the industry. The market is known for large store formats and a highly competitive upstream market that enables store-brand products to be less expensive. The industry is experiencing significant changes due to the rise of supercenters (Walmart), discount grocers (Aldi), and dollar stores, as well as a growing trend toward health and wellness. Retailers are adapting their product offerings and experimenting with new formats, store designs, and technology to appeal to consumers. Manufacturers are also adopting direct-to-consumer models, while some retailers are exploring new distribution models

[6] The number only includes stores with 2 million or more in US dollars. Accessed at https://www.fmi.org/our-research/supermarket-facts. Weekly sales per square foot of selling area is 18.41 dollars and average weekly sales per supermarket is 638,756 dollars in 2021.

like micro-fulfillment centers to improve inventory management and delivery times. These changes are driving innovation and competition in the US grocery market.

Market concentration is a central concern in the field of Industrial Organization, as it has important implications for market outcomes and welfare. The Concentration Ratio (CR) is a widely used measure of market concentration that calculates the share of total industry sales that is held by the top firms in the market. In this chapter, I use the CR to analyze the level of competition in the food retail industry at different points in time using the top 4, 8, and 20 firms as our measure of market concentration following Dong et al. (2022). The Herfindahl-Hirschman Index (HHI) is another commonly used measure of market concentration that calculates the sum of squared market shares across all firms in the market. The HHI ranges from 0 to 10,000, with higher values indicating greater market concentration.

In Figure 1, the CR values reveal significant variations in market concentration levels across different geographic areas and over time. For instance, the CR values for the grocery retail industry show that market concentration is particularly high for the top 20 firms, with these firms accounting for 80 percent of total industry sales in the markets. As shown in Figure 1, the average HHI[7] values for county, state, and national levels reveal distinct patterns in the level of market concentration over time. Specifically, the county-level HHI ranges from 2600 to 2800 over the period 2004 to 2020, with a slight decrease observed during this time. At the state level, HHI values range from 1500 to 1700 during this period, while the national-level HHI is significantly lower, ranging from 500 to 1000. These patterns suggest that market concentration in the food retail industry is highest at the county level and lower at the state and national levels, which may

[7] See Zeballos et al. (2023) who also document the level of HHI by different geographic regions using data from National Establishment Time Series (NETS).

reflect differences in the competitive landscape and consumer preferences across different geographic areas. Understanding these patterns of market concentration can inform policy decisions aimed at promoting competition and protecting consumers in the grocery retail industry. These measures are particularly useful for understanding the grocery retail industry, as this industry is characterized by a small number of large firms that exert significant market power. By analyzing the level of concentration in the industry using the CR and HHI measures, we can better understand the degree of competition in different markets and identify areas where antitrust enforcement or other policy interventions may be necessary to protect consumers and promote competition.

In the US grocery industry, retail configurations and markups are influenced not only by traditional factors such as supply chain costs and competition but also by network economies and scope of services. Network economies refer to the advantages that firms gain from being part of a network, such as the ability to share resources and collaborate with other firms. Scope of services, on the other hand, relates to the range of services that a firm offers to customers, including product variety, quality, and convenience. Network economies and scope of services play a significant role in shaping the retail configurations of firms in the US food retail industry. For instance, firms may join a network of suppliers to gain access to a wider range of products or to reduce the costs of distribution. Additionally, firms may offer a wider scope of services, such as online ordering and delivery, to attract more customers and increase their markups. The impact of network economies and scope of services on retail configurations and markups is evident in the strategies employed by firms in the industry. For example, firms may collaborate with other firms to offer a wider range of products or to share marketing costs. Moreover, firms may invest in new technologies to offer online ordering and delivery services, which not only attract more customers but also increase their markups by providing added convenience.

The COVID-19 pandemic has underscored the significance of network economies and the scope of services in the US food retail industry. Firms that were able to leverage their network economies and offer a wider scope of services, such as online ordering and delivery, were better positioned to adapt to the changes in consumer behavior and maintain their market share and profitability (Hortacsu & Syvrson, 2015). However, network economies and scope of services also pose challenges for firms in the US food retail industry. Firms must carefully manage their relationships with suppliers and other firms in the network to ensure that they are receiving the maximum benefit. Additionally, firms must continually invest in new technologies and services to remain competitive, which may require significant upfront costs. In short, network economies and scope of services are essential factors in shaping retail configurations and markups in the US food retail industry. Firms must carefully manage their relationships with suppliers and other firms in the network and invest in new technologies and services to remain competitive in a constantly evolving market. As such, the study of network economies and scope of services in the US food retail industry offers valuable insights into market competition, pricing theory, and consumer welfare.

This study observes 57,592 establishments of samples across the U.S. between 2004 and 2020 to estimate firm-level markups in the U.S. food grocery sector. The approach used in this study follows De Loecker & Warzynski (2012), who have made new contributions to the literature on markup estimates that build on Hall (1988). Their method proposes cost minimization by producers and relies on data on the output and input of each establishment, rather than estimating demand, as in the new empirical IO method (Bresnahan, 1989). By estimating the related production function, the study can estimate markups at the firm-level.

The data for this study comes from two sources: store information from Nielsen's TDLinx and the Quarterly Census of Employment and Wages (QCEW). Nielsen's TDLinx data provides reliable and unique retail store data for inputs/outputs at the establishment level across the U.S. The study uses output measured in annual revenues and two inputs: labor (number of employees) and capital (square footage) at the establishment level, covering the period from 2004 to 2020. To identify the retail configuration effect, I define three variables as 1) network economies, i.e., the number of stores owned by the same company, 2) scope of services, i.e., the principal component of services (Food: beer/wine, Non-food: gas/pharmacy) provided on-site scaled from 0 to 100, and 3) retail formats as a unique categorical dummy from 1 to 6.

TDLinx has distinct advantages over NETS when it comes to estimating production functions. It provides several input measures, including labor, square footage (capital), and the number of checkout registers (investment), which are critical for modeling the relationship between input factors and output levels in the production process of a retail store. Accurately measuring these input factors is necessary to identify the factors that are most important for increasing output levels and optimizing the production process. TDLinx also offers data on store characteristics, such as whether the store provides gas, pharmacy, wine, and liquor, allowing for a more comprehensive understanding of the range of services offered by a retail location. Lastly, TDLinx provides a parent firm indicator, which is useful for constructing the number of networks. This information can help identify the ownership structure of different retail locations, which is particularly important for this study which seeks to understand the concentration of market power in the retail industry.

Although our data is unique in providing store characteristics, it has some limitations.[8] It does not include either total variable cost or input expenditures (i.e., capital and materials costs) for measuring markups like in Compstat[9] data which provides firm-level of accounting details. Instead, it only provides the number of employees at the establishment level. Moreover, it lacks information about other input data, such as materials and energy usage, but those are provided by Census Bureau at the industry or sectoral level. However, this study is not concerned with materials as an input in the food retail industry because materials[10] (1 percent of total operating costs) are not considered primary inputs, in contrast to labor (11 percent) (FMI, 2007).

To address these limitations, the study uses data from QCEW, which includes total annual wages and the number of establishments in all counties and periods from 2004 to 2020. The next step is to compute the annual labor expenditure at the establishment level by dividing total annual wages by the total number of establishments in each county, which is then multiplied by the number of employees at the establishment to determine the store's total annual wage bill. Since the two inputs (labor and capital) are the only observables in the data, it is not feasible to estimate production

[8] See Cho et al. (2019). The National Establishment Time-Series (NETS), which provides comparable data sets, provides the number of employees at the establishment level. However, it does not provide capital input data, which is necessary to estimate production functions requiring at least two inputs (labor and capital).

[9] Compustat is a comprehensive database that provides financial, statistical, and market information on publicly traded companies (i.e., S&P 500) in the United States and Canada. The database includes detailed financial data, such as income statements, balance sheets, cash flow statements, and financial ratios, as well as market data, such as stock prices and trading volumes.

[10] Of all food retailing expenses, store labor accounts for the largest portion, with payroll at 11.5 percent of sales and employee benefits at 3.6 percent together comprising more than half of the gross margin (the opposite of expenses in manufacturing industries).

functions with different inputs (i.e., materials) in this study. The descriptive statistics showing key variables for estimating the production functions are reported in Table 1.

3. Theoretical Model and Empirical Strategy

3.1. Theoretical Model

Following De Loecker et al. (2012),[11] this study uses the PFA to recover markups of price over marginal cost. Based on the assumption of cost minimization by the retail stores, the production function is:

$$Q_{itc} = Q_{itc}(L_{itc}, K_{itc}, \Omega_{itc})\ , \tag{1}$$

where L_{itc} is a labor input of production, K_{itc} is the capital stock, and Ω_{itc} is productivity. The cost-minimizing firm's first-order condition for L_{itc} becomes:

$$\frac{1}{\lambda_{itc}} = \frac{\partial Q(\cdot)}{\partial L_{itc}} \frac{1}{W_{itc}}\ , \tag{2}$$

where λ_{itc} is a Lagrange multiplier measuring marginal costs. By multiplying both sides by the firm's price P_{itc}, the right-hand side equation can be rewritten in terms of the output elasticity of θ^{l}_{itc}, multiplied by its inverse revenue share:

$$\mu_{itc} = \theta^{l}_{itc} \frac{P_{itc} Q_{itc}}{P^{l}_{itc} V_{itc}}\ , \tag{3}$$

[11] The markup estimation using PFA was introduced by Hall (1988) and further developed by De Loecker and Warzynski (2012) and shows that find exporting firms have higher markups than non-exporting firms. The DLW approach used in different specifications are well discussed by Doraszelski & Jaumandrew (2019).

where output elasticity on labor input l is denoted by θ_{itc}^{l}, and $\frac{P_{itc}Q_{itc}}{P_{itc}^{V}V_{itc}}$[12] is the revenue share of the labor expenditure for each establishment i in year t. Although we do observe actual quantities of labor and capital in the data, the quantity of revenues is not available. To this end, the following production function is estimated.

3.2. Measuring Retail Markups

To measure markups, it is necessary to estimate input elasticity from the production function and to compute the inverse share of labor expenditure of total revenues that are directly observed in our data. Following Ackerberg, Caves, and Frazer (2015 hereinafter, ACF), it estimates the gross output production function[13] with two inputs, $Y = Y(L, K, \omega; \beta)$, where L is labor, K is capital, and ω is firm-specific productivity, to obtain estimates for β. The model specifies Y as a second-order polynomial translog function, so the production function becomes:

$$y_{itc} = \beta_c + \beta_l l_{itc} + \beta_k k_{itc} + \beta_{ll} l_{itc}^2 + \beta_{kk} k_{itc}^2 + \beta_{lk} l_{itc} k_{itc} + \omega_{itc} + \varepsilon_{itc,}, \qquad (4)$$

which also can be expressed as:

$$q_{itc} = f(l_{itc}, k_{itc}) + \omega_{itc} + \varepsilon_{itc}. \qquad (5)$$

---

[12] The corrected expenditure share $\frac{\frac{P_{itc}\widetilde{Q_{itc}}}{exp(\hat{\varepsilon}_{itc})}}{P_{itc}^{V}V_{itc}}$ is used to measure markups, as suggested in De Loecker & Warzynski (2012).

[13] As suggested by DLW, both value-added and gross output production functions can be used to recover markups. In addition, there is no need an extra assumption of using a fixed proportion of materials for producing a unit of output. This study is not concerned about excluding material as another input as in manufacturing industry. Of all food retailing expenses, store labor accounts for the largest portion, with payroll at 11.5 percent of sales and employee benefits at 3.6 percent together comprising more than half of the gross margin (the opposite of expenses in manufacturing industries).

Here all output and input variables are expressed in logs, y_{itc} denotes revenue deflated by the own price index at the establishment level, l_{itc} is labor for the establishment i in year t, and k_{itc} is capital for the establishment i in year t.[14]

Deflated revenues are used as an output measure where researchers do not observe the physical quantity. However, it is important to note that this could lead to biased estimates since a firm's price could be higher than average industry prices (Bond et al., 2021). To deal with the bias caused by unobserved output prices, the revenues for grocery stores and supercenters are deflated by their own price index, respectively obtained from QCEW.[15] In this regard, this study uses a strategy similar Jafari et al.'s (2022) to reduce the bias caused by the absence of output prices. Then, the model assumes that the rest of the deviations from price indices can be regarded as firm-specific, which change little over time. Moreover, the use of store-fixed effects and county-fixed effects accounts for store-specific deviations from average industry prices and variations in input prices and product differentiations across the markets by capturing unobserved price differences (Jafari et al., 2022). Once the GMM estimates are identified, we can estimate the output elasticity with respect to any of the inputs and compute markups at the store level.

In the first stage, the model obtains the estimates of $\hat{\phi}_{itc}$ and $\hat{\varepsilon}_{itc}$ by regressing the following equation:

---

[14] This study uses two separate price deflators to deal with the bias caused by the absence of output prices. Output is the log of revenues deflated by the own price index (PPI) for supermarkets and other grocery stores (NAICS 445110) and warehouse clubs and supercenters (NAICS 452311), following Jafari et al. (2022) and Chenarides et al. (2021), who estimated markups applying DLW (2012).

[15] Revenue is deflated by its own price index (PPI) for supermarkets and other groceries (NAICS 445110) and warehouse clubs and supercenters (NAICS 452311).

$$q_{itc} = \phi_{itc} + \varepsilon_{itc} \, , \tag{6}$$

where $\phi_{itc} = f(l_{itc}, k_{itc}) + h(l_{itc}, k_{itc}, checkouts_{itc})$, and $h(\cdot)$ refers to the inverse of the material demand function as proxy of the productivity term. After the first stage, the estimate of $\hat{\phi}_{itc}$ is used to compute unobserved productivity shocks ω_{itc} and any input coefficients β, below.

$$\widehat{\omega}_{itc} = \phi_{itc} - \beta_c - \beta_l l_{itc} - \beta_k k_{itc} - \beta_{ll} l_{itc}^2 - \beta_{kk} k_{itc}^2 - \beta_{lk} l_{itc} k_{itc} \, . \tag{7}$$

The second stage uses the two-step generalized method of moments (GMM) methodology following ACF and De Loecker (2013), applied for parameter identification:

$$y_{itc}^* = \beta_c + \beta_l l_{itc} + \beta_k k_{itc} + \beta_{ll} l_{itc}^2 + \beta_{kk} k_{itc}^2 + \beta_{lk} l_{itc} k_{itc} + \xi_{itc} + \varepsilon_{itc} \, . \tag{8}$$

The second stage allows the law of motion of productivity to depend on lagged productivity and investment, which represents firm-level decisions, as suggested by De Loecker (2013).[16] In the second stage, investment as the number of checkout registers at the store level is added along with past productivity ω_{itc-1}, which follows an AR(1) process,[17] as described by the following $g_t(\cdot)$ function:

$$\omega_{itc} = g_t(\omega_{itc-1}, checkouts_{itc-1}) + \xi_{itc} \, ., \tag{9}$$

where ξ_{itc} is recovered by regressing ω_{itc} on its lag ω_{itc-1} and past technology state as $checkouts_{itc-1}$ in $t-1$ non-parametrically, using a second-order polynomial to approximate g_t.

[16] See Curzi et al. (2021) who used intermediate inputs as a proxy for unobserved productivity in the food industry.

[17] Additional decision variables such as innovation, investment, and export participation are suggested by De Loecker (2013) due to the potential bias of restricting the productivity process to being completely exogenous.

Finally, the moments for the GMM procedure are constructed to recover the parameter of inputs in the production function:

$$E[\xi_{itc}|l_{itc-1}, k_{itc}, l_{itc-1}^2, k_{itc}^2, l_{itc-1}k_{itc}] = 0 \ . \tag{10}$$

Therefore, the model assumes that ξ_{itc} is independent of the capital used in t, which is chosen in $t-1$. Since the current choice of labor inputs is correlated with productivity shocks, it is reasonable to use lagged labor to identify its parameter (DLW).

4. Results and Discussion

Table 2 presents the impact of retail configuration on markups and revenue per square footage. The results show that both network economies and the scope of services show a positive and significant impact on logged markups. This indicates that all food retailers could increase market power due to the network economies as well as scope of services. For example, a 1 percent increase in a store's network and scope of services would increase the markups by 2.4 percent and 1.4 percent, respectively. This result is consistent with previous findings by Cotterill (1999) and Bonnano & Lopez (2009),[18] suggesting that these effects make food retailers more efficient by lowering distribution costs and attract customers by increasing demand for grocery items.

The results also show that all food retailers except supercenters are less productive than conventional supermarkets (benchmark) in increasing markups, and all coefficients show high significance (at the 1 percent percent level). This finding suggests that conventional supermarkets can be represented as direct competitors of supercenters. It also shows that small-scale

[18] They find a positive effect of the scope of services on demand and prices, generating short-run economies of scope and a price-increasing effect due to market power.

supermarkets (e.g., superettes -45.1 percent) have lower market power to increase their markups compared to the high-quality supermarkets (e.g., natural/gourmet foods -0.06 percent) even though the high-quality supermarkets exhibit less efficient productivity in increasing markups than conventional supermarkets. Most supermarkets and supercenters, but not superettes, provide a wider product choice with cheaper prices along with pickup/delivery services to increase online sales. Furthermore, they can utilize a more efficient distribution network to reduce operating costs while maintaining product quality for perishable items.

Table 2 also reports a comparable effect on logged revenue per square footage, which measures a store's productivity (revenue per sqft). The effect of the non-food scope of services shows five times larger than that of food services in increasing markups and productivity. The effect of non-food services on markups is attributed to gaining cost efficiency whereas the effect of food service is mainly due to market power. This finding is in line with previous findings (Bonnano & Lopez, 2009; Cotterill, 1999), who find the 2.31 percent increase in the quantity of milk sold is due to the increase in food services and 1.25 percent to the increase in store size.

The effect of types of retailers on markups shows the stark difference [19] in markups and productivity for both supercenters (44%) and superettes (-36%), indicating their relative market power and productivity compared to conventional supermarkets. This finding represents that supercenters (like Walmart) could increase their markups without having to increase prices due to both network economies and scope of services that primarily lower cost and enable stores to tap related markets and shopping convenience.

[19] Calculated based on exp(0.366)-1 =0.44 or 44% and exp(-0.452)-1=-0.358 or 36%

Table 3 shows estimated markups using labor inputs[20] by grocery stores (except for supercenters) and supercenters, which are included in the same grocery channel code in the data, even though these stores' formats do not share the same NAICS code provided by census data.[21] By separating the supercenters out, it is more reasonable to compare the markups between grocery stores and supercenters, which shows that the higher markups are driven by supercenters. Table 3 also shows that markups vary among different supermarket formats from between nearly zero to 60 percent. Panel A shows that grocery stores (all types except supercenters) have 6.3 percent markups and supercenters have 16.2 percent markups, on average. [22] Panel B shows the markups by independent stores and chain stores, indicating the network effect increases their average markups overall. Consistent with previous study by Jia (2008) and Holmes (2005), Walmart exhibits a higher scale economies compared to other grocery chains, implying that they decrease input (labor and capital) costs to increase their profit margins.[23] Dong et al. (2022) documents the annual gross margins (27%) and profit margins (1%) in food retail industry between 1990 and 2019, showing that both measures have remained relatively constant.

[20] The elasticity of labor and capital inputs are estimated by OLS, two-stage least squares (2SLS), and two-stage GMM regression. I obtain a comparable estimate for labor input ranging from 0.594 to 0.662 and use the elasticity obtained from the two-stage GMM regression to calculate markups, following the best practice in this field (Ackerberg et al., 2015; De Loecker & Warzynski 2012; De Loecker et al., 2020). Our returns to scale (RTS) under different regressions show that there is an increasing pattern of returns to scale (1.036), which is the sum of labor and capital input elasticity. The similar pattern of returns to scale can be also found in Keh & Chu (2003).

[21] Under the same grocery channel, I observe 6 different subchannel that includes supermarket limited assortment, natural/gourmet foods, warehouse grocery, superette, conventional, supercenters, and military commissary. This study does not include military commissary.

[22] Statista (2022) reports Walmart's gross profit margin as ranging from 23.1 percent to 24.9 percent for 2006-2022. It should be noted that profit margin is calculated from revenues minus cost of goods sold (COGS), which must be differentiated when interpreting the magnitude of markups.

[23] Average profit margin per supermarket is reported as between 1 and 3 percent.

Table 4 reports all food retailer types used to compare the markups. There is a stark difference, on average, among the retailers and supercenters, which show the highest markups, followed by natural/gourmet foods, compared to other retailers. Given the number of establishments and their competition, it is not surprising that conventional supermarkets have lower markups than high-quality supermarkets (natural/gourmet stores) that provide a more limited variety of product categories but with higher prices and quality to attract high-income consumers. In the food retail industry, the weakest retail format, the superette, shows the lowest level of markups, which may be a possible cause of a contraction trend across the U.S. (Lopez et al., 2023; Cho & Volpe, 2017). Therefore, this result suggests the presence of asymmetrical power in the food grocery sectors that could decrease consumer welfare in the market, as Hirsch & Koppenberg (2020) demonstrate concerning the relationship between small and large firms.

Figure 2 presents the kernel density estimates of the markups, showing that grocery stores charge prices around 4-8 percent above marginal cost, whereas supercenters have 17 percent markups. This finding supports previous literature (Richards et al., 2018), suggesting that the food retail industry is highly competitive and has lower net margins than other industries due to the high level of competition among the largest retailers in the U.S. (e.g., Walmart, Target, and Amazon). Most of the low-quality (superette) and high-quality supermarkets (natural/gourmet) have markups between 3.8 and 7.5 percent, and the distribution is quite overlapped and highly skewed to the left. Supercenters (e.g., Walmart), as we already showed, have 17 percent markups. Figure 3 plots the markup distribution by the scope of services to compare stores providing a full line of non-food services with those that do not provide any such services, showing a lower markup distribution for the stores providing no services, as expected.

Figure 4 shows the average markups trend, indicating a stagnated pattern between 2010 and 2015 and an increasing pattern since 2015, suggesting a rising markup trend in the food retail sector (Döpper et al., 2022; De Loecker et al., 2020). The increasing pattern of markups in 2020 represents the fact that food grocery retailers were the COVID-19 winners, driving a 57 percent increase in grocery sales due to the dramatic shift toward home-related consumption (Ralston, 2022). Markups for supercenters have been high, between 14 and 17 percent, as compared to other food retailers. Our finding is robust when we check the size of the establishment.

Figure 5 shows a stark difference in markups, where chain stores consistently maintained markups twice as high as independent stores between 2004-2010. The early 2000s showed a rising markup trend until 2010 for both independent and chain grocery stores. However, the markups consistently decreased after that, reflecting a new era of proliferating dollar stores and new retail chains. Then markups increased again, although they have not bounced back fully.

Figure 6 corroborates the previous finding by showing the markups (revenue-weighted) by store size for the same period. There is a clear decreasing trend starting in 2010, followed by a rising markup trend since 2015. However, the average markup has not fully recovered yet, as the values in the early 2000s show higher markups. This result reflects the intensified competition among retailers in downstream markets (Koppenberg & Hirsch, 2022). This finding also suggests that there exist economies of scale in the grocery sector, as markups increase with the size of the stores and the trend has decreased over the time period studied.

Additionally, if the retail market is saturated, deploying buyer power to pressure processors could result in lower upstream market costs being passed on to consumers, lowering oligopoly markups (Li & Luo, 2020; Dobson & Waterson, 2007). Finally, this study documents county-level markup trends across the U.S. in Figure 7-9, using geographical maps for the years 2004, 2010, and 2020.

The legend indicates the average markups at the county level each year, showing that 28.7 percent of all counties saw markups of at least 10 percent in 2004.

5. Conclusion

This paper employs a production-function-based approach using establishment-level data to measure the impact of retail configuration on markups in the evolving U.S. grocery retail industry for the period 2004-2020. The main findings suggest that both network economies and the scope of services from various retail formats enhance markups. For instance, supercenters (such as Walmart) have 2.5 times greater markups despite lower prices, owing to cost efficiency. Further results show that markups increased up to 20 percent from 2015-2020, which is consistent with findings in the recent industrial organization literature. Our findings suggest that intensified competition among retailers in downstream markets lowers markups for supermarkets. The average markup for grocery stores is 4 to 8 percent over marginal costs. The distribution of markup values for low- and high-quality supermarkets under the grocery retail format exhibit positive skewness. Our production function estimates show that there exists a scale effect in grocery retailing since a store's productivity increases with its size. We find that large grocery chain stores owning more than 500 stores nationally are much more efficient, at least three times more, than independent grocery stores.

In conclusion, this study provides useful insights into the implications of new retail configuration formats for firm markups in the evolving U.S. grocery retail industry. The empirical findings confirm that both economies of scope, as well as economies of scale, allow retailers to enhance markups. The study also highlights the impact of intensified competition on markups, with lower markups for supermarkets due to increased competition from downstream markets.

From a policy perspective, the study suggests that policymakers may need to consider the impact of mergers and acquisitions on market competition and consumer welfare, particularly in relation to the complementary nature of merging firms' scope of services. Industry leaders may also need to focus on developing technology that expands the scope of services offered and enhances economies of scale to remain competitive and improve markups. The findings of this study contribute to the broader understanding of the relationship between retail configuration and firm markups in the grocery retail industry. These insights can also be relevant to other retail sectors undergoing significant changes in response to technological advances and changes in consumer preferences. Overall, the study provides important insights into the factors that influence markups in the grocery retail sector. The study confirms the importance of economies of scale and scope and highlights the impact of intensified competition on markups. These insights can be useful for retailers seeking to improve their profitability and for policymakers looking to promote competition and protect consumer welfare.

Although we show that these effects come through technology via a retail production function, future studies may incorporate more fully the demand or consumer preferences as inducing technology adoption that expands both the scope of services and economies of scale. From a policy perspective, as mergers focus on market shares and size of operation, the nature of complementarity of merging firms in terms of their scope of services is also important in determining the impacts on competition and consumers.

References

Ackerberg, D. A., Caves, K., & Frazer, G. (2015). Identification properties of recent production function estimators. *Econometrica*, 83(6), 2411-2451.

Berry, S., Gaynor, M., & Morton, F. S. (2019). Do increasing markups matter? Lessons from empirical industrial organization. *Journal of Economic Perspectives*, 33(3), 44-68.

Bonanno, A., & Lopez, R. A. (2009). Competition effects of supermarket services. *American Journal of Agricultural Economics*, 91(3), 555-568.

Bond, S., Hashemi, A., Kaplan, G., & Zoch, P. (2021). Some unpleasant markup arithmetic: Production function elasticities and their estimation from production data. *Journal of Monetary Economics*, 121, 1-14.

Bresnahan, T. F. (1989). Empirical studies of industries with market power. *Handbook of Industrial Organization*, 2, 1011-1057.

Chidmi, B., & Lopez, R. A. (2007). Brand-supermarket demand for breakfast cereals and retail competition. *American Journal of Agricultural Economics*, 89(2), 324-337.

Chenarides, L., Gomez, M. I., Richards, T. J., & Yonezawa, K. (2021). *Retail Markups and Discount-Store Entry*. The SC Johnson College of Business Applied Economics and Policy Working Paper Series.

Cho, Clare & W. McLaughlin, Patrick & Zeballos, Eliana & Kent, Jessica & Dicken, Chris. (2019). *Capturing the Complete Food Environment with Commercial Data: A Comparison of TDLinx, ReCount, and NETS Databases*. Technical Bulletins 288291, United States Department of Agriculture, Economic Research Service.

Cho, C., & Volpe, R. (2017). Independent grocery stores in the changing landscape of the US food retail industry (No. 1477-2017-5743).

Cotterill, R. W. (1999). Market power and the Demsetz quality critique: An evaluation for food retailing. *Agribusiness: An International Journal*, 15(1), 101-118.

Curzi, D., Garrone, M., & Olper, A. (2021). Import competition and firm markups in the food industry. *American Journal of Agricultural Economics*, 103(4), 1433-1453.

Decker, R., Haltiwanger, J., Jarmin, R., & Miranda, J. (2014). The role of entrepreneurship in US job creation and economic dynamism. *Journal of Economic Perspectives*, 28(3), 3-24.

Decker, R. A., Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2020). Changing business dynamism and productivity: Shocks versus responsiveness. *American Economic Review*, 110(12), 3952-3990.

De Loecker, J., & Warzynski, F. (2012). Markups and firm-level export status. *American Economic Review*, 102(6), 2437-71.

De Loecker, J. (2013). Detecting learning by exporting. *American Economic Journal: Microeconomics*, 5(3), 1-21.

De Loecker, J., Eeckhout, J., & Mongey, S. (2021). *Quantifying market power and business dynamism in the macroeconomy* (No. w28761). National Bureau of Economic Research.

De Loecker, J., Eeckhout, J., & Unger, G. (2020). The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics*, 135(2), 561-644.

Döpper, H., MacKay, A., Miller, N., & Stiebale, J. (2022). *Rising Markups and the Role of Consumer Preferences*. Harvard Business School Strategy Unit Working Paper, (22-025).

Dobson, P. W., & Waterson, M. (2007). The competition effects of industry-wide vertical price fixing in bilateral oligopoly. *International Journal of Industrial Organization*, 25(5), 935-962.

Dong, X., Balagtas, J. V., & Byrne, A. T. (2023). A closer look at the relationship between concentration, prices, and market power in food retail—A monopolistic competition and differentiated products approach. Applied Economic Perspectives and Policy.

Doraszelski, U., & Jaumandreu, J. (2019). *Using Cost Minimization to Estimate Markups*. CEPR Discussion Paper No. DP14114, Available at SSRN: https://ssrn.com/abstract=3496603.

Ellickson, P. B. (2006). Quality competition in retailing: A structural analysis. *International Journal of Industrial Organization*, 24(3), 521-540.

Ellickson, P. B. (2007). Does Sutton apply to supermarkets?. *The RAND Journal of Economics*, 38(1), 43-59.

Ellickson, P. B., Houghton, S., & Timmins, C. (2013). Estimating network economies in retail chains: a revealed preference approach. *The RAND Journal of Economics*, 44(2), 169-193.

Ellickson, Paul B. (2016). "The Evolution of the Supermarket Industry: From A&P to Walmart, in *Handbook on the Economics of Retail and Distribution*, edited by Emerk Basker. Cheltenham: Edward Elgar Publishing, pp. 368-391, 2016. URL: http://dx.doi.org/10.2139/ssrn.1814166.

Food Marketing Institute. (2007). *Marketing Costs*. Food Marketing Institute. URL: https://www.fmi.org/docs/facts-figures/marketingcosts.pdf?sfvrsn=2.

Gauri, D. K. (2013). Benchmarking retail productivity considering retail pricing and format strategy. *Journal of Retailing*, 89(1), 1-14.

Hall, R. E. (1988). The relation between price and marginal cost in US industry. *Journal of Political Economy*, 96(5), 921-947.

Hall, R. E. (2018). *New Evidence on the Markup of Prices over Marginal Costs and the Role of Mega-firms in the US economy* (No. w24574). National Bureau of Economic Research.

Hanner, D., Hosken, D., Olson, L. M., & Smith, L. K. (2015). Dynamics in a mature industry: Entry, exit, and growth of big-box grocery retailers. *Journal of Economics & Management Strategy*, 24(1), 22-46.

Hirsch, S., & Koppenberg, M. (2020). Power imbalances in French food retailing: Evidence from a production function approach to estimate market power. *Economics Letters*, 194, 109387.

Holmes, T. J., & Stevens, J. J. (2005). Does home market size matter for the pattern of trade?. *Journal of International Economics*, 65(2), 489-505.

Holmes, Thomas J. (2011). The Diffusion of Wal-Mart and the Economies of Density. *Econometrica*, 79(1): 253–302.

Hortaçsu, A., & Syverson, C. (2015). The ongoing evolution of US retail: A format tug-of-war. *Journal of Economic Perspectives*, 29(4), 89-112.

Jafari, Y., Koppenberg, M., Hirsch, S., & Heckelei, T. (2022). Markups and export behavior: Firm-level evidence from the French food processing industry. *American Journal of Agricultural Economics*, 105(1), 174-194.

Jia, P. (2008). What happens when Wal-Mart comes to town: An empirical analysis of the discount retailing industry. *Econometrica*, 76(6), 1263-1316.

Keh, H. T., & Chu, S. (2003). Retail productivity and scale economies at the firm level: A DEA approach. *Omega*, 31(2), 75-82.

Kinsey, J., & Senauer, B. (1996). Consumer trends and changing food retailing formats. *American Journal of Agricultural Economics*, 78(5), 1187-1191.

Koppenberg, M., & Hirsch, S. (2022). Output market power and firm characteristics in dairy processing: Evidence from three EU countries. *Journal of Agricultural Economics*, 73(2), 490-517.

Lee, H., & Van Cayseele, P. (2022). Market power, markup volatility and the role of cooperatives in the food value chain: Evidence from Italy. *European Review of Agricultural Economics*.

Li, S., & Luo, R. (2020). Non-Exclusive Dealing with Retailer Differentiation and Market Penetration. *International Journal of Industrial Organization*, 70, 102591.

Lopez, R., Marchesi, K., & Steinbach, S. (2023). Dollar Store Expansion, Food Retail Competition, and Rural Employment. In ASSA Annual Meeting, January (Vol. 6, p. 8).

Lowrey, J., Richards, T. J., & Hamilton, S. F. (2020). Food Bank Donations and Retail Pricing. Available at SSRN 3743633.

Maican, F., & Orth, M. (2021). Determinants of economies of scope in retail. *International Journal of Industrial Organization*, 75, 102710.

Ralston, K. (2022). *COVID-19 Economic Implications for Agriculture, Food, and Rural America*. USDA ERS Webpage. URL: https://www.ers.usda.gov/covid-19/food-and-consumers/.

Richards, T. J., Hamilton, S. F., & Yonezawa, K. (2018). Retail market power in a shopping basket model of supermarket competition. *Journal of Retailing*, 94(3), 328-342.

Shaked, A., & Sutton, J. (1987). Product differentiation and industrial structure. The *Journal of Industrial Economics*, 131-146.

Shepard, A. (1991). Price discrimination and retail configuration. *Journal of Political Economy*, 99(1), 30-53.

Smith, D. A., & Ocampo, S. (2022). The evolution of US retail concentration. arXiv preprint arXiv:2202.07609.

Statista. (2022). *Walmart's gross profit margin worldwide from fiscal year 2006 to 2022*. Statista Webpage. URL: https://www.statista.com/statistics/269414/gross-profit-margin-of-walmart-worldwide-since-2006/ .

Sutton, J. (1991). Sunk costs and market structure: Price competition, advertising, and the evolution of concentration. MIT press.

Sutton, J. (2007). Market structure: theory and evidence. Handbook of Industrial Organization, 3, 2

Zeballos, E., Dong, X., & Islamaj, E. (2023). A Disaggregated View of Market Concentration in the Food Retail Industry. Amber Waves: The Economics of Food, Farming, Natural Resources, and Rural America, 2023 (Economic Research Report Number (ERR-314)).

Tables and Figures

Table 1. Descriptive statistics.

	Unit	Mean	Std. Dev.	Min	Max
Output					
Revenue	Deflated in 1,000$	13,624	15,314	260	171,600
Inputs					
Labor (L)	Number of employees	64	93	1	992
Capital (K)	Square footage in 1,000s	24	21	1	200
Time	Trend (2004=1)	9.105	4.853	1	17
Retail configuration					
#Stores (Network)	Number	448.721	705.629	1	2723
Scope of services					
Food	Index	65.232	41.394	0	100
Non-food	Index	17.365	28.086	0	100
Store format	Dummy category	4.388	1.263	1	6
Observations	540,444				

Note: Revenue is deflated by its own price index (PPI) for supermarkets and other groceries (NAICS 445110) and warehouse clubs and supercenters (NAICS 452311). Retail types used in the sample include conventional supermarket (benchmark), limited assortment, natural/gourmet foods, warehouse grocery, superette, supercenters, and. Services provided by each establishment are estimated through principal component analysis (PCA) using the binary data whether each store provides wine, beer, a gas station, and a pharmacy.

Table 2. Impact of retail configuration on markups and revenue per square foot.

	(1) $ln(Markups)$	(2) $ln(Revenue/sqft)$
Network Economies		
#Stores (Network)	0.016***	0.017***
	(0.0005)	(0.001)
Scope of Services		
Food	-0.002***	0.002***
	(0.0004)	(0.001)
Non-food	0.016***	0.011***
	(0.0005)	(0.001)
Types		
Limited Assortment	-0.109***	-0.011
	(0.006)	(0.010)
Natural/Gourmet Foods	-0.057***	0.109***
	(0.006)	(0.010)
Warehouse store	-0.148***	-0.071
	(0.030)	(0.079)
Superette	-0.452***	-0.551***
	(0.006)	(0.009)
Supercenter	0.366***	0.303***
	(0.014)	(0.022)
Observations	535,249	535,249
Adj R-Squared	0.9213	0.7475
Store FE	Yes	Yes
Year FE	Yes	Yes
County FE	Yes	Yes

Note: Revenue is deflated by its own price index (PPI) for supermarkets and other groceries (NAICS 445110) and warehouse clubs and supercenters (NAICS 452311). Conventional supermarket is the benchmark in network economies and types. Standard errors in parentheses. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table 3. Markups comparison.

	Obs.	Mean	Std. Dev.	Min	Max
Panel A					
Grocery stores (except supercenters)					
μ_{GMM}	500,108	0.063	0.030	0.006	0.656
Supercenters					
μ_{GMM}	40,336	0.162	0.049	0.010	0.641
Observations	540,444				
Panel B					
Independent stores					
μ_{GMM}	196,423	0.063	0.030	0.006	0.656
Chain stores					
μ_{GMM}	344,021	0.080	0.044	0.008	0.656
Observations	540,444				

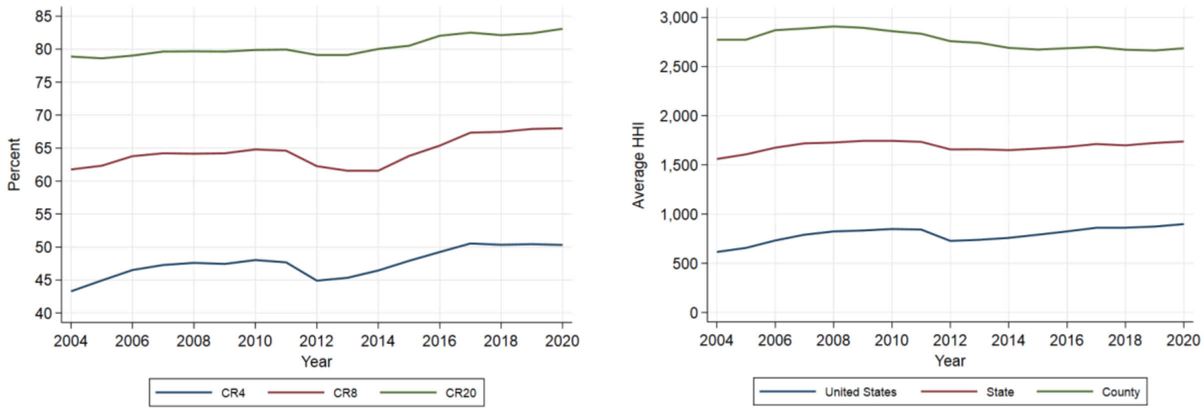
Note: All data samples are defined as grocery category, including supercenters, based on the TDLinx data definition. To compare the markups of supercenters with other grocery stores, a unique subchannel code is used to identify them separately. Another unique code (if the store is an independent store) is applied to identify the independent and chain stores. Estimates of labor elasticities are obtained two-stage GMM.

Table 4. Markups by grocery format.

Estimates	Obs	Mean	Std. Dev.	Min	Max
1 - Limited Assortment					
μ_{GMM}	38,743	0.047	0.023	0.009	0.443
2 - Natural/Gourmet Foods					
μ_{GMM}	28,041	0.083	0.037	0.009	0.465
3 - Warehouse Grocery					
μ_{GMM}	4,404	0.044	0.020	0.009	0.263
4 - Superette					
μ_{GMM}	126,861	0.042	0.015	0.006	0.460
5 - Supermarket-Conventional					
μ_{GMM}	300,259	0.072	0.029	0.006	0.656
6 - Supercenter					
μ_{GMM}	40,336	0.162	0.049	0.010	0.641

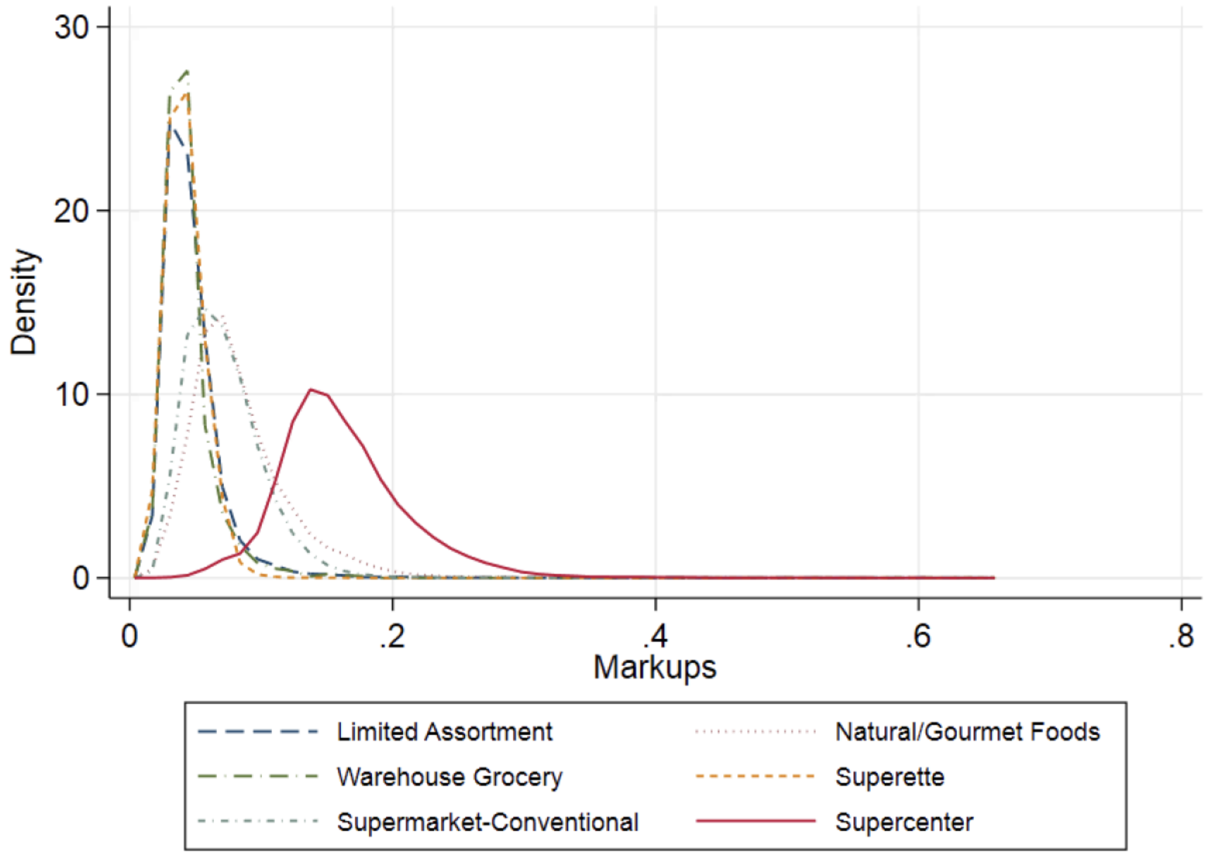
Note: All data samples are defined as grocery category, including supercenters, based on the TDLinx data definition. The markups are estimated in equation (3). To compare the markups at a disaggregated level within the same grocery channel, a unique store-level subchannel code is applied to identify each store type. Labor elasticities to calculate markups are obtained from two-stage GMM.

Figure 1. National Concentration ratios for sales and Herfindahl-Hirschman Index (HHI) for National, State, and County-level markets, 2004-2020



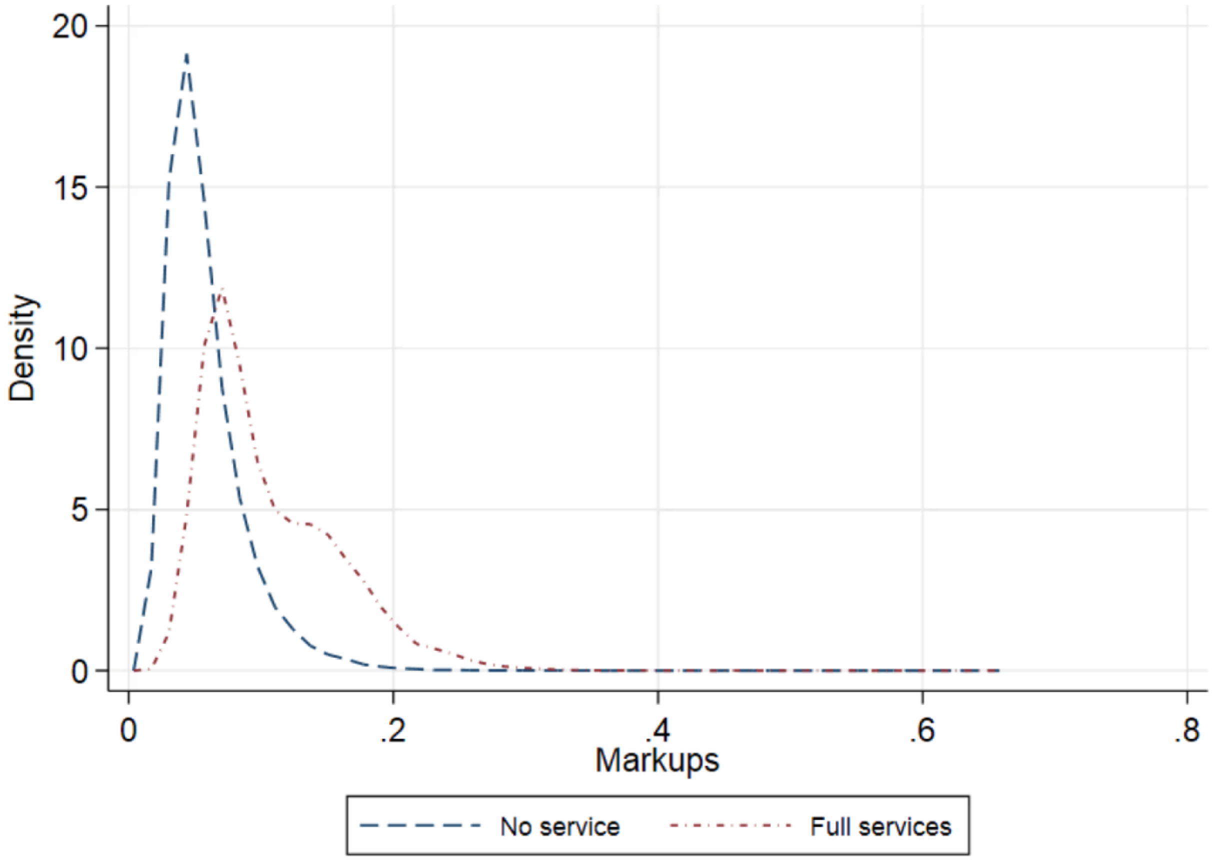
Note: CR4= top4; CR8 = top8; CR20 = top20. The sales are estimated by firm-level using TDLinx data. HHI = Herfindahl-Hirschman Index.

Figure 2. Kernel density estimates of the markups by grocery store formats.



Note: The density is the proportion of cases per unit of markups. The revenue weighted average markups are used from this figure to the end.

Figure 3. Kernel density estimates of the markups by the scope of services.



Note: The scope of services is measured in numbers from 0 to 4 at the establishment level if the store provides non-food services (gas, pharmacy, beer, and wine).

Figure 4. Average markups (revenue weighted) trend by retail format from 2004 to 2020.

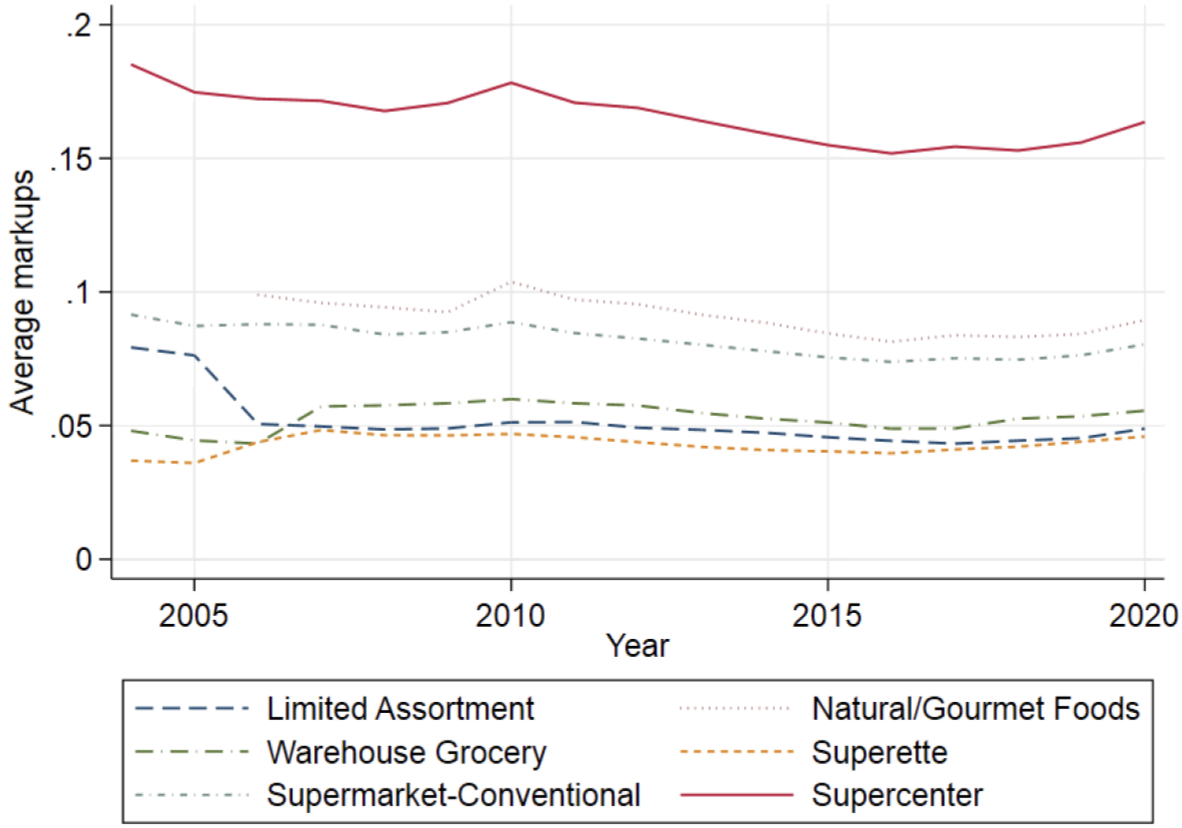


Figure 5. Average markups trend by chain types from 2004-2020.

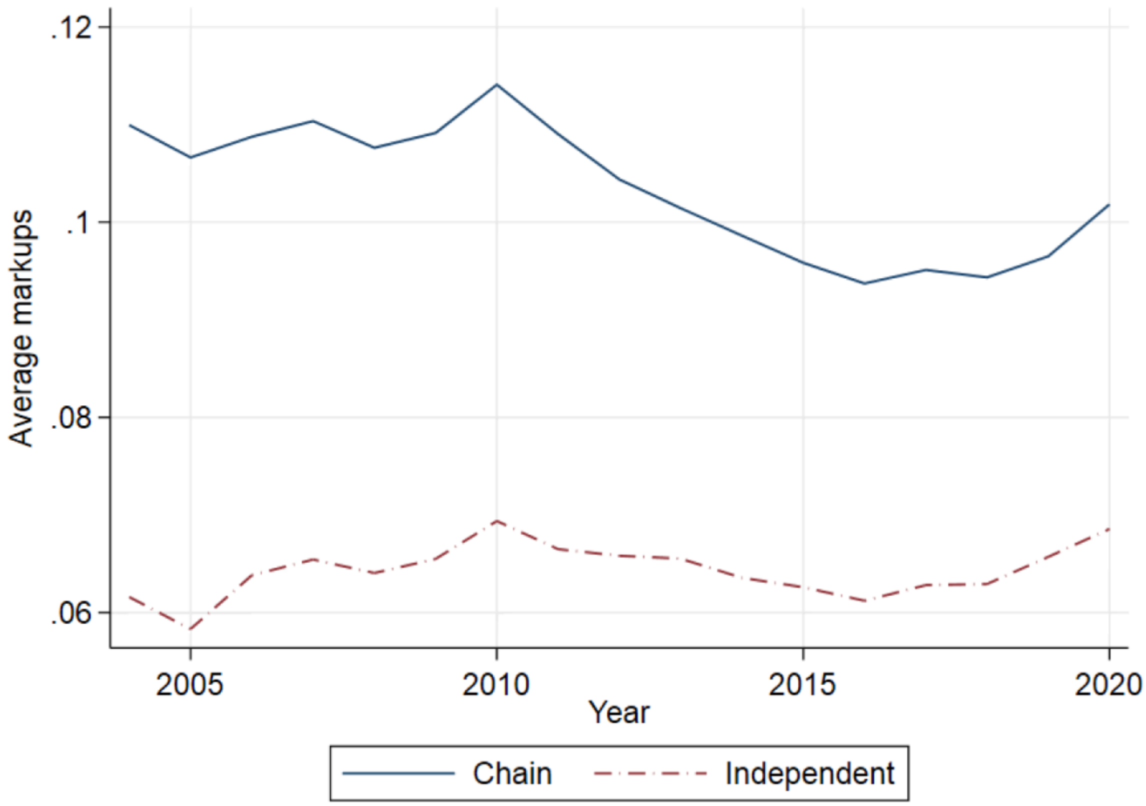


Figure 6. Average markups trend by size from 2004-2020.

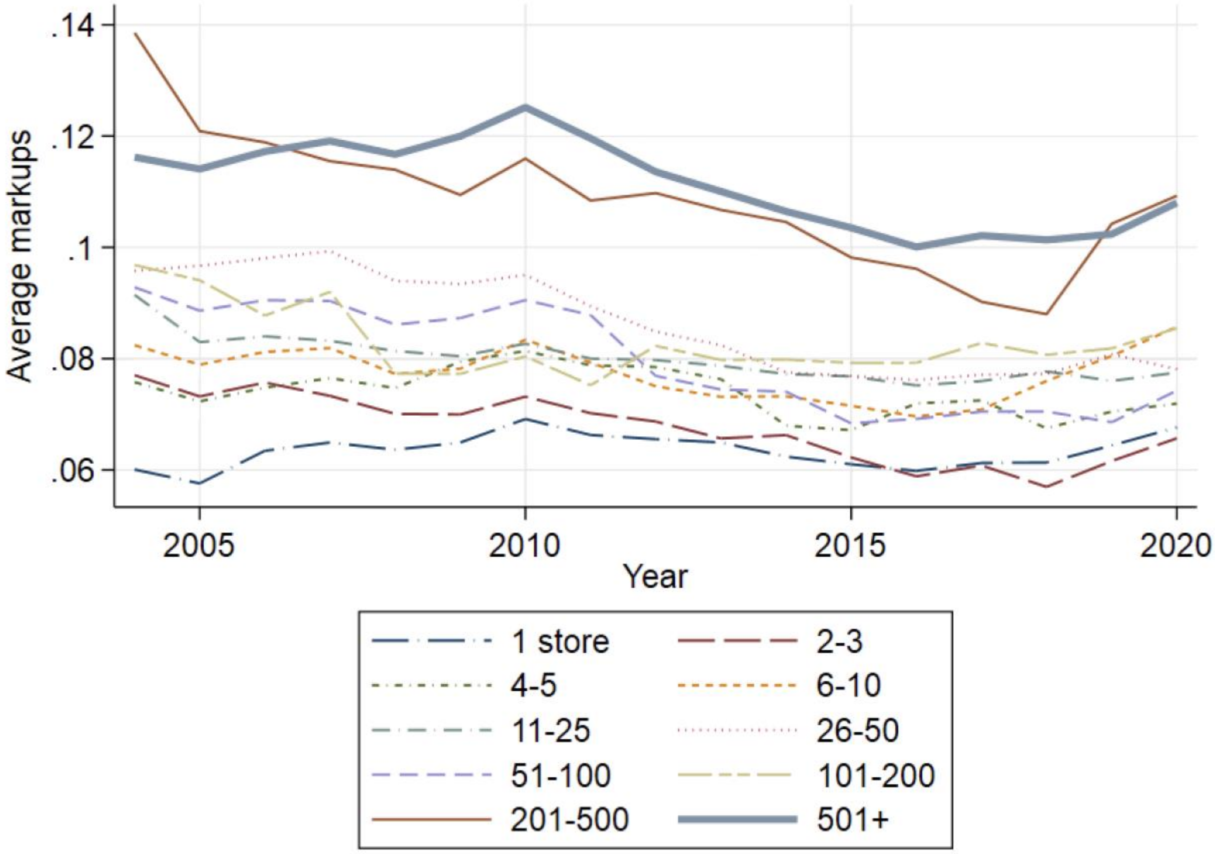
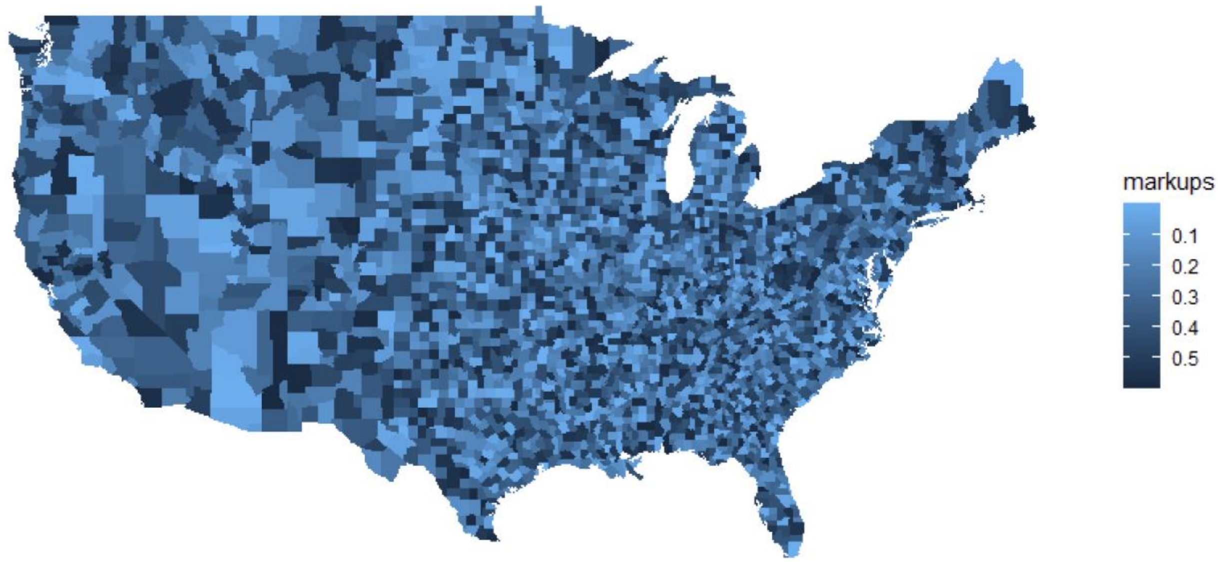
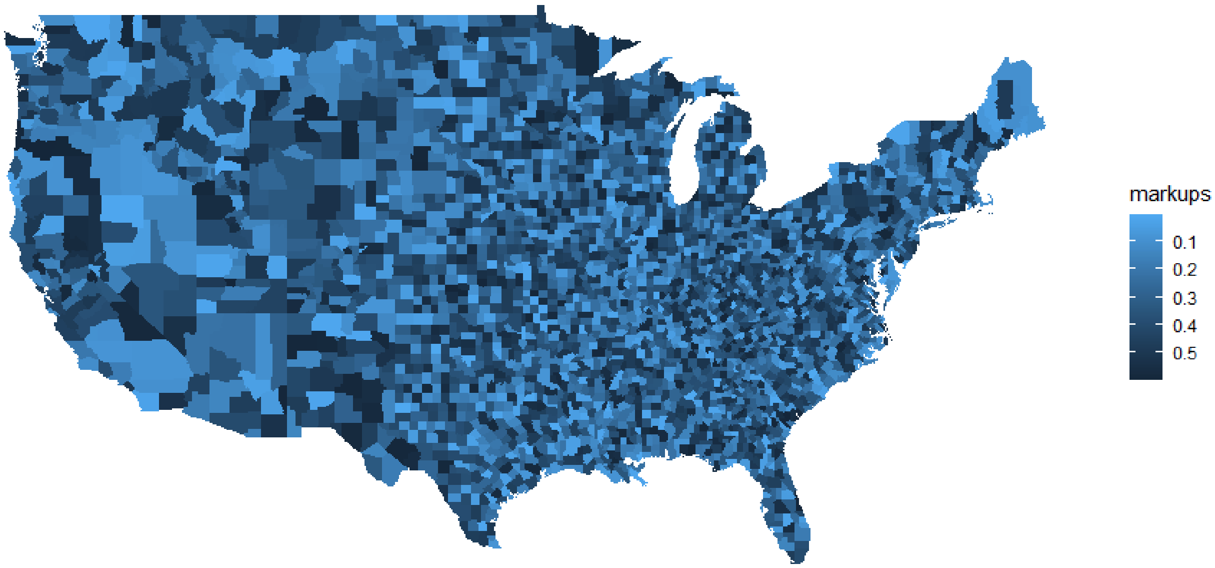


Figure 7. Average markups by county in 2004.



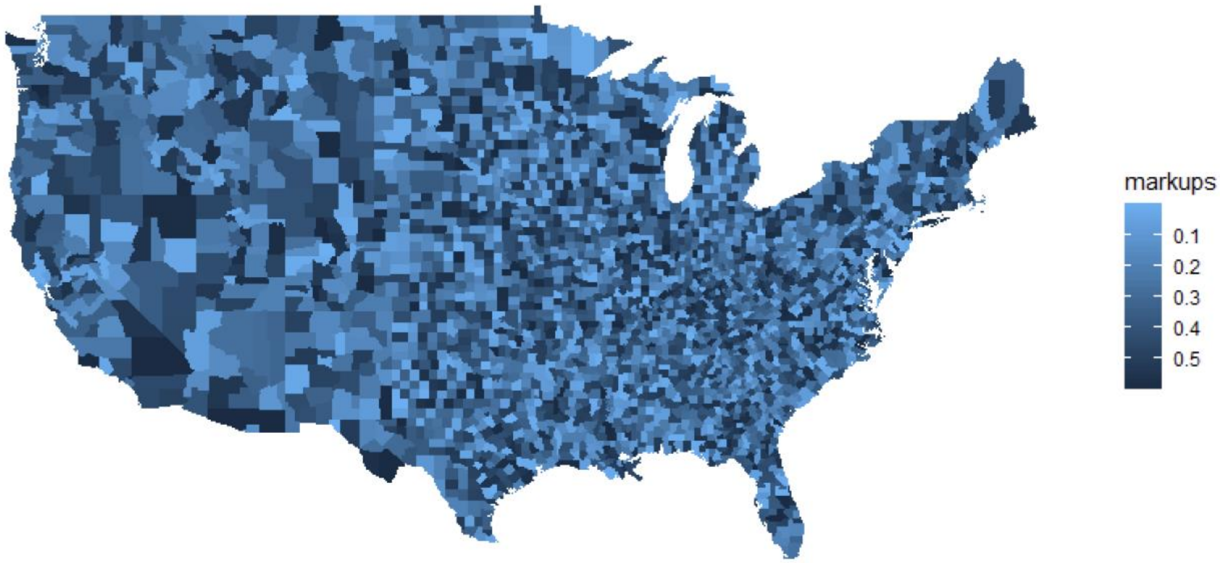
Note: There are 904 counties (28.7 percent of all counties) having markups over 10 percent in 2004.

Figure 8. Average markups by county in 2010.



Note: There are 703 counties (22.3 percent) having markups over 10 percent in 2010.

Figure 9. Average markups by county in 2020.



Note: There are 814 counties (25.9 percent) having markups over 10 percent in 2020.

Appendix

Table A1. Labor expenditure share over revenues of grocery stores.

Year	Obs.	Mean	Std. Dev.	Min.	Max.
2004	29,907	0.108	0.065	0.010	0.669
2005	30,550	0.103	0.062	0.011	0.633
2006	30,464	0.108	0.061	0.011	0.641
2007	31,113	0.109	0.062	0.011	0.966
2008	30,874	0.107	0.060	0.010	0.862
2009	30,876	0.108	0.061	0.011	0.652
2010	31,726	0.114	0.065	0.014	0.763
2011	32,227	0.109	0.063	0.014	0.991
2012	32,498	0.107	0.064	0.014	0.914
2013	32,805	0.105	0.063	0.012	0.899
2014	32,884	0.103	0.061	0.010	0.827
2015	33,019	0.101	0.060	0.009	0.836
2016	33,124	0.099	0.058	0.009	0.855
2017	33,394	0.101	0.059	0.009	0.881
2018	32,651	0.102	0.060	0.009	0.898
2019	31,701	0.105	0.062	0.009	0.943
2020	30,631	0.111	0.065	0.011	0.929

Note: Labor expenditure share over revenues at the establishment-level is used to calculate markups in equation (3). We report annual average of the estimates.

Table A2. Production function estimation results.

Variable	Estimate
lnL	1.182***
	(0.0003)
lnK	-0.118***
	(0.0002)
$(lnL)^2$	-0.074***
	(0.0001)
$(lnK)^2$	-0.015***
	(0.00002)
$(lnL) * (lnK)$	0.096***
	(0.001)
Observations	540,444
Year FE	Yes
Store FE	Yes

Note: Revenue is deflated by its own price index (PPI) for supermarkets and other groceries (NAICS 445110) and warehouse clubs and supercenters (NAICS 452311). Standard errors in parentheses. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

Table A3. Estimated markups.

	Obs.	Mean	Std. Dev.	Min	Max
Panel A					
Grocery stores (except supercenters)					
μ_{OLS}	500,108	0.056	0.027	0.005	0.589
μ_{IV}	500,108	0.057	0.027	0.005	0.595
Supercenters					
μ_{OLS}	40,336	0.145	0.044	0.009	0.575
μ_{IV}	40,336	0.147	0.044	0.009	0.581
Observations	540,444				
Panel B					
Independent stores					
μ_{OLS}	196,423	0.048	0.025	0.005	0.561
μ_{IV}	196,423	0.048	0.025	0.005	0.566
Chain stores					
μ_{OLS}	344,021	0.071	0.040	0.007	0.589
μ_{IV}	344,021	0.072	0.040	0.007	0.595
Observations	540,444				

Note: All data samples are defined as grocery category, including supercenters, based on the TDLinx data definition. To compare the markups of supercenters with other grocery stores, a unique subchannel code is used to identify them separately. Another unique code (if the store is an independent store) is applied to identify the independent and chain stores. Estimates are obtained from OLS and two-stage least square (2SLS). The lag of labor is used as an instrument variable for 2SLS.