Vertical Contracts and Rival Entry: Evidence from the US Yogurt Industry *

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Abstract

Manufacturers often form formal and informal vertical contracts with retailers, enabling them to influence retail prices and product assortment. In particular, the contracts may empower incumbents to effectively counter a rival's attempts to enter the retailer. Using scanner data on the US yogurt market, our empirical evidence suggests that incumbent and dominant yogurt manufacturers strategically deter the entry of an innovating rival, Chobani, which popularized Greek yogurt, likely via vertical contracts with retailers. We estimate a structural model of demand and manufacturer-retailer pricing and assortment. Vertical contracts with an incumbent manufacturer create a trade-off for retailers given limited shelf space: obtaining vertical transfers from incumbents *versus* capturing potential profits from adding rival's products. Counterfactual analysis shows that at least 20% retail chains keep an incumbent brand instead of introducing Chobani products to obtain more profits, implying distorted assortment due to vertical contracts and losses in consumer surplus.

JEL Codes: D43, L13, L42, L66

Keywords: manufacturer-retailer contracts, manufacturer entry, strategic responses

*Researcher(s)' own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the NielsenIQ data are those of the researcher(s) and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

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1 Introduction

In concentrated industries, the entry of innovative competitors often prompts dominant incumbents to react by taking measures to contain their expansion.[1] In retail sectors, where manufacturers rely on intermediaries to reach consumers, it can be particularly difficult for an entrant firm to introduce its products when market concentration reflects systematic collaboration between incumbent manufacturers and retailers to protect their joint profits and limit the presence of competing products. For example, Asker and Bar-Isaac (2014) have shown that the presence of vertical contracts and the anticipation of lower vertical transfers from incumbents to retailers after an upstream entry are sufficient for downstream retailers to internalize the dominant position of an incumbent manufacturer and choose to foreclose the market to potential entrants.

In this paper, we provide evidence of strategic deterrence in retail markets and examine its impacts on retailers' profitability and consumers' welfare by studying the relationship between within-retailer shares of incumbent manufacturers and the introduction of a new product by an innovative entrant in the US yogurt industry. Our study focuses on the rise of Chobani, a new yogurt manufacturer specializing in Greek yogurt. In 2006 Greek yogurt accounted for a mere 0.04% of US yogurt sales. By 2016, the sales share of Greek yogurt achieved a remarkable surge, reaching 50% of the national yogurt market. This growth in the new format was mainly driven by Chobani, which entered the US market in 2008 and quickly captured about 44% - 50% of Greek yogurt sales from 2010 to 2012, significantly shifting the competition landscape among yogurt manufacturers.

The US yogurt industry during the introduction and expansion of Chobani provides a unique setting to understand the effects of market concentration on the foreclosure of innovative rivals. Chobani's growth took place during a period when Dannon and Yoplait dominated traditional (non-Greek) yogurt sales, and continued after Dannon and Yoplait launched their own Greek yogurt products in 2010. Using NielsenIQ dataset, we provide evidence on retail assortment patterns that are consistent with *strategic entry deterrence* by the two incumbent manufacturers. We show that the introduction of Chobani products is delayed in retailers where traditional yogurt sales are dominated by Dannon or Yoplait.

Specifically, a one standard deviation increase in the traditional yogurt sales at the retailer-level Herfindahl-Hirschman Index (HHI) is associated with a 9.9 months delay in Chobani's entry. Conversely, we observe an early adoption of Dannon and Yoplait's Greek yogurt products, which were launched in 2010, at those same retailers. For Dannon in

[1] Recent empirical papers have documented many different strategies that incumbents use to maintain market power under the threat of entrants, for example killer acquisitions (Cunningham et al., 2021), fighting brands (Bourreau et al., 2021), and predatory pricing (Elzinga and Mills, 2009)

particular, a one standard deviation increase in the HHI at retailers where Dannon is the biggest supplier implies an average decrease of 16.9 months in the time difference between the launching date of Dannon's Greek product and Chobani's. These patterns persist even after controlling for local demand and logistic differences, suggesting that the vertical relationships between dominant incumbents and retailers deter Chobani entry.

To better evaluate the impact of these relationships while systematically accounting for demand confounders, we specify and estimate a random coefficient demand model and a pricing model. This approach allows us to simulate retail profits with counterfactual assortment decisions, and quantify the opportunity cost of retailers from delaying the adoption of Chobani.

On the demand side, we tailor the canonical BLP model (Berry et al., 1995) to our setting, by including region-specific non-linear time trends as a proxy for consumers' increasing awareness of Greek yogurt. This enables us to explain a key data pattern: the earlier popularity of Greek yogurt in the Northeast region compared to other regions in the country and Greek yogurt's gradual increase in popularity. The model yields significantly different consumer awareness estimates for Greek yogurt in different regions, implying varying incentives for retailers to carry Chobani and capitalize on its growing demand across different geographical areas. On the supply side, we specify a two-stage game that encompasses wholesale and retail pricing decisions given the assortment. In the US yogurt industry, single-markup models with wholesaler pricing fits the data better compared to a double-markup linear pricing model (Villas-Boas, 2007; Duarte et al., 2021). We hence assume that retail prices are determined using a simple fixed markup rule that is invariant to changes in market structure. As in De Loecker and Scott (2022), we recover the retail markups using an equivalence condition between the demand and the production function approach for the estimation of average manufacturer markups.

Using the demand and marginal cost parameters estimates, we simulate variable profit of a retailer if a non-staple brand from the dominant incumbent is swapped with Chobani. Our results show that 20% of the product swaps generate positive counterfactual profit for retailers, indicating that the retailer could have increased profits if it adopted Chobani in that DMA-quarter instead of a Dannon/Yoplait brand. Furthermore, while demand conditions would explain assortment choices for Yoplait brands at most retailers, for a significant number of retailers where Dannon is the dominant supplier, neither logistics nor demand conditions could rationalize their assortment choices during the rise of Chobani. Moreover, this distorted assortment condition is attenuated when Dannon is the dominant incumbent.

A plausible explanation for our results is that the presence of formal and informal vertical contracts between Dannon and the retailers could have played a role in the assortment decisions and created a barrier to the dissemination of Chobani products.[2] Previous work has shown that Dannon and Yoplait's dominance is linked to their long-term vertical contracts with retailers, such as category captaincy (Viswanathan et al., 2020; Zhu, 2022) and slotting allowances (Hristakeva, 2022).[3] Moreover, the delay in Chobani's entry in retailers could benefit the launch of the incumbents' own Greek products because, as our findings indicate, Greek yogurt significantly steals market share from traditional yogurt and consumers exhibit strong brand loyalty in their yogurt choices.

The strategic deterrence of innovative products can potentially harm consumers by delaying the availability of products that are better suited to their needs. Hence, regulation of vertical contracts could have improved welfare by offering consumers earlier access to innovative products like Greek yogurt.

1.1 Related Literature

Our paper contributes to the literature on vertical relationships and incumbent responses to rivals. In addition to the long history of theoretical analysis of vertical contracts between manufacturers and retailers (Tirole, 1988), there is a growing empirical literature on how vertical relations affect terms of trade, as well as the assortment choice of retailers and welfare distribution. Vertical relationships can help mitigate downstream moral hazard and optimize assortment, generating efficiency gains, while they may also cause efficiency loss due to the foreclosure effect on competing products.

For instance, vertical bundling or full-line forcing directly affects retail assortment and can lead to distorted product offerings (Ho et al., 2012; Crawford et al., 2018). An example is discussed in Conlon and Mortimer (2021) for a dominant candy manufacturer that offers a lump sum rebate to a retailer that owns vending machines only if certain quantity targets and product stocking requirements are satisfied. Using an experimental approach, they show that these vertical rebates facilitate the manufacturer to foreclose its main competitor's best-selling vending machine products (i.e., upstream foreclosure), despite the fact that retailers could earn higher profits by carrying those products. The distorted assortment results in lower consumer surplus, net the efficiency gains from eliminating downstream moral hazard.

The closest paper to ours is Luo (2024). The author examines how the manufacturer-

[2] Informal vertical contracts rely upon mutual trust and repeated interactions, but do not have legal enforcement, e.g., successive implementation of the suggested retail price. Examples of formal vertical contracts are slotting fees, rebates, and category captaincy.

[3] Category captaincy arrangement is a long-term contract where retailers delegate product assortment, shelf placement, and pricing decisions of an entire product category to a leading manufacturer within that category. Slotting allowances refer to manufacturers' upfront payments, independent of the retailers' quantity purchases, to secure scarce shelf space (Marx and Shaffer, 2007).

retailer relationships in the beer segment affect the distribution of new products in the cider segment. She shows that the retailer offers preferential assortment to leading manufacturers by increasing the availability of their new products on the shelf. Notably, unlike our setting, there is no new manufacturer entry, instead, the focus is on the introduction of new products developed by the incumbents.

Our paper also contributes to an empirical literature on the effects of vertical contracts in the US yogurt industry Villas-Boas, 2007. Hristakeva (2022) provides evidence that vendor payments by yogurt manufacturers constitute a large share of the retailer's variable profits and incentivize retailers to distort product assortment. Zhu (2022) provides evidence the relationship between Dannon and Yoplait with retailers in the traditional yogurt segment is marked by category captaincy contracts.

There is also extensive literature that discusses the response of incumbents facing entrants. Incumbents can react to the threat or actual entry of competitors via several channels such as building excess capacity and intensifying advertising efforts. Facing the threat of entry, incumbents often pursue strategic entry deterrence, in order to protect their profits once actual entry alters the competitive landscape (Tirole, 1988). Empirical evidence has been found for responding behavior of incumbents facing threats of entry. For example, Goolsbee and Syverson (2008) study how incumbents respond to the threat of entry by significantly lowering prices in the US airline industry. Pharmaceutical incumbents make strategic investments to deter generic entry before their patents expire Ellison and Ellison (2011).

After the entry takes place, incumbents may still adjust prices and also change non-price attributes in response to the intensified competition caused by entrants. Matsa (2011) documents that retailers reduce their stock-out rates (i.e., improve the quality of service) after the entry of Walmart. Using data on the French mobile telecommunication industry, Bourreau et al. (2021) show that incumbent oligopolies fail to sustain their tacit semi-collusion in the pre-entry period, and each develops a cheap fighting brand to compete against the entrant carrier that offers a cheaper alternative cellphone package.

Our work bridges the research strands by demonstrating that vertical arrangements may enable incumbents to strategically deter a rival manufacturer, leading to substantial impacts on consumer welfare. The insight is that the incumbent responses represent another channel through which vertical contracts affect product availability in the retail market.

More broadly, our work contributes to the literature on *early entry advantage* and market share persistence. For instance, Bronnenberg et al. (2009) document persistent larger shares for brands in cities closer to the brand's original entry than in cities farther away from its origin. Schmalensee (1982) provides theoretical rationale for the persistent advantage of pioneering brands based on consumer learning. Our work adds to this strand of research by highlighting another avenue for pioneer brands to maintain their market dominance, which is to strategically deter the entry of competitors through vertical contracts with retailers.

2 Data Source and Industry Background

We first report the source of data used for the empirical analysis and then discuss the industry background for our study. Key features of the US yogurt market during the period of interest are highlighted.

2.1 Data Source

Our main data source on the US yogurt industry is the NielsenIQ Retail Scanner (RMS) data, provided through the Kilts Center at the University of Chicago. The dataset records weekly sales, revenue, and product details for more than 30,000 retail stores in the US, including universal product code (UPC), product line (e.g. *Dannon Light and Fit*), parent manufacturer (e.g. *Dannon*), and product attributes like size, organic, Greek, and flavor.

The full sample covers 205 Designated Market Area (DMA) in 49 states in the US. Our sample spans from the first quarter of 2006 to the fourth quarter of 2016. We focus on two major retail formats, grocery stores, and mass merchandisers. Other formats of retailing, including convenience stores, dollar stores, gas station stores, and liquor stores, might have very different pricing and assortment decision strategies. We hence exclude them from our empirical analysis. [4]

2.2 The Traditional Yogurt Market

Before the rise of Chobani in 2008, the traditional yogurt market in the US was dominated by two manufacturers, Dannon and Yoplait, that controlled about 70% of the national sales of yogurt. Table 1 reports the nation-level market shares of Dannon and Yoplait in the traditional yogurt and Greek sub-markets by year. Nationally, the share of Yoplait in the traditional yogurt segment is 5 to 15 percentage points larger than that of Dannon over the years. The share of the *big two* are far larger than the share of the third largest manufacturer in a year.

The high nation-level market concentration is accompanied with a large, yet heterogeneous sales shares of Dannon and Yoplait across retailers before the entry of Chobani. Some

[4] In the original NielsenIQ sample, grocery stores on average contribute 91.7% and mass merchandisers contribute 7.8% of the sample's total yogurt revenue in a year.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
National yogurt sales (index)	100	104	111	115	125	137	142	152	155	158	156
Traditional yogurt sales share(%)	100	100	98	95	87	74	60	49	44	43	44
Dannon	29	31	30	31	34	34	32	28	29	30	33
Yoplait	41	41	43	43	42	42	44	44	45	42	37
Third largest manuf.	3	3	3	3	3	3	4	4	4	6	8
Greek yogurt sales share(%)	0	0	2	5	13	26	40	51	56	57	56
Chobani	0	0	12	32	44	50	46	37	32	31	35
Dannon	0	0	0	0	3	9	17	26	29	29	29
Yoplait	0	0	0	0	6	5	6	8	10	11	7

Note: Authors' calculation based on the full yogurt dataset of NielsenIQ. Only stores that are observed in every year during the period are included. *Third largest manufacturer* refers to the national brand that is the third largest in the traditional yogurt market in a given year. This manufacturer is Breyers in 2006, Dean Foods 2007-2010, Healthy Foods 2011-2013, and Noosa 2014-2016. The aggregate sales share of private brands in the traditional yogurt market ranges from 12% to 16%, trending down over time.

Table 1: Market Share by Manufacturer and Year

retail chains are characterized by the overwhelming dominance of either Dannon or Yoplait and hence have HHI greater than 0.50. Others demonstrate a more evenly distributed sales between the two leading manufacturers, with relatively low HHI.

Figure 1 plots Dannon's within-chain yearly sale share against Yoplait's within-chain share during 2006 and 2007 across retail chains. The dots are nearly perpendicular to the 45-degree line, signifying a significant asymmetry between the two manufacturers' shares. In some chains, one manufacturer plays a much more dominant role than the other.

A potential reason for the heterogeneity in sales shares between Dannon and Yoplait at the chain-level could be the prevalence of vertical contracts. Vertical contracts can contribute to large manufacturers' persistent dominance within retail chains (Hristakeva, 2022; Luo, 2024). Some vertical contracts, such as category captaincy, further give large manufacturers the ability to influence retailers' assortment and pricing decisions (Zhu, 2022).

2.3 The Rise of Greek Yogurt

Greek yogurt is not a uniquely defined product with a federal standard of identity. It differs from traditional yogurt in its "high protein content and thicker consistency." Greek yogurt is produced using technologies different from that used for producing traditional yogurt. Basically, to produce Greek yogurt, it is necessary to incorporate concentrated milk protein into the milk-fat, either directly or by using the traditional straining process.

As Table 1 shows, the aggregate share of Greek yogurt out of yogurt sales was minimal before 2008, but achieved an 2500%+ growth from 2007 to 2016 and has commanded more than 50% of the US yogurt revenue since 2013. The first Greek yogurt was, in fact, introduced by a manufacturer called Fage that was active in the US market back in 2005. It was, however,

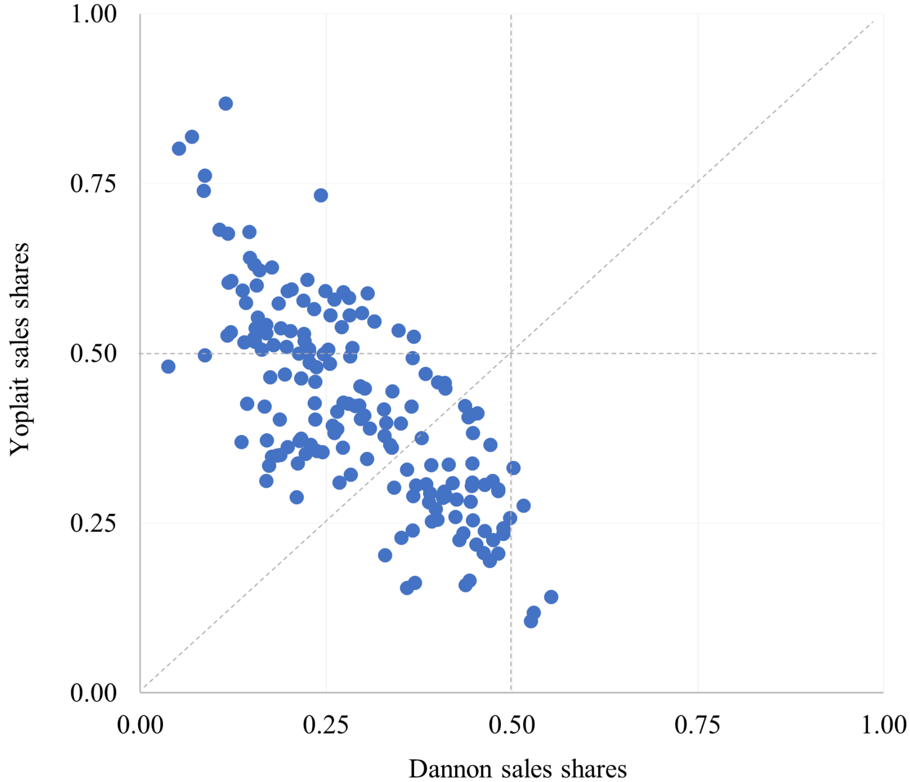


Figure 1: Non-Greek Yogurt Shares of Dannon and Yoplait across Retailers 2006-2007
Note: Authors' calculation based on the trimmed sample, focusing on non-Greek (traditional) yogurt products. A retail chain is defined by the retailer identifier, parent company identifier, and format.

only after Chobani launched its Greek yogurt line in 2008 that Greek yogurt started gaining vast popularity. Sales of Chobani's products had an impressive increase over the next five years. By 2012, Chobani became a major player in the US yogurt industry.[5]

Chobani has consistently focused on producing Greek yogurt and played a leading role in expanding its Greek product lines. The success of Chobani soon caught the attention of the leading incumbent manufacturers, Dannon and Yoplait, prompting them to launch their own Greek yogurt products starting from January 2010.[6] Dannon kept pace with Chobani in introducing Greek yogurt products and managed to sustain a significant share within the Greek segment. Yoplait, however, was not able to catch up with Chobani or Dannon, echoing the low sales shares of Greek Yoplait in Table 1.[7]

[5]Figure A1 provides more illustration on the distribution of Greek and traditional yogurt sales across manufacturers and by year.

[6]The Dannon Group owned brands Brown Cow and Stonyfield that sold some Greek products in 2008 and 2009. We do not consider those products as we try to focus on the mainstream Dannon products for the analysis.

[7]One explanation for why Dannon sustained a high share in the Greek segment and Yoplait not, is that Dannon Greek yogurt production employs traditional methods using cultures imported from Greece, resulting in a thicker, creamier texture. In contrast, Yoplait's production focuses more on mass production

2.4 Effects of Greek Yogurt Entry on Traditional Yogurt Sales

Table 1 shows that over the period of 2006 to 2016, the total yogurt sales in the US increased by nearly 56%. The rise of Greek yogurt may contribute to the total growth in yogurt sales, which indicates a considerable *market expansion* effect. On the other hand, we see that traditional yogurt lost some of its market share to Greek yogurt over time, which indicates a *business stealing effect*.

We examine the net market expansion or business stealing effect of Greek yogurt on non-Greek yogurt using the RMS data. Following Davis (2006), we estimate Equation 1 to quantify the net effect of selling Greek yogurt.

$$vol^{NG}_{smt} = \beta_0 + \beta_1 \mathbf{1}\{UPC^{G}_{smt} > 0\} + \beta_2 UPC^{NG}_{smt} + \gamma_{r(s)} + \eta_{m,q(t)} + \epsilon_{smt}, \tag{1}$$

where the dependent variable is the dollar or volume sales of non-Greek yogurt at the store(s)-DMA(m)-quarter(t) level. The indicator, $\mathbf{1}\{UPC^{G}_{smt} > 0\}$, equals one if the number of Greek yogurt UPCs carried by a store in a quarter is positive. We control for the number of traditional yogurt UPCs carried by the store (UPC^{NG}_{smt}) as a proxy for the store size, as well as the retailer ($\gamma_{r(s)}$) and market-quarter fixed effects ($\eta_{m,q(t)}$). The coefficient of interest is β_1; a positive β_1 indicates a net market expansion effect, and a negative β_1 indicates a net business stealing effect.

Table 2 reports the results. Columns (1) and (2) indicate a net business stealing effect of Greek yogurt on traditional yogurt sales. On average, selling Greek yogurt products reduces the dollar sales of non-Greek yogurt by 14.4% relative to the mean of store-level non-Greek sales and reduces the volume sales of non-Greek yogurt by 13.5% relative to the mean. In addition, we estimate Equation 1, with the number of Greek UPCs in place of the Greek indicator. Columns (3) and (4) show that adding every 10 additional Greek UPCs has a negative effect on non-Greek revenue, equivalent to 8.7% of the average, as well as a negative impact on the non-Greek volume sales, amounting to 8.1% of the mean.

2.5 Consumer Purchase Patterns

HMS data reveal a few important patterns regarding consumer purchase behavior. We focus on households that are surveyed every year from 2007 to 2015 in this subsection. Relying on households in other window of time does not affect the patterns in significant ways.

techniques using stabilizers like gelatin, yielding a thinner texture than Chobani and Dannon.

	Sales ($1,000) (1)	Vol. Sales (1,000 OZ) (2)	Sales ($1,000) (3)	Vol. Sales (1,000 OZ) (4)
Store w/ Greek (1, yes)	-4.79*** (1.65)	-40.10*** (15.01)		
No. Greek UPCs			-0.29*** (0.07)	-2.40*** (0.61)
No. traditional UPCs	1.19*** (0.10)	9.78*** (0.90)	1.18*** (0.12)	9.65*** (1.06)
Retail FEs	Y	Y	Y	Y
Market-quarter FEs	Y	Y	Y	Y
No. observations	339,208	339,208	339,208	339,208
R^2	0.66	0.66	0.68	0.68

Note: * p-value< 10%, ** p-value< 5%, *** p-value< 1%. Standard errors are clustered at the retailer level and reported in parentheses. *OZ* means ounces, and *FEs* means fixed effects.

Table 2: Market Expansion *versus* Business Stealing Effects of Greek Yogurt

Retail concentration On average, more than 90% of a household's yogurt expenditure is concentrated within a single retail chain in a DMA-quarter. Additionally, given that yogurt expenditure only accounts for 1.3% of the household's food expenditure in a quarter (2.4% if conditional on households that purchase yogurt), it is unlikely that the consumer choice of retail store, therefore, is solely determined by yogurt assortment or prices. On the retail side, retailers compete in a complex way to attract consumers to their stores and then set assortment and prices in each category. Given that yogurt expenditure is such a small share of a consumer's food budget, it is unlikely that retailers attract consumers relying heavily on their yogurt assortment or pricing strategies, either.

Manufacturer concentration Every year, an average household makes 11 yogurt purchases in grocery or mass merchandiser stores. There is roughly 1 purchase per month, on average. Each month, a median household buys four different yogurt UPCs. These yogurt products are, on average, produced by 1.5 manufacturers. In fact, more than 65% of the households buy products made by only one manufacturer. Buying from more than 3 manufacturers within a month is rare.

State dependence in manufacturer choices State dependence is widely observed in branded food purchases (Dubé et al., 2010). To examine state dependence in yogurt consumption, we compare the unconditional and conditional probabilities of repurchase for Chobani, Dannon, and Yoplait products (see subsection E for details). Table 3 shows that the repurchase probabilities are higher than the marginal probabilities of a purchase for all manufacturers. Conditional on the previous purchase being initiated by a price discount or an assortment change, the repurchase probabilities still significantly exceed the marginal probability of purchase. This suggests that high repurchase rates are not simply the result of unobserved brand preferences, but driven by state dependence.

Brand	Purchase	Repurchase		
		all	price discounts	assortment change
Chobani	0.166	0.660	0.589	0.500
Dannon	0.230	0.656	0.591	0.468
Yoplait	0.468	0.805	0.777	0.564

Table 3: Purchase and Repurchase Probabilities

Experience with Greek yogurt Before 2008, very few consumers have experience with Greek products offered by niche-market manufacturers like Fage. Since the rise of Chobani, a growing number of consumers have bought Greek yogurt. HMS data suggest, Chobani Greek is the first Greek yogurt that 27.3% of the households ever buy, Dannon Greek for 22.6%, and Yoplait Greek for 25.1%. The other quarter of households first taste Greek yogurt from Fage, Greek Gods, private brands, etc.

Households tend to stay with the first Greek manufacturer they experience, especially if the manufacturer is Chobani. Specifically, if a household buys its first Greek product from Chobani, the chance that it continues to buy Chobani the second time is 53.2%. If it buys Greek yogurt from Dannon (Yoplait) first, the chance that it stays with Dannon (Yoplait) is 50.3% (47.7%). If the household's first two purchase of Greek yogurt are both from a manufacturer, the chance that it stays with the manufacturer on the third time is 69.5%, 65.8%, and 57.7% for Chobani, Dannon, and Yoplait, respectively.

3 Chobani Entry Patterns

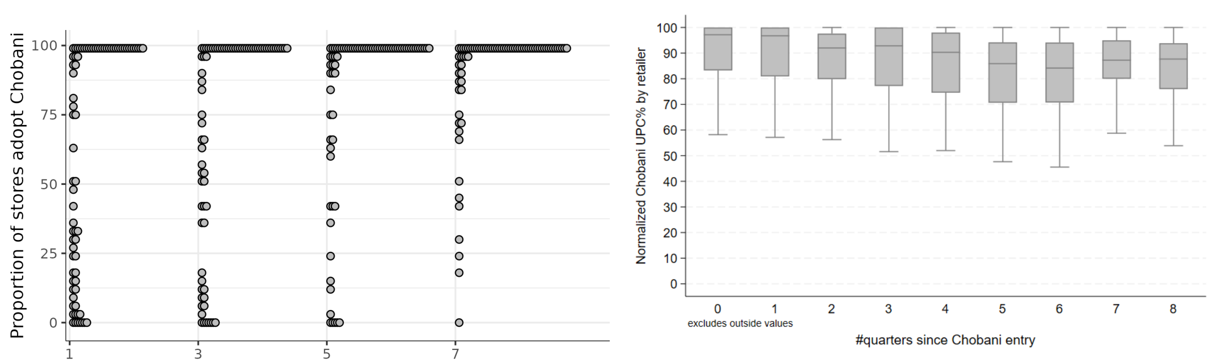
In this section, we document the main patterns of Chobani's entry across retailers.[8] The key takeaways are that, similar to other retail categories, the entry of Chobani is largely a retailer-level decision rather than a store- or market-level one. Also, the timing of Chobani's entry differs greatly across retail chains even after accounting for possible logistical barriers from supplying at different US regions and local demand heterogeneity. Furthermore, a later

[8]We employ a trimmed sample of product-manufacturer-retailer-DMA-quarter-year observations to examine the Chobani entry patterns across retailers and DMAs. In section 4 we describe how we trimmed the NielsenIQ data to create this sample.

adoption of Chobani by a retailer is correlated with a dominant position of either Dannon or Yoplait in the retailer's traditional yogurt segment prior to Chobani's entry.

Pattern 1. *Once a retailer starts selling Chobani, it offers the product in nearly all its stores, with each store carrying almost the same set of Chobani UPCs.*

Once a retailer decides to carry Chobani products, it distributes Chobani to all its stores in a relatively short window. This is illustrated in Figure 2. Panel (a) shows the percentages of stores within a retailer that offer Chobani's Greek yogurt products, broken down by each quarter since Chobani first entered that retailer. In the first quarter following Chobani's entry (i.e., quarter 1 in the figure), most retail chains already show a high adoption rate near 100% of their stores. Although some chains sell Chobani in only a small share of stores in the first quarter post-entry, the percentage rapidly increases toward full adoption. This pattern suggests that the adoption of Chobani is determined at the retail chain level, with partial adoption within chains likely due to logistical difficulties rather than demand-related factors.[9]



(a) Percentage of Stores Selling Chobani (b) Stores Selling Normalized % Chobani UPCs

Figure 2: Uniformity within Retailer in Chobani Greek Yogurt Adoption.

Note: Authors' creation based on the trimmed sample. The horizontal axis indicates the quarter relative to the entry quarter of a brand's Greek yogurt products for a retailer. For instance, if Chobani enters retailer 1 in quarter 1 of 2008, then 2008 quarter 1 is labeled "0" in the horizontal axis, 2008 quarter 2 is labeled "1". In both panels, the middle bar in the box indicates median, the upper bar of the box 75 percentile, and the lower bar of the box 25 percentile, the upper (lower) bar is the upper (lower) adjacent value. The adjacent values are located in a distance of 1.5 times the inter-quartile range from the nearest end of the box.

Panel (b) of Figure 2 plots the normalized share of Chobani's UPCs carried by stores within chain during the first year of adoption. To calculate this share, we first identify the largest number of Chobani's UPCs carried by a store and year-quarter t for retailer r, denoted

[9] Panel (b) Figure A6 illustrates the adoption of Chobani by *slow adopters*, referring to retailers who adopted Chobani in less than 25% of their stores during the initial two quarters of selling Chobani. Notably, these slow adopters do not exhibit any geographical clustering in their few stores carrying Chobani; instead, they are spatially dispersed. This again confirms that demand-related factors do not play a primary role in entry decisions.

as $C_{rt}^{UPC,max}$. Then for a store s in DMA m and within retailer r, we calculate its number of Chobani's UPCs carried, denoted as C_{srmt}^{UPC}, in the same period. The normalized share of UPCs carried by the store is then $\frac{C^{UPC}{}_{srmt}}{C_{rt}^{UPC,max}} \times 100\%$. The figure indicates that once a retailer adopts Chobani, most stores carried a consistent depth of Chobani's product assortment within the first two years of adoption. The patterns shown in Figure 2 holds for both local retailers and retailers operating across multiple regions in the US (see Figure A5), providing further evidence that Chobani's entry is a retailer-level decision.

Pattern 2. *Chobani entry time varies significantly across retailers, but little across geographical areas.*

Chobani's roll-out began in the Northeast and South, particularly in New York State where its first plant was established. By the second quarter of 2008, Chobani's products were available at retailers in the Midwest, and they had reached retailers in the West region by the first quarter of 2009 Figure A4. The rapid geographical reach suggests that Chobani did not encounter significant difficulties in distributing its products nationwide.

Despite limited variation in the entry time of Chobani across regions, the entry time varies considerably across retail chains within a region. We decompose the variance of Chobani's entry time into retailer fixed effects and DMA fixed effects. The results below show that about 70.1% of the variance in entry time can be attributed to the retailer fixed effects, whereas DMA fixed effects only account for 6.7% of the variance. This suggests that the timing of Chobani's entry is predominantly determined by retailer heterogeneity rather than local demand factors or the proximity to its plants.

$$\underbrace{Var(AdoptionTime)}_{100\%} = \underbrace{Var(Retailer_{FE})}_{70.1\%} + \underbrace{Var(DMA_{FE})}_{6.7\%} + \underbrace{2Cov}_{4.2\%} + \underbrace{Var(e)}_{19.0\%}$$

There are three potential reasons that can explain this large variation in Chobani entry time across retailers: (i) Logistics. The regions where the two largest manufacturers dominate may also present logistical challenges for shipping Chobani products (e.g., limitations in distributor shipping capacity due to incumbents' dominance). (ii) Consumer preferences. Retailers may find it unprofitable to introduce Chobani products in markets where consumers strongly prefer Dannon or Yoplait, given the significant market shares of these brands. (iii) Retailer-manufacturer vertical relationships. Drawing on the theory by Asker and Bar-Isaac (2014) and the significant role of vertical contracts in the yogurt industry (Hristakeva, 2022; Zhu, 2022), vertical contracts may enable incumbent manufacturers to transfer excess profits resulting from their market power to retailers in exchange for larger shelf space. If the entry of Chobani could reduce the profits of dominant incumbents and thus the vertical transfers, for instance, retailers may opt to delay the entry of Chobani to avoid reducing these transfers.

To evaluate the third explanation, we examine the persistence of the correlation between entry delay and within-retailer concentration after partially controlling for logistic and demand factors. Specifically, we run the following regression:

$$Entry_r^C = \alpha + \beta HHI_r^{pre2008} + \eta X_r + \gamma_{region(r)} + \epsilon_r. \tag{2}$$

where $Entry_r^C$ refers to Chobani's entry time delay within a retailer r, which is calculated as the difference between the month the retailer started carrying Chobani products and January 2008, the month when Chobani first launched. $HHI_r^{pre2008}$ is the pre-2008 HHI of the traditional yogurt segment, X_r are demographic characteristics (i.e., income, number of children, age) of consumers that shop at that retailer and $\gamma_{region(r)}$ are region fixed effects. The demographic information comes from NielsenIQ Home Scanner Dataset (HMS). Assuming that observed demographics reflect differences in yogurt taste across retailers and that logistical challenges primarily involve finding distributors in the region, these control variables partly control for the other explanations mentioned above.

The results are reported in Table 4. Column (1) shows that for a given retailer, the Chobani's entry time delay is positively correlated with the average HHI for the sales of traditional yogurt during the years 2006 and 2007. This positive correlation also exists, when we use Concentration Ratio 1 (i.e., CR1 or the sales share of the largest manufacturer) or the retail-level share difference between Dannon and Yoplait during the pre-Chobani period. Column (2) shows that the positive correlation between HHI and entry delay persists after controlling for logistic and demand factors. Furthermore, by including a separate slope for retailers where Dannon or Yoplait is the dominant manufacturer, respectively, we demonstrate in Column (3) that the effect remains in similar magnitudes regardless of which manufacturer dominates. These results suggest the third pattern:

Pattern 3. *Chobani's entry delay in a retailer is positively correlated with the retailer's sales concentration in the traditional yogurt segment before 2008.*

Different from Chobani's entry pattern, the adoption of Dannon and Yoplait Greek products by the majority retailers was done by the third quarter of 2010, or within half of a year since Dannon and Yoplait Greek products became available (see Figure A3 and Figure A4). We extend the analysis of Equation 2 to the adoption timing of Dannon and Yoplait Greek products. In Column (4) of Table 4, we regress the entry time of Dannon or Yoplait Greek products on HHI calculated from Dannon or Yoplait traditional yogurt sales. The results indicate that for Dannon, there is a negative correlation between its dominance before 2008

	Adoption of Greek products					
	C	C	C	D/Y	C-D/Y	1{C-D/Y>0}
	(1)	(2)	(3)	(4)	(5)	(6)
HHI	9.89***	7.87***				
	(1.63)	(1.69)				
Yoplait: HHI			8.14***	2.61	2.84	0.17
			(2.16)	(2.20)	(3.24)	(0.10)
Dannon: HHI			6.79***	−9.17**	16.86**	0.41**
			(1.55)	(4.59)	(6.88)	(0.17)
Number of stores	No	Yes	Yes	Yes	Yes	Yes
Region FE	No	Yes	Yes	No	Yes	Yes
Demographic controls	No	Yes	Yes	Yes	Yes	Yes
Observations	88	87	87	83	83	83
R^2	0.32	0.60	0.60	0.22	0.54	0.42

Note: * p-value< 10%, ** p-value< 5%, *** p-value< 1%. Retailers in DMAs where Chobani enters first in the corresponding region are excluded from the regressions. Standard errors are clustered at the retailer level and in parentheses. *No.* means the number of. *Retailer controls* include the average number of stores belonging to the retailer in the DMA during the pre-Chobani period and the number of regions that the retail chain operates. Demographic variables include the average income, presence of kids, and the age of household head among households that visit a retailer for at least once during a period.

Table 4: Chobani Entry and Incumbent Dominance

and the adoption of its Greek yogurt products after January 2010, namely, Dannon's Greek yogurt was introduced earlier in retailers where its traditional yogurt sales were more concentrated. Column (5) further shows that the entry time difference between Chobani and Dannon Greek products (a negative $C - D$ means Chobani Greek is available before Dannon Greek) narrows the more dominant Dannon is in traditional yogurt sales before 2008. Indeed, Dannon is more likely to sell Greek products before Chobani the more dominant it is in traditional yogurt sales before 2008. However, we do not such effects for Yoplait Greek products.

Taken together, the descriptive evidence shows that the timing of Chobani entry is largely determined at the retailer level and that entry is significantly delayed in retailers where traditional yogurt sales were previously dominated by Dannon or Yoplait. If this delay is driven by incumbents' strategic deterrence rather than consumer preferences, then the delay of Chobani would have generated an opportunity cost for retailers. In the following sections, we employ a demand model and pricing model to systematically address potential confounders such as demand heterogeneity, cost differences across brands, and to capture equilibrium adjustments of manufacturer prices, in order to quantify the opportunity cost of retailers of not adopting Chobani's products earlier.

4 Structural Empirical Analysis

We now formally introduce the trimmed sample of data. Using this sample, we estimate structural demand and supply models to capture the trade-off between selling Chobani to meet the increasing demand for Greek yogurt and the potential benefit from vertical contracts with dominant incumbent manufacturers, in particular, Dannon and Yoplait.

4.1 Trimmed Sample

We retain the relatively important DMAs, retailers, manufacturers, and product lines in the RMS sample to maintain a manageable sample size for structural estimation. Throughout the rest of the paper, we define a market at the retailer-DMA-quarter level, following Duarte et al. (2021); Conlon and Gortmaker (2023) and a number of other studies. This definition abstracts away from inter-retailer competition within a DMA-quarter. Conceptually, we focus on the choice in the second stage of a two-stage consumption decision: a consumer chooses a retail chain in the DMA-quarter and then selects a yogurt product from the retailer. This assumption is justified in our context by the fact that consumers typically shop at one retail chain in a DMA-quarter (see subsection 2.5 for statistics).

Following Hristakeva (2022), we define a product line by size category, Greek status, fat content, flavor status, and brand name. The sizes are grouped into three categories, no larger than 8 ounces, 8 to 16 ounces, and larger than 16 ounces. The Greek status for a UPC is either yes or no. The fat content of a UPC is either full fat or reduced/zero fat (i.e., light). The flavor of a UPC is either plain or flavored. An example of a product line includes UPCs with a size of no more than 8 ounces, characterized as Greek, full-fat, and plain Dannon Activia.

Trimming: We apply four key steps to trim the original NielsenIQ sample:

(1) We remove one DMA that is only observed for one year and those with relatively few retailers (median number of retailers smaller than six). This leaves us with 71 DMAs.

(2) We exclude retailers observed for only one year or in one DMA and those not observed before selling Chobani products.

(3) We compute aggregate volume shares of manufacturers relative to total sales. We retain manufacturers with median volume shares by market larger than 2.5% and maximum shares larger than 25% to ensure the product is significant and a market leader in at least one market.

(4) We retain product lines with median volume shares per market greater than 0.1% and maximum shares exceeding 5.0% to ensure the product is significant in most markets and among the most popular in at least one market.

This process results in a trimmed sample consisting of 441,812 observations across 70 DMAs. In total, there are 15,273 retailer-DMA-quarter markets. The sample includes 164 retailers (defined by retailer name, parent retailer name, and channel format), 9 national-brand manufacturers, 77 national-brand products, 85 private labels, and 532 private-label products. The complete list of product lines in the trimmed sample is presented in Table B4.

Market size: We define potential market sales of yogurt as the potential yogurt purchases by all consumers visiting a given retail chain in a given DMA and quarter. To estimate consumer flow in a retail chain using NielsenIQ RMS and HMS data, we follow three steps:

(1) We compute total volume sales of fresh milk and fresh eggs for each retailer-DMA-quarter based on RMS data.

(2) We calculate the total volume purchase of fresh milk and eggs by households shopping at a given retailer in a specific DMA-quarter and compute the average per-household purchase of fresh milk and eggs for each retailer-DMA-quarter.

(3) We estimate the number of consumers buying milk and eggs for a retailer-DMA-quarter by dividing the total volume sales of fresh milk (eggs) by the average per-household purchase of fresh milk (eggs). Use the larger of these two estimates as the number of consumers for a given retailer-DMA-quarter market.

Given the estimated number of consumers, we estimate the potential volume purchase of yogurt. We first calculate the average household purchase of yogurt in a market using HMS data. We then multiply this per-household yogurt purchase by the estimated number of consumers to determine the market size. The inside share of a yogurt product, therefore, equals the RMS volume sales of the product in a retailer-DMA-quarter divided by the estimated market size. One minus the sum of inside shares generates the outside share.

Summary statistics: In a given market, the aggregate sales and volume sales captured by the trimmed sample, on average, account for 49.9% and 51.1% of the RMS, respectively. Summary statistics of the variables in the trimmed sample are displayed in Table 5. Additional statistics of the sample are reported in Table B3.

	Mean	SD	Min	Q1	Median	Q3	Max
Price	0.14	0.06	0.06	0.10	0.13	0.18	0.39
Share	0.01	0.02	0.00	0.00	0.00	0.01	0.51
Size_2	0.11	0.31	0.00	0.00	0.00	0.00	1.00
Size_3	0.49	0.50	0.00	0.00	0.00	1.00	1.00
Greek, 1 if yes	0.25	0.44	0.00	0.00	0.00	1.00	1.00
Light, 1 if yes	0.90	0.30	0.00	1.00	1.00	1.00	1.00
Plain, 1 if yes	0.16	0.37	0.00	0.00	0.00	0.00	1.00
PL, 1 if yes	0.12	0.32	0.00	0.00	0.00	0.00	1.00
Outside share	0.69	0.14	0.34	0.58	0.69	0.80	0.95

Note: *Q1* means the first quartile of the variable's distribution, and *Q3* means the third quartile. *Share* is the product level volume share within retailer-DMA-quarter. $Size_2$ is the indicator for products of size between 8 and 16 ounces, and $Size_3$ is the indicator for products of size larger than 16 ounces. *PL* is the private label indicator.

Table 5: Summary Statistics

4.2 Demand Model

We start our structural analysis by estimating a random coefficient demand model (Berry et al., 1995) (henceforth BLP). We simplify the demand-side dynamics by abstracting away from factors such as network effects and switching costs as in Bourreau et al. (2021), but we explicitly model the time-variant consumer awareness of Greek yogurt using region-specific trends.

The indirect utility of a consumer i from consuming a certain yogurt product j in a retailer-DMA-quarter market, t, is a function of product characteristics X_{jt} and prices p_{jt}, a region-quarter (g)-specific learning factor L_{ijg} over Greek products, and unobserved common and idiosyncratic demand heterogeneity, $\tilde{\xi}_{jt}$ and ε_{ijt}, respectively.

$$u_{ijt} = X_{jt}\beta_i + \alpha_i p_{jt} + L_{ijg} + \tilde{\xi}_{jt} + \varepsilon_{ijt} \tag{3}$$

where product characteristics X_{jt} include the size of the product (i.e., less than 8 ounces, 8-16 ounces, and larger than 16 ounces) and the indicators for low-fat and plain flavor. Since the product line length can be an important determinant of product choice (Richards et al., 2017; Hristakeva, 2022), we also include the ratio of a product line's number of UPCs at a retailer-DMA-quarter over the total number of UPCs at the same retailer-DMA-quarter.

Consumer preferences on these product variables vary with individual demographic characteristics. Specifically, the price and characteristic coefficients have a common and individual-specific component: $(\beta_i, \alpha_i) = (\bar{\beta}, \bar{\alpha}) + \eta_{it}'\Pi$, where η_{it} is demographic information such as income, number of kids in the household, and education of the household head in a retailer-DMA-quarter. Following the BLP literature, we define "mean utility" $\delta_{jt} = X_{jt}\bar{\beta} + p_{jt}\bar{\alpha} + \tilde{\xi}_{jt}$ and "idiosyncratic utility" $\mu_{ijt} \equiv (X_{jt}\eta_{it}^{X'} + p_{jt}\eta_{it}^{p'})\Pi$.

We decompose the unobserved component $\tilde{\xi}_{jt}$ into: a time-invariant retailer $\times$ DMA effect that captures unobserved market or retailer characteristics such as retailer location; a brand $\times$ region effect capturing region-specific unobserved preference for certain brands; a year-quarter effect capturing the overall yogurt consumption trend; and an unobserved residual at the product-retailer-DMA-quarter level.

$$\tilde{\xi}_{jt} = \xi_{retailer \times DMA} + \xi_{brand \times region} + \xi_{quarter} + \xi_{jt}$$

Greek yogurt awareness: To capture consumer learning in explaining the gradual transition of market demand after Chobani entry, we specifically model learning using the L_{ijg} component. We follow Ackerberg (2003) and assume that the consumer choice over products is made under uncertainty about how much she/he actually values the characteristic introduced by the new product, i.e., the new good possesses an experience nature.

In our case, consumers are initially unaware about how the Greek format affects their utility, leading them to make decisions based on expectations. Specifically, the region-quarter learning component can be modeled as:

$$L_{ijg} = \text{Greek}_j \mathbb{E}[\beta_i^{Greek} | a_g]$$

where Greek_j is a dummy equal to one if the product purchased is Greek yogurt, β_i^{Greek} is the value that individual i places on consuming Greek yogurt relative to the outside option, and a_g is a region-quarter variable that can shift the expectation.

The uncertainty over the new characteristic's coefficient incorporates different random aspects from consuming a new product, for instance, the possibility of a negative experience. This uncertainty will be reduced by previous purchases of the good or by external factors, such as the number of other nearby individuals that already consumed the new good (McFadden and Train, 1996), and the amount of advertisement to which the individual was exposed (Ackerberg, 2003).[10]

In the current version of the paper, we assume that within a region, the actual mean taste for Greek is uniform among consumers and that the learning process follows a common quadratic function of time *trend*.

$$\mathbb{E}[\beta_i^{Greek} | a_g] = \gamma_1^g trend + \gamma_2^g trend^2$$

[10] We omit prestige effects from advertisement because Ackerberg (2003) shows that it is not important in the yogurt industry.

Identification: We make a standard timing assumption following the literature (Eizenberg, 2014; Hristakeva, 2022): when the product choice sets are determined at the manufacturer $\times$ retailer level, the market-specific demand shocks are not observed. Under the timing assumption, the identification condition is that ξ_{jt} is unobserved at the assortment stage and, thus, is independent from the observed product characteristics in the retailer-DMA-quarter.

Based on this identification condition, we construct instrumental variables (IVs) to address endogeneity in prices and market shares. The first set of instruments are cost or markup shifters, which include input/transportation costs interacting with product characteristics. The input/transportation cost IVs reflect the fact that operational costs affect prices, but are not correlated with demand-side unobservables. Specifically, they include milk prices, and distance to nearest plant $\times$ size. The second set of instruments, differentiation IVs, characterize the degree of differentiation of each product in a retailer-DMA-quarter and exploits variation in household demographics across retailer-markets (Gandhi and Houde, 2019).

Following Goolsbee and Petrin (2004); Chintagunta and Dubé (2005); Conlon and Gortmaker (2023), we incorporate micro-moments to strengthen the identification of the random coefficients. Specifically, we match the following micro-moments that we computed from HMS data with the model predictions: the conditional expectation of income given a purchase of product j ($E[income_i \mid 1\{j > 0\}]$), the conditional expectation of number of children in a household given a purchase of product j, $E[\#\text{ of kids} \mid 1\{j > 0\}]$, and the conditional expectation of household-head education given a purchase of Greek yogurt product j, $E[education_i \mid 1\{Greek_j\} = 1\}]$.

Estimation: We normalize consumer i's utility from the outside option as $u_{i0rmt} = \varepsilon_{i0rmt}$. The shocks ε_{ijt} and ε_{i0t} are assumed to be independently and identically distributed. Type I extreme value and each consumer purchases one unit of the good that gives her the highest utility from the set of available products J_t. The expected market share of product j in market t takes the following form:

$$\tilde{s}_{jt}(\theta) = \int \frac{\exp(X_{jt}\beta_i + \alpha_i p_{jt} + L_{ijg} + \tilde{\xi}_{jt})}{1 + \sum_{k \in J_t} \exp(X_{krmt}\beta_i + \alpha_i p_{krmt} + L_{ikg} + \tilde{\xi}_{krmt})} f(\alpha_i, \beta_i)\, \mathrm{d}\alpha_i\, \mathrm{d}\beta_i. \tag{4}$$

We construct a restricted GMM estimator by staking the set of aggregate data moments ($\frac{1}{N}\sum_{jt} \xi_{jt} Z_{jt}$) and the set of micro-moments:

$$\min_{\theta} G(\theta) W G(\theta)' \quad \text{s.t.} \quad \tilde{\mathbf{s}}(\theta) = \mathbf{s}$$

where $\mathbf{s}$ is the vector of observed market shares. Estimates are computed using the Python package **pyblp**'s (Conlon and Gortmaker, 2020) implementation of the nested fixed point algorithm proposed by Berry et al. (1995).

Results: Table 6 reports the results from the demand model. Comparing the Logit-OLS and the logit-2SLS regressions, the results confirm the strength of the IVs. The price coefficient shifts in the expected direction, when the price instruments are used: from -12.32 to -37.26.

	Logit-OLS		Logit-2SLS		BLP	
	Coef.	SE	Coef.	SE	Coef.	SE
	(1)	(2)	(3)	(4)	(5)	(6)
Linear coefficients (means)						
Price	-12.32	(0.59)	-37.26	(6.27)	-45.07	(6.68)
Size, medium	-0.39	(0.05)	0.19	(0.17)	0.30	(0.19)
Size, large	-0.63	(0.05)	-1.00	(0.10)	-1.07	(0.11)
Light	0.24	(0.11)	-0.21	(0.17)	-0.27	(0.18)
Plain	-0.71	(0.04)	-1.13	(0.11)	-1.23	(0.12)
Fraction of UPCs	2.04	(0.5)	1.81	(0.41)	1.61	(0.52)
Random coefficients (standard deviations)						
Constant					3.24	(1.03)
Constant × #Children					0.13	(0.03)
Price × income					0.08	(0.02)
Greek × education					0.15	(0.02)
No. observations	441,182		441,182		441,182	
Retail-manufacturer FEs	Yes		Yes		Yes	
Year-quarter FEs	Yes		Yes		Yes	
Brand-region FEs	Yes		Yes		Yes	
Regional Greek time-trends	Yes		Yes		Yes	
Own price elasticity, mean	-1.746		-5.281		-5.900	
Own price elasticity, median	-1.601		-4.842		-5.425	
Diversion outside option, mean	0.680		0.680		0.319	
Diversion outside option, median	0.678		0.678		0.304	

Note: Household information regarding the number of children, income, and education is sourced from NielsenIQ HMS data. *Size, medium* is an indicator for product lines that produce yogurt in containers of 8-16 oz. *Size, large* is an indicator for product lines that produce yogurt in containers of more than 16 oz. *Light* equals 1.0 if a product line is of reduced fat and 0.0 otherwise. *Plain* equals 1.0 if a product line is not flavored and 0.0 otherwise. *Fraction of UPCs* equals the number of UPCs of a given manufacturer out of the total number of UPCs carried by a retailer-DMA-quarter, indicating the shelf occupation of the manufacturer. *Income* is expressed in 2015 real US dollars, while *Education* is an indicator set to one if the household head has completed college or above. Standard errors clustered at the retailer level are in parentheses.

Table 6: Demand Model Results

Incorporating individual idiosyncratic preferences further decreases the price coefficient and cuts the mean diversion ratio to the outside option from 0.68 to 0.32. The estimates from the random coefficient model are intuitive and precise. The price × income random coefficient suggests decreasing price sensitivity with increasing income. The Greek × education random coefficient indicates that households with higher education have a higher preference for Greek yogurt. Households prefer medium-size yogurt to large-size and prefer flavored, less light yogurt. The fraction of UPCs, our proxy for shelf space occupied by each manufacturer, also has a large, positive impact on product sales. The mean (median) own-price elasticity from the BLP model is -5.43 (-5.90), comparable to other BLP model applications in yogurt (Villas-Boas, 2007; Hristakeva, 2022).

Figure 3 shows how the awareness of the Greek format evolved differently across geographical regions. Panel (a) depicts the sales of Greek yogurt relative to total sale of yogurt in the four regions. Panel (b) plots the Greek yogurt market share minus regional average. Panel (c) plots the model predicted mean utility for Greek yogurt for different geographic regions. Our model effectively accounts for the varying evolution of Greek yogurt awareness.

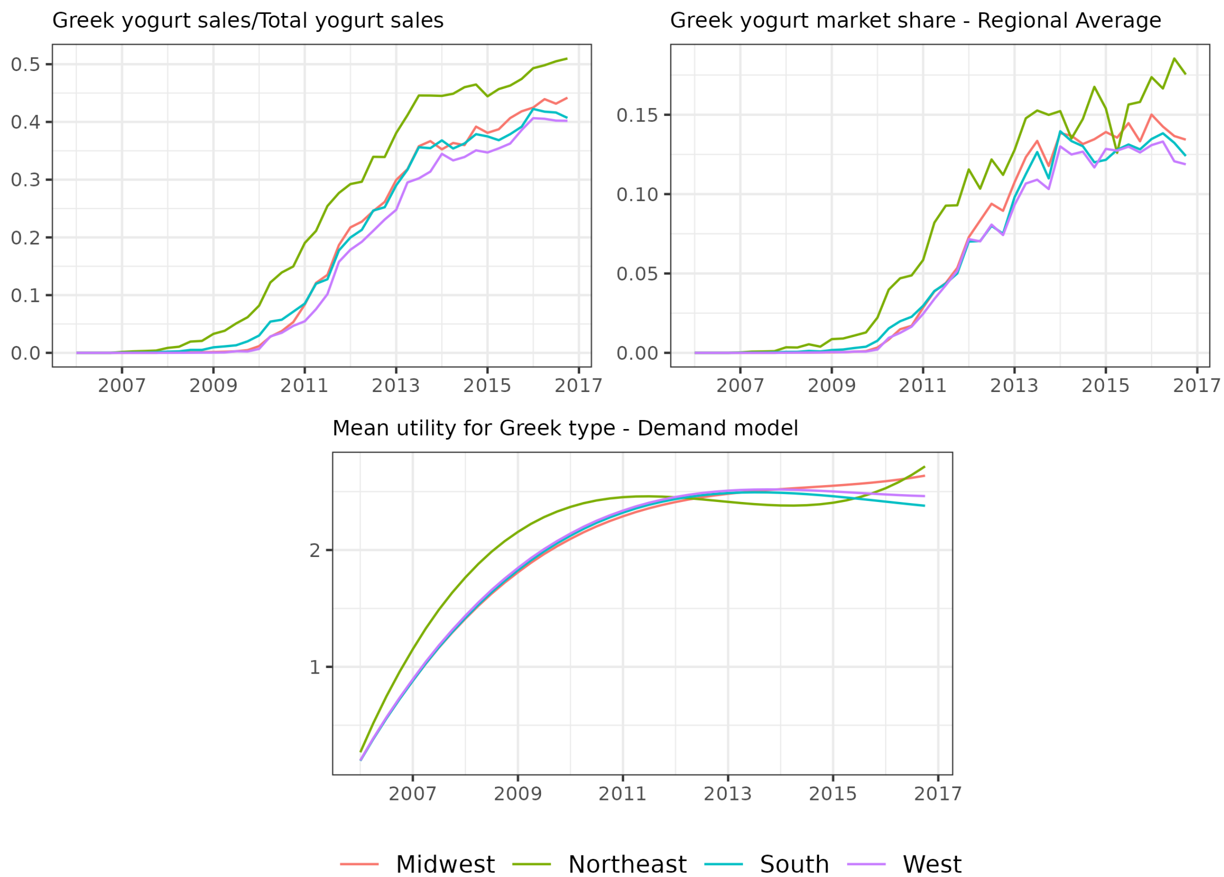


Figure 3: Region-Level Dynamics for Awareness in Greek Yogurt
Note: Authors' creation based on data and the estimation results.

4.3 Supply Model

In this section, we specify and estimate a three-stage supply model to describe product assortment and pricing decisions of retailers, taking into account the retailer-manufacturer arrangements.

The timing of the model is as follows: in the first stage, a retailer makes assortment decisions, factoring in vertical contracts with an incumbent dominant manufacturer. The retailer observes the distributions of demand and cost shocks at this stage, but not their realizations. In the second stage, given the assortments and the realizations of demand and cost shocks, manufacturers determine wholesale prices. Finally, the retailer sets retail prices in the third stage. The game is solved by backward induction.

In the game, all manufacturers observe the assortment of products A chosen by the retailer. Firms play a Nash-Bertrand pricing game to set prices. Notation follows subsection 4.2.

Retail pricing: Villas-Boas (2007) and Duarte et al. (2021) provide evidence that, for the US yogurt industry, a model in which retail prices are determined by wholesale prices with a constant retail markup better fits the data against alternative vertical models, such as a model of double marginalization and linear pricing, or a model with zero wholesale markups and product-specific retail markups. This result is not exclusive to the yogurt segment; Miller and Weinberg (2017) and De Loecker and Scott (2022) show an analogous result for the retail sale of beer, and Bonnet and Dubois (2010) for the bottle water segment.

To allow for both the possibility of positive retailer markups and predominance of wholesaler margins in the determination of retail prices, we assume that retailers choose prices by maximizing a combination of variable profits in market t and the welfare that consumers draw from the yogurt segment product set:

$$\max_{p_t} M_t \sum_{j \in A_t} s_{jt}(p_t)(p_{jt} - w_{jt}) + \kappa V(p_t, A_t),$$

where M is the mass of shoppers at the retailer, w is the wholesale price, s_j is the market share of product j, and $V = \int \log[1 + \sum_{j \in A_t} \exp(\delta_j + \mu_{ij})]/\alpha_i dF(i)$ is the inclusive value generated by the yogurt segment's prices and assortment. In the spirit of De Loecker and Scott (2022), the inclusion of the consumer welfare term in the retailers' objective can be seen as a linear approximation of a broader game between supermarkets choosing segment prices to influence consumers' store choice. The κ term captures the importance of the yogurt segment for the competition between retailers. In appendix ??? we show how to derive this specification from a multiple period retailer decision.[11]

Solving for the optimal retail pricing, we have:

$$p_{jt} = (1-\kappa)\Delta_t^r(p_t, A_t) + w_{jt}$$

where $\Delta_t^r(p_t, A) \equiv -[I(A_t)\frac{\partial \mathbf{s}}{\partial \mathbf{p}} I(A_t)]^{-1} I(A_t) s_t$ is the retail markup without welfare considerations, $I(A_t)$ is the diagonal ownership indicator matrix with element (j, j) equal to one if the products j is on the retailer's shelf, and $\frac{\partial \mathbf{s}}{\partial \mathbf{p}}$ is the matrix of partial derivatives of shares with respect to retail prices. The wholesale price is determined, taking the retail margin response into account.[12]

Wholesale pricing: Given a subset $A_t^f \subset A_t$ of products owned by the manufacturer f and the retailer's pricing rule p, equilibrium wholesale prices in a given market t are determined by the manufacturer's profit maximization problem:

$$\max_{\{w_{jt}\}_{j \in A_t^f}} M_t \sum_{j \in A_t^f} (w_{jt} - mc_{jt})\, s_{jt}(p(w)),$$

where mc_j represents the constant marginal cost of producing and distributing product j.

Wholesale prices are determined by the first-order condition:

$$w_{jt} = mc_{jt} + \Delta_{jt}^f(A, \kappa) \tag{5}$$

where $\Delta_t^f(A, \kappa) \equiv -[I(A_t^f)\frac{\partial \mathbf{p}}{\partial \mathbf{w}}(\kappa)\frac{\partial \mathbf{s}}{\partial \mathbf{p}} I(A_t^f)]^{-1} I(A_t^f) s_t$ is the vector of manufacturers' margin at market t and $\frac{\partial \mathbf{p}}{\partial \mathbf{w}}(\kappa)$ is the matrix of retail price responses to wholesale prices. Note that, as $\kappa \to 1$ the matrix $\frac{\partial \mathbf{p}}{\partial \mathbf{w}}$ converges to the identity matrix.

Substituting the wholesale price expression into the retail price equation, we have an equilibrium retail pricing formula:

$$p_{jt} = (1-\kappa)\Delta_t^r(A) + mc_{jt} + \Delta_{jt}^f(A, \kappa) \tag{6}$$

To estimate marginal costs for products not yet offered, we assume a linear relationship between cost and a vector of observable cost-shifters (x_{jt}) and an unobservable cost shock that we consider to be mean independent: $mc_{jt} = \gamma x_{jt} + \epsilon_{jt}$, with $\mathbb{E}[\epsilon_{jt} x_{jt}] = 0$.

[11]This framework is also similar to how Gowrisankaran et al. (2015) model the determination of the prices and hospital network by managed care organizations.

[12]Note that we assume that wholesale prices are the only marginal cost relevant for the determination of the retail price. This facilitates the approximation of the margin using from production function approaches, as we discuss later, and is corroborated by industry information that other costs involved in the distribution of yogurt (e.g., stocking products in the shelf) are born by manufacturers.

Finally, the equilibrium variable profits for the retailer and for the manufacturer f can then be expressed based on revenues and margins:

$$\pi^r(O_t, A_t) = M_t(1-\kappa)\sum_{j\in A_t}\Delta_t^r(A_t)s_t, \qquad \pi^f(O_t, A_t) = M_t\sum_{j\in A_t^f} s_{jt}\Delta_{jt}^f(A_t,\kappa) \tag{7}$$

where s_{0t} is the share of the outside option, and O_t is the vector of all observed variables used for the calculation of profits (i.e., price, shares, product characteristics, etc.).

Results: The manufacturer margins implied by the demand estimates and our assumption on retail margins generate a marginal cost distribution with mean 10.5 cents per pound, of which less than 1% are negative. To predict the marginal cost of products not offered for the simulation of equilibrium prices and shares after a counterfactual change in the assortment, we regress marginal cost on two cost shifters: distance to the nearest manufacturing plant of the firm that owns the product and state-level milk prices.[13]

The regression results takes the form:

$$c_{jt} = \underset{(0.047)}{0.156}\log(\text{DistanceToNearestPlant}_j) + \underset{(0.078)}{0.990}\log(\text{MilkPrice}_t) + FE_{jt} + \hat{\varepsilon}_{jt},$$

where the fixed effect term, FE_{jt}, include dummies of product and market-year. Standard errors are reported in the parentheses under the coefficients.

In Table 7 we present the results from the price decomposition shown in the pricing Equation 6 and the variable profit estimates based on the definitions in Equation 7. Our estimates imply that on average the manufacturer's margins account for 27.8% of the retail price of yogurt, while the retail margins account only for 8.3%. The correspondent retail gross profit margin is 9% which is in line with what articles with detailed grocery retail firm-level data have used (Smith, 2004), and is significantly lower than the margins implied by the model of double-marginalization with linear vertical pricing.(Hristakeva, 2022; Duarte et al., 2021; Villas-Boas, 2007).

4.4 Opportunity Cost of Delayed Adoption

In this subsection, we outline our estimation approach of retailer opportunity cost of delaying the entry of Chobani. In the first stage, the retailer makes product offering decisions denoted by $A_j \in \{0,1\}$, where $A_j = 1$ if product j is offered and 0 otherwise. The entire product portfolio for the retailer is then given by the following J-dimensional vector:

[13] **DATA SOURCE AND DESCRIPTION FOR DISTANCE AND MILK.**

	Mean	Median	Std
Price decomposition (cents/lb.)			
Retail Price	15.3	14.1	5.9
Manufacturer margin	3.7	3.5	0.8
fraction of price(%)	27.8	26.7	11.3
Retail margin	1.1	1.1	0.3
fraction of price(%)	8.3	7.5	3.7
Marginal cost	10.5	9.2	6.1
Variable profits per market ($\times 10^5$ \$)			
Retail	0.83	0.15	1.88
gross margin(%)	9.1	8.7	2.8
Chobani	0.26	0.05	0.73
gross margin(%)	14.6	14.3	2.6
Dannon	0.75	0.13	1.94
gross margin(%)	27.1	26.0	6.0
Yoplait	1.13	0.25	2.41
gross margin(%)	38.3	35.5	11.6

Table 7: Pricing and Profits Results

$A \equiv (A_1, ..., A_J)' \in \{0,1\}^J$. To estimate the opportunity costs of delaying Chobani entry for retailers, we employ conterfatual product swaps that replaces the incumbent brand with Chobani products.

Empirical implementation: Our estimation of the opportunity cost is based on feasible product swaps constructed as follows. First, the swap is applied to the product portfolio within each specific market t (retailer-DMA-quarter). Second, each swap entails the removal of an *incumbent* I's products and the introduction of the *entrant* E's products, i.e., $j \in A^I$ and $k \in A^E$, respectively. Third, to better reflect real-world dynamics, we focus on brand-level swaps, recognizing that retailers often introduce or remove entire brands rather than subsets of products for brands. Fourth, in addition to restricting $A_j = 1$ and $A_k = 0$ in market t, we require that $A_k = 1$ in at least one other market within the same region, with regions defined as in section 3; and $A_k = 0$ for more than 25% of the total markets within a retailer. Finally, the swap is applied only when the incumbent's share of yogurt sales is the largest at retailer i, indicating it's dominance.[14]

[14] An example swap meeting these conditions is as follows. For retail chain 817 operating in DMA 501, we observe no sales of brand "CHOBANI" and positive sales of brand "DANNON LIGHT N FIT CARB" in quarter 2 of year 2008. In the meantime, "CHOBANI" is found to be available in some other DMAs within the Northeast region during the same year-quarter. We also find that Dannon is the dominant manufacturer for the retailer in 2008, accounting for xx% of the retailer's yogurt volume sales. A moment condition is

We focus on a subset of feasible swaps where the incumbent brands removed are those ranking low in terms of revenue/profit generated for retailers. From these swaps we can compute the variable profit differences between the counterfactual assortment and the observed assortment. To enable comparisons across retailers and DMAs with different sizes of retail segments, we normalize the estimated profit difference by dividing it with the retailer-DMA average revenue over time periods. This normalized profit difference is an estimate of retailer opportunity cost of delaying Chobani entry.

Results: We use the demand and pricing models to generate a vector of variable profit differences from each swap simulation. Out of 6,086 profit differences 20% are positive, which suggests that these retailers would have increased its profits by adopting Chobani in that DMA-quarter instead of continuing to carry the lower-performing Dannon/Yoplait brand.

Using an indicator variable for the positive profit differences, we run a probit regression to understand the determinants of the opportunity costs. We regress this indicator on a set of variables that describe regional or retailer-level characteristics. The results are shown in Table 8. The coefficients of indicators for Northeast and West regions are estimated to be negative. This reflect the fact that Chobani first entered and enjoyed higher demand in these regions, and retailer-DMAs in the Northeast region which delayed the adoption of Chobani likely incurred profit loss. The coefficient for the time trend is estimated to be significantly positive, indicating that counterfactual swaps occurring later in time are more likely to result in a positive profit difference. This finding is expected, as it reflects our model of consumers' increasing preference for Greek yogurt over time.

Interestingly, based on the last three coefficients shown in Table 8, a higher CR1 does not imply a higher probability of incurring opportunity costs for Yoplait products, but it does when Dannon is the dominant incumbent. Put it in a specific context, for an average-sized retailer located in the South making assortment decisions during the fourth quarter of 2009, a Dannon-Chobani product swap had an almost 40% higher probability than a Yoplait-Chobani product swap of being profitable for the retailer. This probability increases by 7.5% if this retailer has a CR1 greater than the median.

Figure 4 plots the distribution of the estimated normalized profit differences, separately for retailers with higher CR1, and retailers with lower CR1. Each observation represents a retailer-swap pair. The swaps on average decrease variable profits by 0.9% relative to revenue, reflecting the nature of initially lower demand for innovative products such as Chobani. Interestingly, the distribution of the normalized profit difference for retailers with a higher

then formulated by replacing all "DANNON LIGHT N FIT CARB" products with "CHOBANI" products, and estimated by computing the retail variable profits before and after the swap.

	$\mathbf{1}\{\Delta_{jk}\hat{\Pi}^r(O_t, A) > 0\}$	
Constant	-0.138	(0.162)
Northeast	-0.392	(0.089)
South	0.021	(0.054)
West	-0.221	(0.063)
Time Trend	0.111	(0.016)
Time Trend.^{2}	-0.003	(0.001)
log(Retailer×DMA avg. revenue)	-0.093	(0.012)
$\mathbf{1}\{CR1 > median(CR1)\}$	-0.107	(0.042)
$\mathbf{1}\{$Swap Danone product$\}$	1.046	(0.089)
$\mathbf{1}\{CR1 > median(CR1)\} \times \mathbf{1}\{$Swap Danone product$\}$	0.345	(0.163)
Number of retailers	72	
Number of swaps	8	
Observations	6,086	

Table 8: Probit Regression - Probability of Positive Swap Profit Difference

concentration ratio of the leading manufacturer (CR1) is shifted to the right compared to retailers with a lower CR1. This provides evidence against the hypothesis that the positive correlation between Chobani adoption delay and the concentration of manufacturer sales is driven by demand considerations. Furthermore, for 20% of the retailer-swaps where the profit difference is positive and demand does not justify keeping the incumbent product, we estimate an average opportunity cost of 0.8% relative to revenue. If this opportunity cost to retailers is compensated by vertical transfer from incumbent manufacturers, these transfers could be substantial, especially given that most retailers operate with gross margins of around 4% relative to revenues.

To examine heterogeneity in the opportunity costs across brands, we plot the distribution of profit differences by incumbent products in Figure 5. The results are coherent with the results from Table 8. We observe that, relative to Yoplait products, many more retailers incur positive opportunity costs of carrying Dannon's products instead of Chobani's. This is especially true for the product line *Dannon Creamy*, for which we observe that more than half of retailers incur positive opportunity cost of delaying Chobani entry. In contrast, in the case of Yoplait products, demand factors (i.e. high demand for Yoplait) seem to be driving assortment decisions for most retailers.

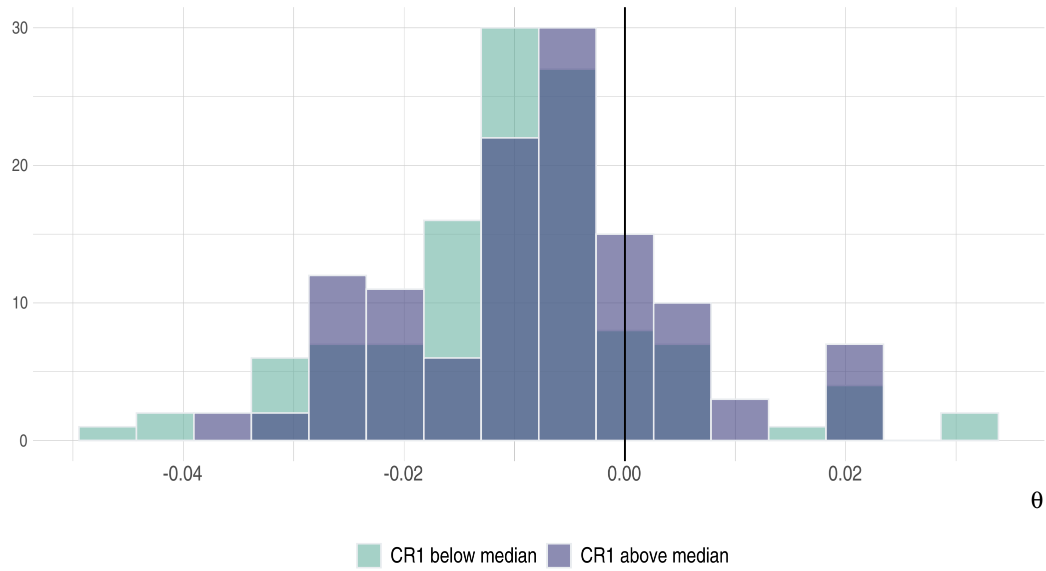


Figure 4: Retailer Transfer Estimates Distribution by Sales Concentration

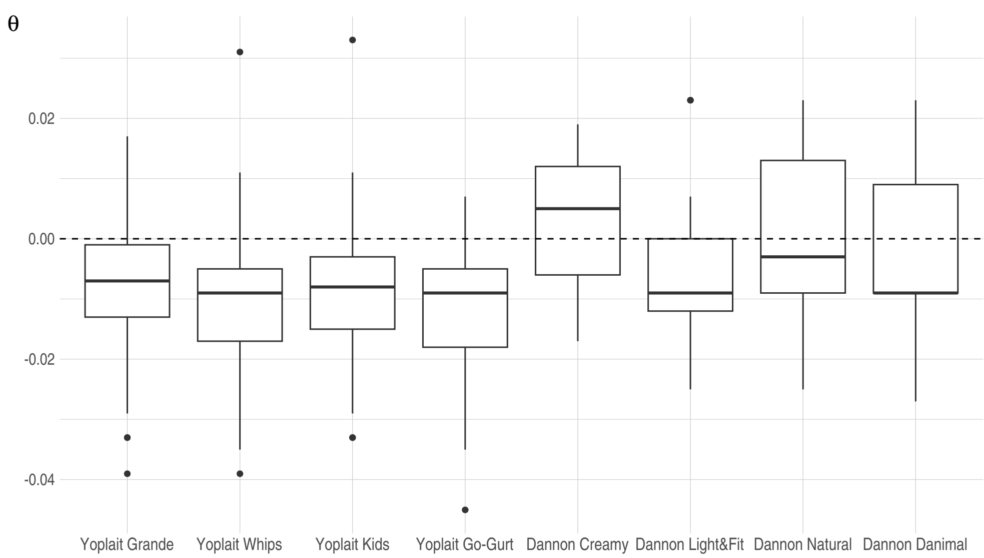


Figure 5: Retailer Transfer Estimates by Incumbent Brands

4.5 Welfare Effects of Delaying Chobani

5 Results Discussion

Thus far, we have presented empirical evidence demonstrating that the entry of Chobani was significantly delayed when the incumbent manufacturer held a dominant sales share in a retail chain. In this section, we discuss incentives for retailers to delay entry and the potential role vertical relationship plays in the delay.

Interpretation of opportunity cost for retailers: Recall that there is evidence for state dependence in manufacturer choices in yogurt purchase, generally speaking, and first-move advantage in the consumption of Greek yogurt. State dependence implies that consumers tend to stick with the first Greek yogurt brand they try. If this initial brand is Chobani, incumbent manufacturers would need to invest significantly more in advertising to convince consumers to switch to their Greek yogurt products and overcome established inertia. If this additional investment is costly, incumbents have a strong incentive to deter Chobani's entry until they can launch their own Greek version.

Industry reports and existing literature have documented that retailers may be compensated for lost profits resulting from delaying Chobani's entry through vertical transfers from the incumbent manufacturer. These transfers could take the form of direct payments, such as slotting fees or rebates, but they can also include indirect advantages that the dominant incumbent provides to the retailer, such as category captaincy contracts that lower retail costs associated with restocking and gathering demand information for making assortment decisions. Under some general assumptions over assortment choice, our estimate of retailers's opportunity cost can be taken as a lower-bound estimate for the difference in vertical transfers between incumbent and entrants in this industry. If we assume that manufacturers make take-it-or-leave-it offers to retailers, as in Hristakeva (2022), then the opportunity cost can be interpreted as a point estimate of the vertical transfer differential.

Our work bridges the research areas of retail vertical arrangements and incumbent strategic deterrence when facing a rival manufacturer. We highlight vertical contracts as another channel that affects the competition landscape and consumer welfare in the retail industry.

6 Concluding Remarks

References

Ackerberg, D. A. (2003). Advertising, learning, and consumer choice in experience good markets: an empirical examination. *International Economic Review 44*(3), 1007–1040.

Ackerberg, D. A. and M. Rysman (2005). Unobserved product differentiation in discrete-choice models: estimating price elasticities and welfare effects. *RAND Journal of Economics 36*(4), 771–789.

Asker, J. and H. Bar-Isaac (2014). Raising retailers' profits: On vertical practices and the exclusion of rivals. *American Economic Review 104*(2), 672–686.

Berry, S., J. Levinsohn, and A. Pakes (1995). Automobile prices in market equilibrium. *Econometrica: Journal of the Econometric Society 63*(4), 841–890.

Bonnet, C. and P. Dubois (2010). Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance. *The RAND Journal of Economics 41*(1), 139–164.

Bourreau, M., Y. Sun, and F. Verboven (2021). Market entry, fighting brands, and tacit collusion: Evidence from the french mobile telecommunications market. *American Economic Review 111*(11), 3459–99.

Bronnenberg, B. J., S. K. Dhar, and J.-P. H. Dubé (2009). Brand history, geography, and the persistence of brand shares. *Journal of Political Economy 117*(1), 87–115.

Canay, I., G. Illanes, and A. Velez (2023). A user's guide to inference in models defined by moment inequalities. Technical report, National Bureau of Economic Research.

Chernozhukov, V., D. Chetverikov, and K. Kato (2019). Inference on causal and structural parameters using many moment inequalities. *The Review of Economic Studies 86*(5), 1867–1900.

Chintagunta, P. K. and J.-P. Dubé (2005). Estimating a stockkeeping-unit-level brand choice model that combines household panel data and store data. *Journal of Marketing Research 42*(3), 368–379.

Conlon, C. and J. Gortmaker (2020). Best practices for differentiated products demand estimation with pyblp. *The RAND Journal of Economics 51*(4), 1108–1161.

Conlon, C. and J. Gortmaker (2023). Incorporating micro data into differentiated products demand estimation with pyblp. Technical report, NYU working paper.

Conlon, C. T. and J. H. Mortimer (2021). Efficiency and foreclosure effects of vertical rebates: Empirical evidence. *Journal of Political Economy 129*(12), 3357–3404.

Crawford, G. S., R. S. Lee, M. D. Whinston, and A. Yurukoglu (2018). The welfare effects of vertical integration in multichannel television markets. *Econometrica 86*(3), 891–954.

Cunningham, C., F. Ederer, and S. Ma (2021). Killer acquisitions. *Journal of Political Economy 129*(3), 649–702.

Davis, P. (2006). Measuring the business stealing, cannibalization and market expansion effects of entry in the us motion picture exhibition market. *The journal of industrial economics 54*(3), 293–321.

De Loecker, J. and P. T. Scott (2022). Markup estimation using production and demand data. an application to the US brewing industry. Technical report, Working Paper.

De Loecker, J. and F. Warzynski (2012). Markups and firm-level export status. *American economic review 102*(6), 2437–2471.

Doraszelski, U. and J. Jaumandreu (2019, November). Using Cost Minimization to Estimate Markups.

Duarte, M., L. Magnolfi, M. Sølvsten, and C. Sullivan (2021). Testing firm conduct. Technical report, working paper, University of Wisconsin-Madison.

Dubé, J.-P., G. J. Hitsch, and P. E. Rossi (2010). State dependence and alternative explanations for consumer inertia. *The RAND Journal of Economics 41*(3), 417–445.

Eizenberg, A. (2014). Upstream innovation and product variety in the us home pc market. *Review of Economic Studies 81*(3), 1003–1045.

Ellison, G. and S. F. Ellison (2011). Strategic entry deterrence and the behavior of pharmaceutical incumbents prior to patent expiration. *American Economic Journal: Microeconomics 3*(1), 1–36.

Elzinga, K. G. and D. E. Mills (2009). Predatory pricing in the airline industry: Spirit airlines v. northwest airlines (2005). *The Antitrust Revolution, 5th Edition, edited by J. Kwoka and L. White*.

Gandhi, A. and J.-F. Houde (2019). Measuring substitution patterns in differentiated products industries. Technical report, National Bureau of Economic Research.

Goolsbee, A. and A. Petrin (2004). The consumer gains from direct broadcast satellites and the competition with cable tv. *Econometrica 72*(2), 351–381.

Goolsbee, A. and C. Syverson (2008). How do incumbents respond to the threat of entry? evidence from the major airlines. *The Quarterly journal of economics 123*(4), 1611–1633.

Gowrisankaran, G., A. Nevo, and R. Town (2015). Mergers when prices are negotiated: Evidence from the hospital industry. *American Economic Review 105*(1), 172–203.

Ho, K., J. Ho, and J. H. Mortimer (2012). The use of full-line forcing contracts in the video rental industry. *American Economic Review 102*(2), 686–719.

Hristakeva, S. (2022). Vertical contracts with endogenous product selection: An empirical analysis of vendor allowance contracts. *Journal of Political Economy 130* (12), 3202–3252.

Jaumandreu, J. and R. Lopez (2024). Markups in us food manufacturing accounting for non-neutral productivity. *Journal of Agricultural Economics 75* (2), 573–591.

Luo, B. (2024). Manufacturer–retailer relationships and the distribution of new products. *Marketing Science 43* (1), 114–137.

Marx, L. M. and G. Shaffer (2007). Upfront payments and exclusion in downstream markets. *The RAND Journal of Economics 38* (3), 823–843.

Matsa, D. A. (2011). Competition and product quality in the supermarket industry. *Quarterly Journal of Economics 126* (3), 1539–91.

McFadden, D. L. and K. E. Train (1996). "consumers' evaluation of new products: Learning from self and others. *Journal of Political Economy 104* (4), 683–703.

Miller, N. H. and M. C. Weinberg (2017). Understanding the price effects of the millercoors joint venture. *Econometrica 85* (6), 1763–1791.

Richards, T. J., S. F. Hamilton, and K. Yonezawa (2017). Variety and the cost of search in supermarket retailing. *Review of Industrial Organization 50*, 263–285.

Schmalensee, R. (1982). Product differentiation advantages of pioneering brands. *The American Economic Review 72* (3), 349–365.

Smith, H. (2004, January). Supermarket Choice and Supermarket Competition in Market Equilibrium. *Review of Economic Studies 71* (1), 235–263.

Tirole, J. (1988). *The theory of industrial organization.* MIT press.

USDA-ERS (2019). Dairy products: Per capita consumption, united states.

Villas-Boas, S. (2007). Vertical relationships between manufacturers and retailers: Inference with limited data. *Review of Economic Studies 74* (2), 625–652.

Viswanathan, M., O. Narasimhan, and G. John (2020). Economic impact of category captaincy: An examination of assortments and prices. *Marketing Science 40* (2), 261–282.

Zhu, X. (2022). Inference and impact of category captaincy. Technical report, SSRN 4229142.

Appendix

A The US Yogurt Market and Entry of Greek Brands

In this appendix section, we summarize a few more patterns in the expansion of Greek yogurt across brands, over space, and across retailers during the period of interest.

A.1 Expansion of Greek Yogurt

Figure A1 panel (a) reports the annual per capita consumption of yogurt in the US as reported by the US Department of Agriculture (USDA). There is an upward trend in per capita annual yogurt consumption from about 11.1 pounds in 2006 to nearly 15.0 pounds in 2013. Since 2014, the per capita annual consumption of yogurt has fallen slightly to wiggle around 14.0 pounds.

Employing the full NielsenIQ sample introduced in section 2, panel (b) of Figure A1 shows the normalized revenue sales of Greek and non-Greek yogurt by leading manufacturers in each year (i.e., 2006 annual sales is normalized to 1.0). The height of the stacked bars in a year is the normalized total sales of yogurt in the US, which aligns with the solid curve in panel (a).

The aggregate share of Greek yogurt rose from merely 2.0% in 2008 to more than 50% by 2013. If we track the expansion of Greek yogurt from 2006 to 2016, we see that the growth before 2008 was slow. Largely due to the success of Chobani, the expansion of Greek yogurt accelerated and occupied more than half of the US yogurt market by 2013. From then on, the sales share of Greek yogurt plateaued around 55%.

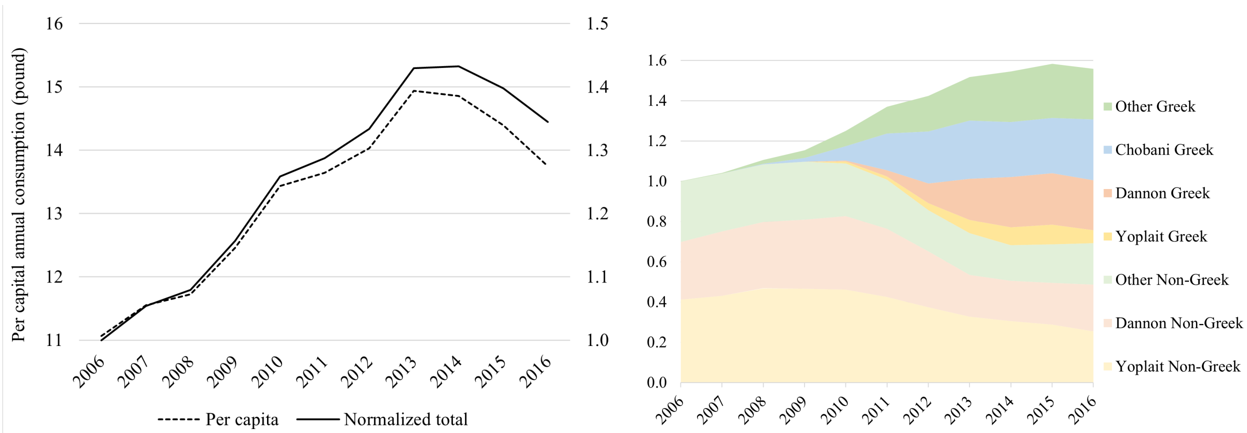
It is interesting to notice that Yoplait eventually lost its competitiveness in the Greek yogurt market with a less than 10% revenue share in 2016, likely due to different texture and taste of its Greek products produced by milk protein concentrate.[15] Dannon, on the other hand, became a leading Greek yogurt seller with a market share comparable to Chobani. Together, Chobani and Dannon account for 60-65% of the Greek yogurt sub-market.

The rise and expansion of Greek yogurt can also be seen from changes in the portfolio of yogurt products by manufacturer. Figure A2 depicts the number of UPCs over the years for the three leading manufacturers, separately for non-Greek and Greek types.

A.2 Impacts of Greek Yogurt

To quantify the overall *market expansion effect* of Greek yogurt introduction, we employ 1975-2016 USDA data of per capita yogurt consumption USDA-ERS (2019), vol_{yr}, and estimate Equation 8.

[15]The production of Greek yogurt through the straining process incurs significantly higher costs compared to traditional production of yogurt. This is primarily due to the utilization of three times more milk to produce an equivalent quantity of Greek yogurt. Additionally, the mass production of Greek yogurt requires specialized machinery that is not required for the production of regular yogurt. Yoplait Greek was produced using milk protein concentrate instead of the straining process, which is a standard process used by Chobani, Dannon, and other Greek yogurt brands at that time. Yoplait Greek is hence likely to enjoy a lower production cost relative to other Greek brands.

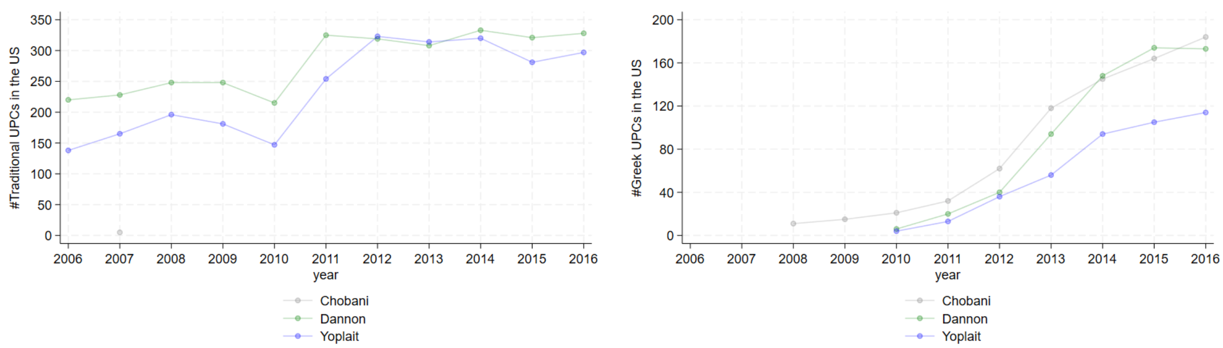


(a) Per Capita and Total Yogurt Consumption

(b) Sales Shares by Manufacturer

Figure A1: Trends in the US Yogurt Market

Note: Authors' creation based on USDA data (https://www.ers.usda.gov/data-products/dairy-data/) and NielsenIQ dataset. The black line in panel (a) tracks per capita yearly consumption of yogurt measured in pound. The gray line tracks the US total yogurt consumption normalized based on 2006 value reported by the USDA. Panel (b) plots the annual sales shares by Greek status and manufacturer using the full NielsenIQ sample. Greek Dannon only includes its Greek products sold under the name of "Dannon" like Dannon Oikos and excludes its Greek products sold under names like Brown Cow or Stonyfield.



(a) Number of Traditional Yogurt UPCs

(b) Number of Greek Yogurt UPCs

Figure A2: Numbers of UPCs by the Top Three Manufacturers

Note: Authors' calculation based on full yogurt dataset of NielsenIQ. For Greek Dannon, we only consider its Greek products sold under the name of "Dannon" like Dannon Oikos and exclude Dannon products sold under names like Brown Cow or Stonyfield.

$$vol_{yr} = \alpha + \beta_1 yr + \beta_2 yr \times D_{2008} + \epsilon_{yr}, \tag{8}$$

where yr represents a linear trend variable to capture the increasing per capita yogurt consumption over the years, D_{2008} is an indicator variable that takes the value of one for years since 2008 (the year when Chobani introduced Greek yogurt in the US). The results in Table A1 suggest a positive trend and an additional increase in per capita consumption after the Greek yogurt introduction by Chobani.

We also look into the impact of Greek yogurt introduction on overall changes in variety and shelf space dedicated to yogurt and Greek yogurt, using a sample of 7,887 stores that are recorded in the NielsenIQ dataset every year from 2006 to 2016. The total number of yogurt UPCs reflects the shelf space granted to the yogurt category by a store (Ackerberg and Rysman, 2005). In the specification, we use subscript s to indicate store, r for retail chain, m for DMA, and t for quarter.

$$UPC_{srmt} = \alpha + \beta_1 trend + \beta_2 trend \times D_{2008} + D_{2008} + R_r + M_m + q_t + \epsilon_{srmt}, \tag{9}$$

where $trend$ is a year-quarter trend variable, R_r and M_m denote the retailer and market (county-level) fixed effects, and quarter fixed effects, (q_t), capture seasonality.

The results are reported in columns (2) to (4) in Table A1. There is a positive trend in the number of UPCs prior to Chobani entry. After 2008, the positive trend is boosted, indicating expanding shelf space for the yogurt category as a whole. These results imply a *market expansion effect* of Greek yogurt. Comparing columns (1) and (2), we learn that the expansion is driven by adding Greek products and increasing the proportion of Greek UPCs (i.e., a *business stealing effect*).

	Consump./capita (1)	Total no. UPCs (2)	Greek no. UPCs (3)	Greek UPC% (4)
$Trend$	0.26***	0.47***	0.21***	0.21***
	(0.02)	(0.14)	(0.02)	(0.03)
$Trend \times D_{2008}$	0.08***	0.60***	1.01***	1.53***
	(0.01)	(0.17)	(0.08)	(0.09)
No. observations	42	346,131	346,131	346,131
R^2	0.96	0.79	0.83	0.87

Note: * p-value< 10%, ** p-value< 5%, *** p-value< 1%. Standard errors are in parentheses and clustered at the retail chain level. Variable *trend* is a yearly linear trend in Column (1) and a year-quarter linear trend in other columns. D_{2008} is an indicator that equals 1 for time after 2008. *No.* means the number of. Specifications from Column (2) to Column (4) account for retailer, DMA, and quarter fixed effects.

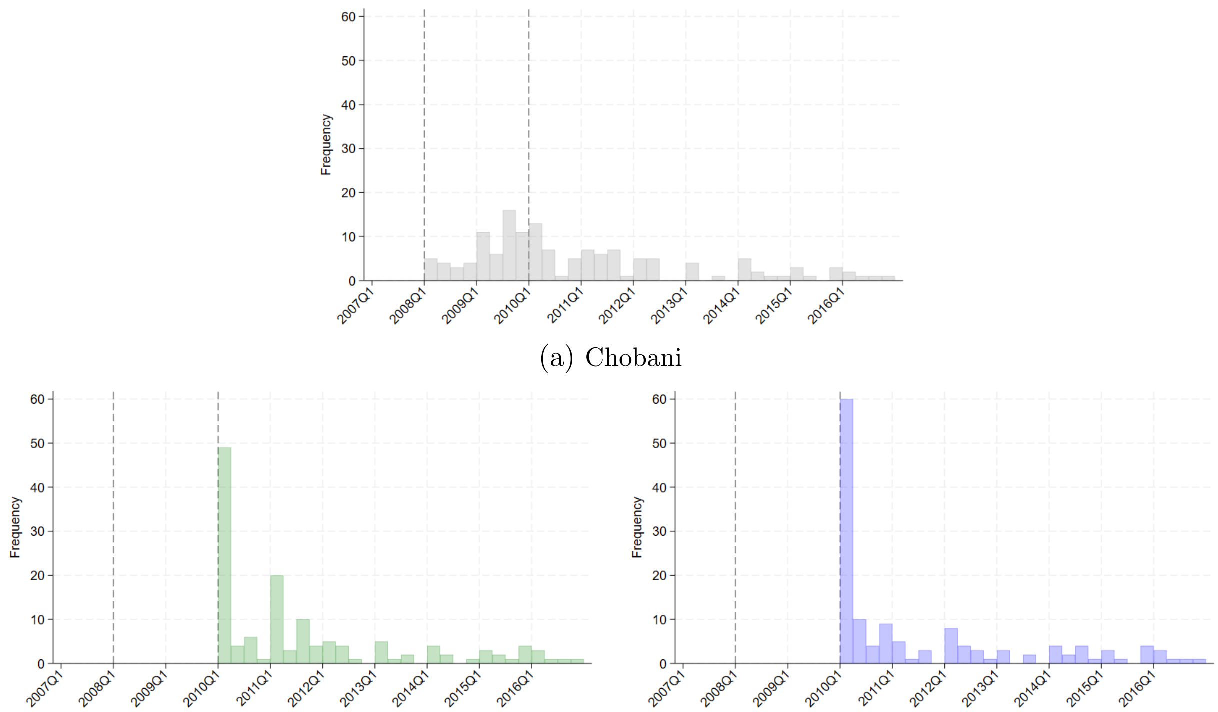
Table A1: Effects of Greek Yogurt Introduction on Industry Trends

A.3 Greek Products by Chobani, Dannon, and Yoplait

Figure A3 plots entry time distributions for Chobani, Dannon, and Yoplait among the sampled retailers, respectively. Although Chobani, Dannon, Yoplait are all sold in more than 85% of the retailers by the end of 2016, there is a noticeable difference in their entry patterns.[16] The two incumbents launched Greek yogurt in 2010 and quickly made their Greek products available in a large number of retailers. Yoplait was even faster than Dannon in introducing Greek yogurt across retailers.

The introduction of Greek products by Chobani, Dannon, and Yoplait follow different spatial patterns, too. In January 2008, Chobani was first sold in a few DMAs near New

[16] Out of 164 retail chains in the trimmed sample, 145 sell Chobani's Greek yogurt products for at least one quarter and in at least one DMA by 2016, while 139 (139) out of 164 retail chains sell Dannon's (Yoplait's) Greek products in at least one store for at least one quarter.



(a) Chobani

(b) Dannon

(c) Yoplait

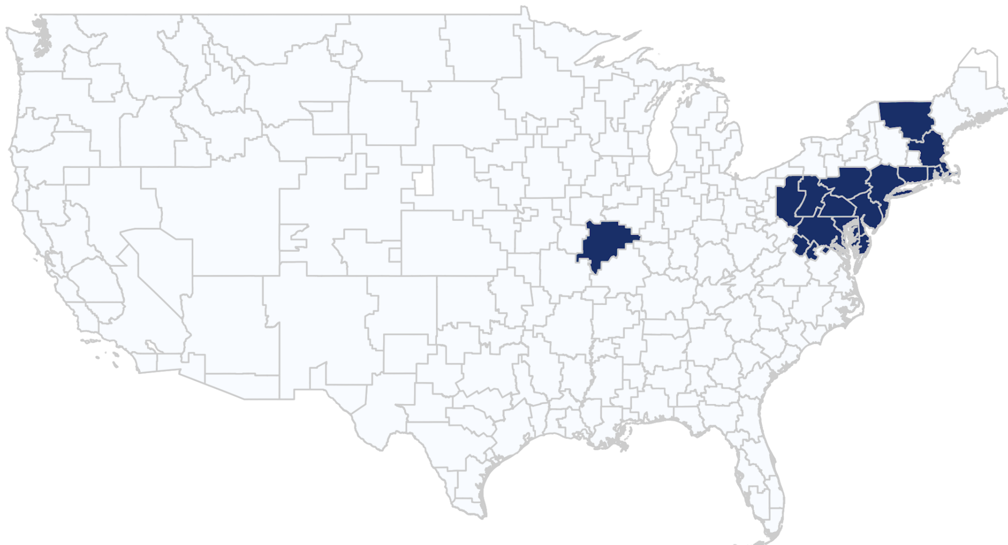
Figure A3: Greek Yogurt Entry by Manufacturer and Retailer 2006-2016.

Note: Authors' creation based on the trimmed sample. The entry quarter is the first quarter when sales of a particular brand is observed in NielsenIQ data. The horizontal axis indicates the year-quarter. The first dashed line indicates quarter 1 2008, and the second dashed line indicates quarter 1 2010. The vertical axis measure the frequency of the entry variable, namely, the number of retailers that introduce a particular manufacturer's Greek products within a given year-quarter.

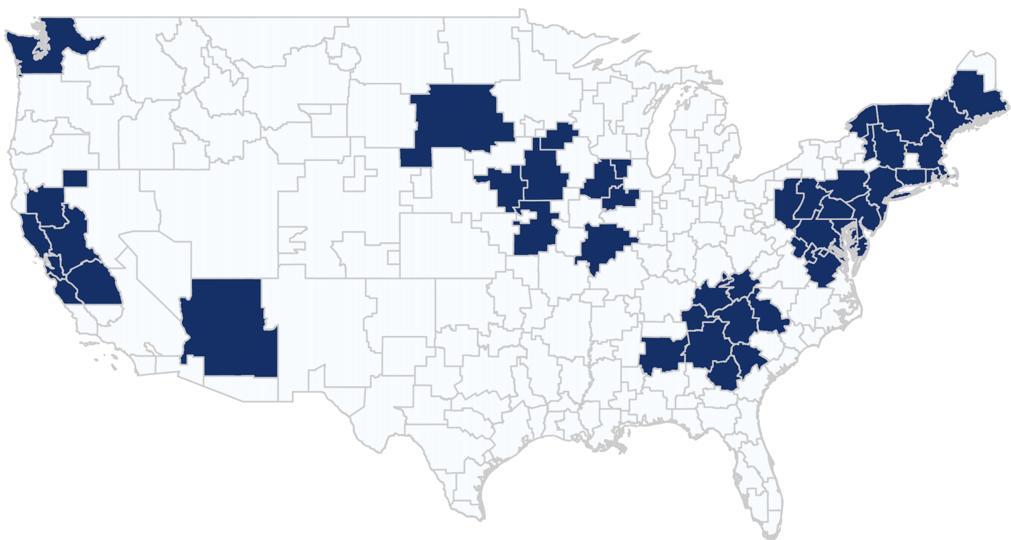
York where its first factory was built. As panel (a) of Figure A4 shows, by 2008 quarter 2, the sales of Chobani were concentrated in a few DMAs around New York.

By the second quarter of 2009, Chobani had expanded into several distant DMAs on the West Coast (see panel (b) of Figure A4), reflecting the rapid establishment of its nationwide distribution network. This spatial roll-out pattern deviated from a typical contagion process, where a product would initially spread to markets in the middle of a country before expanding to the West. In the case of Chobani, the distribution of yogurt followed a direct store delivery model. Shipping yogurt over long distances from the East Coast to the West Coast would incur higher costs compared to serving markets in the middle first. In this regard, the observed roll-out strategy seems to be influenced more strongly by other factors like demand or entry barriers, rather than distribution efficiency. The yearly maps of Chobani penetration across DMAs from 2008 to 2016 are available upon request.

There is a two-year lag before Dannon and Yoplait introduced their Greek yogurt products. The first quarter of 2010 is the first quarter where sales of Greek Dannon and Yoplait are observed in the NielsenIQ data. Upon the first wave of introduction, Dannon and Yoplait penetrated their Greek yogurt products to large numbers of markets thanks to their well-established distribution networks, and the spatial roll-out of Yoplait is even faster than Dannon.



(a) DMAs Selling Greek Chobani as of 2008 Quarter 2

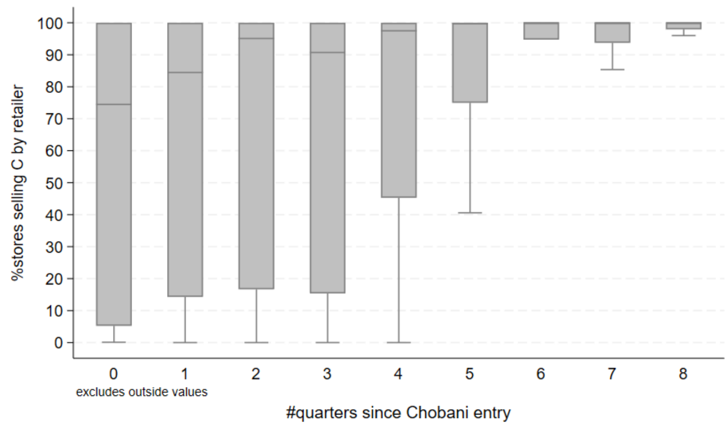


(b) DMAs Selling Greek Chobani as of 2009 Quarter 2

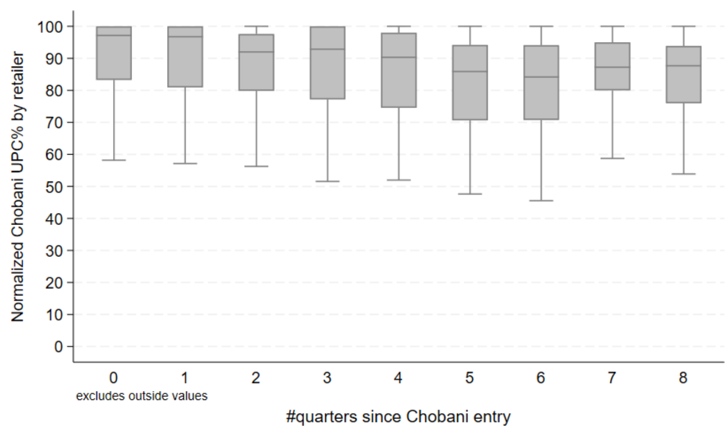
Figure A4: First Batch of Counties Selling Chobani.
Note: Authors' creation based on NielsenIQ data. Darker blue DMAs represent DMAs with Chobani's Greek yogurt entry.

A.4 Retailers Selling Chobani

We plot the percentage of stores carrying Chobani and the normalized percentage of Chobani's products carried by stores that belong to a multi-region retailer (i.e., a retailer operating in more than one region). Figure A5 displays the same patterns as Figure 2, confirming that the adoption of Chobani's products is predominantly a chain-level decision instead of a response to local demand or supply conditions.



(a) Store% Selling Chobani



(b) Store Selling Normalized % Chobani UPCs

Figure A5: Uniformity of Retail Stores Selling Chobani Greek Yogurt (Multi-Region Retailers).

Note: Authors' creation based on NielsenIQ data. The horizontal axis indicates the quarter relative to the entry quarter of a brand's Greek yogurt products for a retailer. For instance, if Chobani enters retailer 1 in quarter 1 of 2008, then 2008 quarter 1 is labeled "0" in the horizontal axis, 2008 quarter 2 is labeled "1", and 2008 quarter 3 is labeled "2". In both panels, the middle bar in the box indicates the median, the upper bar of the box 75 percentile, and the lower bar of the box 25 percentile, the upper (lower) bar is the upper (lower) adjacent value. The adjacent values are located in a distance of 1.5 times the inter-quartile range from the nearest end of the box.

Furthermore, there is considerable variation in Chobani's adoption time given a DMA as panel (a) of Figure A6 displays. Though the median time of adoption in the East is generally earlier, there is considerable difference across DMAs. Similarly, non-trivial temporal heterogeneity exists, though DMAs in the middle region adopt Chobani generally later than the East and West. Again, this indicates that the adoption time is driven by factors other than local demand or location of Chobani plants.

Recall that Figure 2 shows, most retail chains put Chobani products on large shares of their stores soon after they start selling Chobani. A few retail chains, however, carry Chobani products in less than 25% of their stores by the second quarter of selling Chobani. These *slow adopters* operate stores in as many as 69 DMAs out of 71 DMAs in our sample.

To see if these *slow adopters* tend to carry Chobani in a few spatial clusters, we plot the deviation of retailer-DMA-quarter adoption from the retailer-quarter adoption rate. We compute the percentage of stores selling Chobani by DMA m, quarter t for retailer r, generating variable $C\%_{rmt}$. Similarly, we compute the retailer-quarter adoption rate, $C\%_{rt}$. The deviation from the retailer-quarter rate equals $C\%_{rmt} - C\%_{rt}$. Normalize the deviation for comparison across retailers, we have variable $C\%_{rmt}^{norm} = \frac{C\%_{rmt} - C\%_{rt}}{C\%_{rt}}$. The mean deviation in a DMA-quarter is a simple average of $C\%_{rmt}^{norm}$ across retailers.

If the slow adopters select specific DMAs and only sell Chobani in stores located there, for instance, in respond to stronger local demand for Greek yogurt, we would see larger magnitudes of the mean deviation in those DMAs. For instance, a retailer operates in 3 DMAs and has 10 stores in each DMA. One DMA has strong local demand for Greek yogurt and $C\%_{rmt} = 60\%$, while the other two have weak demand for Greek and $C\%_{rmt} = 0\%$. Then $C\%_{rmt}^{norm}$ would be 2, -1, -1, respectively. If all retailers follow this pattern, we would observe the first DMA with a large, positive average $C\%_{rmt}^{norm}$. However, if retailers select different DMAs as focuses to sell Chobani (e.g., $C\%_{rmt} = 60\%$ in the second DMA and $C\%_{rmt} = 0\%$ in the other two), or if they evenly and sparsely sell Chobani (e.g., $C\%_{rmt} = 20\%$ in all three DMAs), we would observe relatively small average $C\%_{rmt}^{norm}$ throughout the map.

Panel (b) of Figure A6 shows that the mean of $C\%_{rmt}^{norm}$ spans from -0.83 to 3.14, and staying small across the majority of DMAs in our sample. In the map, blue denotes a negative mean deviation, while red denotes a positive mean deviation, with darker shades indicating larger magnitudes. It is evident that there is no spatial clustering of DMAs where retailers consistently adopt Chobani either early or late, again dismissing the potential influence of local demand on adoption timing decisions.

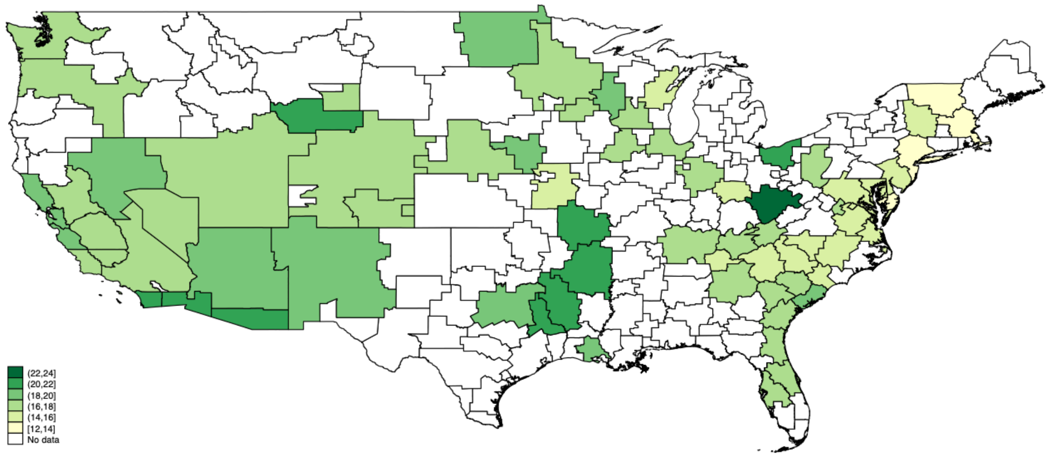
Finally, Figure A7 plots the entry quarter of Chobani by retail-DMA against the sales HHI of traditional yogurt manufacturers (panel (a)) and the differences in sales shares for Dannon and Yoplait (panel (b)) prior to the entry. The absolute Dannon-Yoplait difference in sales shares is an alternative measure of market concentration among incumbent manufacturers; the large the difference of the two leading manufacturers, the more dominated the market by in one of them. In both plots, there is a clear positive relationship between the measure of concentration and the entry time, echoing what Table 4 shows more formally.

A.5 Incumbents' Assortment and Price Responses

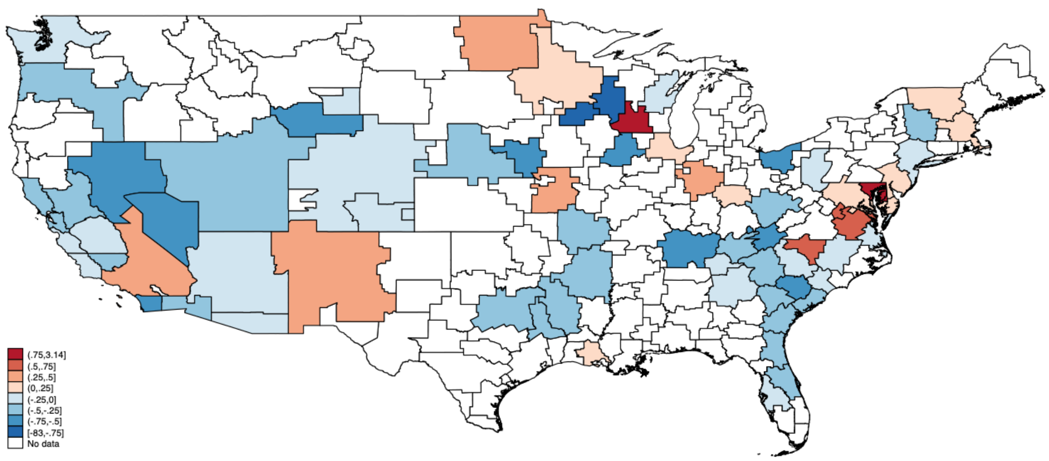
From 2006 to 2009, the popularity of Greek yogurt produced by Chobani surged and expanded into multiple US regions without direct competition from Greek Dannon or Greek Yoplait. In the meantime, Dannon and Yoplait also invested towards the development of traditional yogurt products. Both companies introduced new products that experienced significant success. For example, Dannon Activia in 2006, Dannon DonActivia yogurt drinks in 2007, and Yoplait Fiber One in 2009.

Dannon and Yoplait may adjust the assortment and prices of their traditional yogurt products in response to the entry of Chobani. Specifically, we count the number of traditional yogurt product lines for Dannon and Yoplait in quarters prior to and after the entry of Chobani (i.e., D_{rmt}^{NG} and Y_{rmt}^{NG}, respectively) and before 2010.

We employ an event-study framework to estimate the dynamic responses. Define C_{rmt}^{τ} as a series of variables that indicate quarter relative to the entry of Chobani for a retailer and a DMA. Specifically, C_{rmt}^{-3} refers to quarter 3 prior to Chobani entry, C_{rmt}^{-2} quarter 2



(a) Median Adoption Time by DMA



(b) Mean Deviation from the Retail Adoption Rate by DMA

Figure A6: Spatial Heterogeneity in the Adoption of Chobani

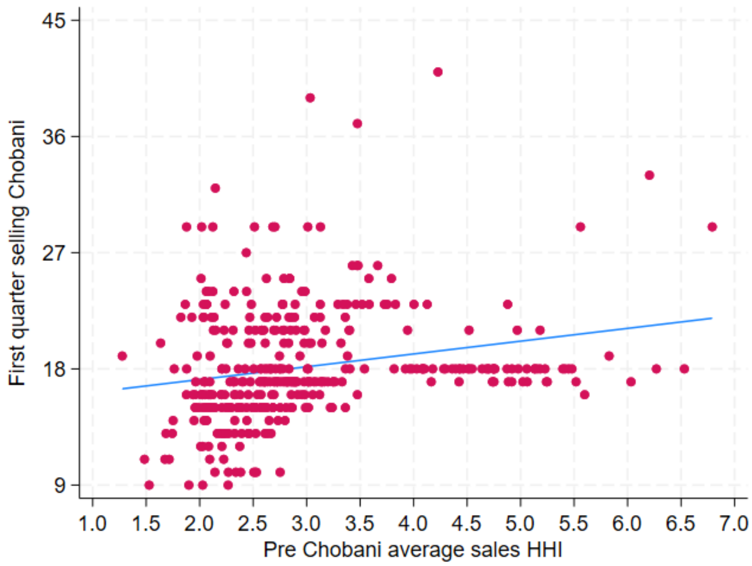
Note: Authors' creation based on NielsenIQ data. In panel (a), the color legend represents the median introduction time of Chobani by retailers in each DMA, with the number indicating the quarter relative to the first quarter of 2006. For example, 12 indicates the first quarter of 2009. Darker color corresponds to later adoption times. In panel (b), blue means a negative mean deviation of the retailer-DMA adoption rate from the retailer adoption rate, while red means a positive mean deviation. Darker the color larger the magnitude of the mean deviation. DMAs with no color are markets not included in the trimmed sample.

prior Chobani, C^{-1}_{rmt} quarter 1 prior Chobani, C^{0}_{rmt} quarter of Chobani entry, C^{1}_{rmt} quarter 1 post-C, and C^{2}_{rmt} quarter 2 post Chobani after Chobani entry.

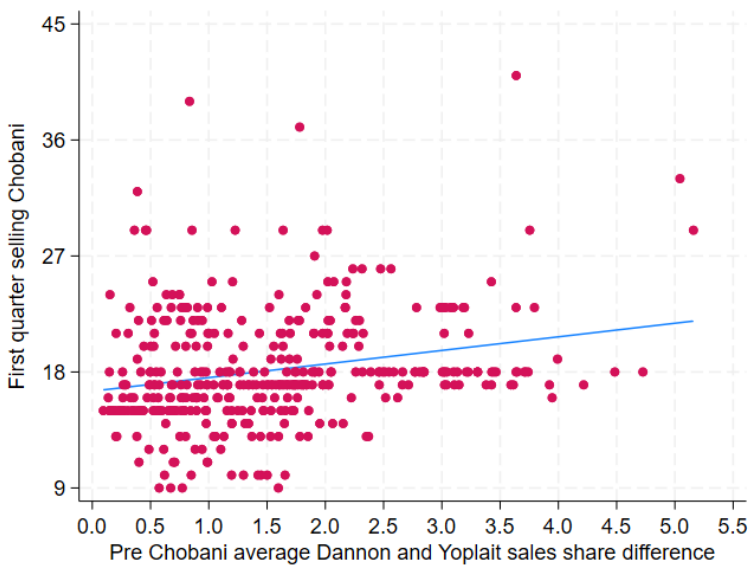
The regression for Dannon is specified as

$$D^{NG}_{rmt} = \alpha + \sum_{\tau=-3}^{\tau=2} \beta^{\tau}_{1} C^{\tau}_{rmt} + \sum_{\tau=-3}^{\tau=2} \beta^{\tau}_{2} C^{\tau}_{rmt} \times HHI^{preC}_{rm} + \beta_3 HHI^{preC}_{rm} + X_{rm} + Z_r + M_{m,q(t)} + \epsilon_{rmt}, \tag{10}$$

where C^{-3}_{rmt} serves as the benchmark and HHI^{preC}_{rm} is the average HHI of brands by sales in the retailer and DMA in a two-year window before Chobani entry (also used in Equation 2). Subscript $q(t)$ indicates year-quarters. Vector $M_{m,q(t)}$ contains DMA-quarter fixed effects that absorb market-specific time-variant shocks. Retailer controls include the average num-



(a) Sales HHI Normalized by Standard Deviation



(b) Share Differences Normalized by Standard Deviation

Figure A7: Chobani entry time and Traditional Yogurt Sales Concentration

Note: Authors' creation based on NielsenIQ data. A dot corresponds to a retail chain in a DMA and its first quarter of selling Chobani Greek yogurt. Year-quarter 1 refers to quarter 1 of 2006, 5 refers to quarter 1 of 2007, etc. The HHI and sales share are normalized by their standard deviations, 0.13 and 0.18, respectively.

ber of stores in the retail chain before Chobani enters and the number of regions in which the chain operates. Other notation follows Equation 2. The regression for Yoplait is similar with the dependent variable being Y_{rmt}^{NG}.

Given a year-quarter, the mean of Dannon's (Yoplait's) number of traditional product lines in a retailer chain and DMA is 11.2 (9.9) with standard deviation of 4.5 (1.9), ranging from 1.3 (3.3) to 19.8 (14.8). The year-quarter sales HHI by retailer and DMA ranges from 0.16 to 0.85 with a mean of 0.36 and standard deviation of 0.12.

The results are reported in Table A2. Overall, there is some weak response by changing the number of traditional product lines. For Dannon, the response is statistically significant, only when the pre-Chobani sales concentration is high. If HHI increases by one standard deviation, the number of traditional Dannon product lines would increase by 2.8 after Chobani entry. Yoplait, in contrast, only have economically weak responses prior to the entry of Chobani, perhaps due to anticipation. Different from Dannon, Yoplait drop a product line in a retail-DMA with high HHI.

Replacing the dependent variable in Equation 10 with the logarithm prices of traditional Dannon's (Yoplait's) product lines, we re-run the regressions. Product-line characteristics, including product brand (e.g., Activia), whether is low/no fat, and whether is flavored, are added as controls. Again, there is limited and weak responses along the price margin. The slight increase in the average price of Yoplait's tradition yogurt echoes the reduction in Yoplait's product lines. This could be the case if Yoplait removes product lines which are relatively unpopular, allowing relatively high equilibrium prices for the remaining Yoplait product lines on the shelf.

	D^{NG} (1)	Y^{NG} (2)	D^{NG} (3)	Y^{NG} (4)	$ln(Dp^{NG})$ (5)	$ln(Yp^{NG})$ (6)	$ln(Dp^{NG})$ (7)	$ln(Yp^{NG})$ (8)
C^{-2}	0.06	-0.31**	0.74	0.63**	-0.01	-0.002	-0.004	-0.02
	(0.34)	(0.15)	(0.70)	(0.27)	(0.01)	(0.01)	(0.02)	(0.02)
C^{-1}	0.25	-0.28*	0.92	0.50*	0.01	0.01	-0.02	-0.03
	(0.48)	(0.16)	(0.80)	(0.27)	(0.01)	(0.01)	(0.02)	(0.02)
C^{0}	0.76	-0.36	-0.33	-0.31	-0.03	0.01	-0.01	0.02
	(0.70)	(0.22)	(1.48)	(0.44)	(0.02)	(0.01)	(0.04)	(0.04)
C^{1}	1.54	-0.23	-5.22*	-1.59*	-0.02	0.01	0.07	0.09
	(0.97)	(0.30)	(2.84)	(0.91)	(0.02)	(0.02)	(0.06)	(0.05)
C^{2}	1.32	-0.43	4.6	0.88	-0.01	0.04*	0.001	-0.06
	(0.97)	(0.43)	(4.28)	(1.81)	(0.02)	(0.02)	(0.12)	(0.10)
C^{-2}HHI			-1.42	-2.21***			-0.01	0.04
			(1.05)	(0.52)			(0.04)	(0.04)
C^{-1}HHI			-1.5	-1.95***			0.07	0.09**
			(1.73)	(0.66)			(0.05)	(0.04)
C^{0}HHI			4.08	0.38			-0.08	-0.07
			(5.17)	(1.48)			(0.12)	(0.10)
C^{1}HHI			23.19**	5.01			-0.32	-0.26
			(9.30)	(3.29)			(0.20)	(0.18)
C^{2}HHI			-11.2	-4.06			-0.03	0.33
			(14.26)	(6.55)			(0.40)	(0.37)
DMA-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Retailer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product controls	No	No	No	No	Yes	Yes	Yes	Yes
R^2	0.81	0.78	0.81	0.78	0.78	0.81	0.78	0.82
No. Observations	906	906	906	906	12,014	9,780	12,014	9,780

Note: * p-value$<$ 10%, ** p-value$<$ 5%, *** p-value$<$ 1%. Standard errors are clustered at the retailer level and in parentheses. Interaction terms end with HHI. The term interacting with variable C^{τ} is specified in row "interact w/". Retailers in DMAs where Chobani enters first in the corresponding region are excluded from the regressions. *No.* means the number of. In the top row, D refers to Dannon, and Y refers to Yoplait. The dependent variables are the numbers of product lines in columns (1) to (4) and the logarithm product-line prices in other columns.

Table A2: Assortment and Price Responses of Incumbents

B Sample Statistics

Summary statistics of the sample for demand estimation are reported below. A national-brand manufacturer has 2 to 30 product lines captured by the sample. The incumbents, Dannon and Yoplait, have the largest numbers of product lines, while Chobani has 6. Over the window from 2006 to 2016, Chobani, Dannon, and Yoplait products are widely sold across DMAs and retailers, at least in some quarters of time. Also worth noticing, Chobani and Fage are the only two manufacturers that specialize in Greek yogurt products. Other manufacturers produce both traditional and Greek yogurt.

Manuf.	#products	#DMAs	#years	#retailers	Greek%	Prices	Vol%
Breyers	7	52	7	57	0.000	0.102	0.027
Chobani	6	70	9	82	1.000	0.199	0.051
Crowley	2	13	11	8	0.000	0.093	0.015
Dannon	30	70	11	87	0.181	0.141	0.099
Fage	5	70	10	80	1.000	0.250	0.009
Johanna	4	33	11	36	0.000	0.096	0.025
Tillamook	3	20	11	19	0.365	0.144	0.028
Wells	2	49	2	34	0.000	0.113	0.009
Yoplait	18	70	11	86	0.080	0.131	0.138
Private label	532	70	11	85	0.189	0.100	0.064

Note: The first nine rows report statistics for the nine national-brand manufacturers, while the last row reports statistics for all private-label product lines. The columns with # sign report the total number of products/DMAs/years/retailers that a manufacturer's products are recorded in the sample. *Greek%* is the volume share of Greek products for a given manufacturer. *Price* is the observation-weighted average price of products sold for a given manufacturer. *Vol%* is the observation-weighted average market volume share products sold for a given manufacturer.

Table B3: Additional Statistics of the Sample

On average, each retailer-DMA-quarter market contains 28.93 products lines with a standard deviation of 9.01. An average of 4.49 manufacturers compete in the market with a standard deviation of 1.09. The outside share has a mean at 0.69 and a standard deviation of 0.14.

Table B4 displays the full list of national-brand product lines in the sample. Each row contains a product line. Their manufacturer, brand anme, Greek, fat, flavor, and size features are also reported. List of 532 private-label products is too long to place here and available upon request.

Table B4: Full List of Product Lines

Size category	Greek, 1 if yes	Low/No fat, 1 if yes	Plain, 1 if yes	Brand Name	Manufacturer
1	0	1	0	Breyers	Breyers
3	0	1	0	Breyers	Breyers
1	0	1	0	Breyers Creme Savers	Breyers
1	0	1	0	Breyers Light	Breyers
1	0	1	0	Breyers Smart!	Breyers
1	0	1	0	Breyers Smooth & Creamy	Breyers
3	0	1	0	Breyers Smooth & Creamy	Breyers
1	1	1	0	Chobani	Chobani
3	1	1	0	Chobani	Chobani
3	1	1	1	Chobani	Chobani
3	1	1	0	Chobani Champions	Chobani
1	1	1	0	Chobani Flip	Chobani
1	1	1	0	Chobani Simply 100	Chobani
1	0	1	0	Crowley	Crowley
3	0	1	1	Crowley	Crowley
3	0	0	1	Dannon	Dannon
3	0	1	0	Dannon Creamy Fruit Blend	Dannon
2	0	0	0	Dannon Dan O Nino	Dannon
3	0	0	0	Dannon Dan O Nino	Dannon
3	0	1	0	Dannon Danimal	Dannon
2	0	1	0	Dannon Danimal Crush Cups	Dannon
1	0	1	0	Dannon Light N Fit	Dannon
1	1	1	0	Dannon Light N Fit	Dannon
3	0	1	0	Dannon Light N Fit	Dannon
3	1	1	0	Dannon Light N Fit	Dannon
2	0	1	0	Dannon Light N Fit Carb	Dannon
3	0	1	0	Dannon Lowfat	Dannon
1	0	1	0	Dannon Lowfat Fruit	Dannon
2	0	1	0	Dannon Lowfat Fruit	Dannon

Table B4 – Continued

Size category	Greek, 1 if yes	Reduced fat, 1 if yes	Plain, 1 if yes	Brand Name	Manufacturer
3	0	1	0	Dannon Lowfat Fruit	Dannon
2	0	1	0	Dannon Natural	Dannon
1	0	1	0	Dannon Natural Flavor	Dannon
1	1	1	0	Dannon Nofat	Dannon
3	0	1	1	Dannon Nofat	Dannon
2	0	1	0	Danone Activia	Dannon
3	0	1	0	Danone Activia	Dannon
3	1	1	0	Danone Activia	Dannon
1	1	1	0	Danone Oikos	Dannon
3	1	1	0	Danone Oikos	Dannon
1	0	1	0	Stonyfield	Dannon
1	1	1	0	Stonyfield	Dannon
3	0	1	0	Stonyfield	Dannon
3	0	1	1	Stonyfield	Dannon
2	0	1	0	Yo Crunch	Dannon
3	0	1	0	Yo Crunch	Dannon
1	1	1	1	Fage Total 0%	Fage
3	1	1	1	Fage Total 0%	Fage
1	1	0	0	Fage Total 2%	Fage
1	1	0	1	Fage Total 2%	Fage
1	1	1	0	Fage Total 2%	Fage
1	0	1	0	La Yogurt	Johanna
3	0	1	0	La Yogurt	Johanna
3	0	1	1	La Yogurt	Johanna
1	0	1	0	La Yogurt Light	Johanna
1	0	1	0	Tillamook	Tillamook
1	1	1	0	Tillamook	Tillamook
3	0	1	0	Tillamook	Tillamook
1	0	1	0	Blue Bunny Light	Wells
1	0	1	0	Blue Bunny Lite 85	Wells

Table B4 – Continued

Size category	Greek, 1 if yes	Reduced fat, 1 if yes	Plain, 1 if yes	Brand Name	Manufacturer
1	0	0	0	Liberte Mediterranee	Yoplait
3	0	0	1	Mountain High	Yoplait
3	0	1	0	Mountain High	Yoplait
3	0	1	1	Mountain High	Yoplait
1	0	1	0	Yoplait	Yoplait
1	1	1	0	Yoplait	Yoplait
2	0	1	0	Yoplait	Yoplait
2	1	1	0	Yoplait	Yoplait
3	0	1	0	Yoplait	Yoplait
2	0	1	0	Yoplait Go-Gurt	Yoplait
3	0	0	0	Yoplait Go-Gurt	Yoplait
3	0	1	0	Yoplait Go-Gurt	Yoplait
3	0	0	0	Yoplait Go-Gurt Fizzix	Yoplait
3	0	1	0	Yoplait Grande!	Yoplait
3	0	1	0	Yoplait Kids	Yoplait
1	0	1	0	Yoplait Light Thick & Creamy	Yoplait
1	0	1	0	Yoplait Thick & Creamy	Yoplait
1	0	1	0	Yoplait Whips!	Yoplait

Note: National-brand product lines are included in the table. Size category 1 means size no larger than 8 ounces, 2 means 8 to 16 ounces, and 3 means larger than 16 ounces.

C Manufacturer Profit Approach

To draw comparisons between retailers, we add the assumption that the difference in vertical transfers is proportional to the effect that the swap has on the incumbent firm's expected variable profit:

$$\mathbb{E}[V_{kt} - V_{jt}] = \theta = \xi \mathbb{E}[\pi^f(O_t, \partial_{jk} A) - \pi^f(O_t, A)]$$

and, analogously to the retail case, we assume that our estimate of manufacturer expected variable profit change $\Delta_{jk}\Pi^f(A) \equiv \pi^f(O_t, \partial_{jk} A) - \pi^f(O_t, A)$ is sufficiently well estimated.

We use the change in expected variable profit of the incumbent firm as it is a natural upper bound on the amount that the manufacturer is willing to transfer to the retailer to maintain its product on the shelf, and its value relative to $\Delta\Pi^r$ is informative of how costly it is for the manufacturer to maintain the product on the shelf.

If $\xi = 1$, then the substitution treat allows retailers to capture all the manufacturer surplus in expectation. For $\xi < 1$, the gains for the manufacturer incumbent from maintaining the product on the shelf more than compensate the amount of vertical transfer it must pay relative to the entrant.

Our moment condition m_{jk} for the swap pair (j, k) can thus be written as:

$$\mathbb{E}[m_{jk}(O_t, \theta)] \equiv \mathbb{E}[\Delta_{jk}\Pi^r(O_t, A) - \xi \Delta_{jk}\Pi^f(O_t, A)] \leq 0 \tag{11}$$

If the swap has a negative impact on the profits of the incumbent manufacturer, then Inequality 11 provides a lower bound for the magnitude of ξ.

D Vertical Transfer Model

Vertical contracts with manufacturers affect retailer profits by reducing the fixed costs of assortment and/or inducing money transfers, such as slotting fees and loyalty rebates (Hristakeva, 2022; Viswanathan et al., 2020). For incumbent manufacturers, the vertical contract agreements only make sense if the necessary vertical transfers are lower than the derived increase in profits, e.g., through guarantee preferential assortment (e.g., excluding novel products) and shelf positions (e.g., placing own products in the middle of the shelf). This creates a trade-off for the retailer that must balance between cost savings and money transfers from vertical contracts, and the potential increase in profits from adding a new entrant's product that is more appealing to consumers than the incumbent's product.[17]

We model the presence of vertical contracts by including product-specific vertical transfers into the retailer's expected profits from an assortment choice. Conditional on the information set I_r, the retailer chooses A to maximize expected profits:

$$\max_{A \in \{0,1\}^J} \mathbb{E}[\pi^r(O_t, A) + \sum_{j \in J} A_j \left(V_{jt} - F_{jt}\right) | I_r],$$

where V_j represents vertical transfers. Variable F_j denotes the fixed cost of adopting product j in the assortment, including the opportunity cost of not having products from non-yogurt categories.

The expectation of variable profits is applied over the distribution of demand and marginal cost shocks. To make the model empirically tractable, we assume that F is a combination of a common component and a product-specific unobserved cost shock:

$$F_{jt}(A) = \eta + \nu_{jt},$$

and that $\mathbb{E}[\nu_{jt}|A, I_r] = 0$.

Moment conditions: Based on a revealed preference approach, we can assume that the observed assortment choice A generates higher profits than any other $A' \in \{0,1\}^J$. In principle, we could use this condition to estimate bounds for the overall cost of adding or removing products from the shelf. Because we only want to understand the cost implications of keeping incumbents instead of adding entrants, we focus on product swaps for a given size of assortment.

To capture swap deviations from an observed product portfolio, A, we introduce a product-pair swap operator ∂_{jk}, which applies on A as follows:

$$\partial_{jk} A = (A_1, ..., A_{j-1}, 1 - A_j, A_{j+1}, ..., A_{k-1}, 1 + A_k, A_{k+1}, ..., A_J).$$

The operator can only be applied for a pair (j, k) if $A_j = 1$ and $A_k = 0$.

Let $\Delta_{jk}\Pi^r(O_t, A) \equiv \pi^r(O_t, \partial_{jk}A) - \pi^r(O_t, A)$ be the difference in the retail variable profits

[17] See Asker and Bar-Isaac (2014) for a deeper theoretical discussion of the effects of vertical contracts on market foreclosure.

from the swap. The revealed preference condition implies:

$$\mathbb{E}[\Delta_{jk}\Pi^r(O_t, A) - (V_{jt} - V_{kt}) - (\nu_{jt} - \nu_{kt})|I_r] \leq 0, \tag{12}$$

where the common component of the fixed cost drops out because the swap does not change the total number of products in A.

As is standard in the literature on inference with moment inequalities, we assume that variable profits are sufficiently well estimated, i.e., $\Delta_{jk}\hat{\Pi}^r(O_t, A) = \mathbb{E}[\Delta_{jk}\Pi^r(O_t, A)] + u_{jkt}$, where u_{jkt} is a measurement error with property $\mathbb{E}[u_{jkt}|A, I_r] = 0$. Moreover, we assume that the difference in vertical transfers between products is known by the retailer at the time of choosing the assortment and can be represented as $\mathbb{E}[V_{jt} - V_{kt}|I_r] = \theta_{jk} + v_{jkt}$, and $\mathbb{E}[v_{jkt}|A, I_r] = 0$. The later condition assumes that the error term is uncorrelated with the assortment choice.

Taking those assumptions, we can rewrite Inequality 12 as:

$$\Delta_{jk}\hat{\Pi}^r(O_t, A) - \theta_{jk} - (u_{jkt} + v_{jkt} + \nu_{jkt}) \leq 0, \tag{13}$$

where $\nu_{jkt} \equiv \nu_{jt} - \nu_{kt}$ and $\mathbb{E}[u_{jkt} + v_{jkt} + \nu_{jkt}|A, I_r] = 0$.

Inequality 13 can be used to estimate lower bounds for the difference in vertical transfer between the incumbent and the entrant for each retailer. Intuitively, the distortion in assortments, represented by the difference in expected retail profits implied by the swap, is informative about the minimum vertical transfers needed from the incumbent to avoid losing its space in the shelf. Furthermore, if the new product generates higher expected profits than the incumbent product for the retailer, then our model rationalizes the current assortment choice by having vertical transfers from the incumbent that are as high as those from the potential entrant.

Test statistic: To perform inference over the moment inequalities derived from our model, we follow the best practices presented in Canay et al. (2023). Define L as the total number of product-pair swaps evaluated, $\mathbf{m} \equiv (m_1, .., m_L)$ the corresponding vector of moment conditions, and T as the total number of markets available.

For a given value of θ, the test statistic for the hypothesis $H_\theta : \mathbb{E}[\mathbf{m}(O_t, \theta)] \leq 0$ takes the form:

$$T_n(\theta) = \max_{l \in 1,..,L} \frac{\sqrt{n}\bar{m}_l(\theta)}{\hat{\sigma}_l(\theta)},$$

where $\bar{m}_l(\theta) = \frac{1}{n}\sum_{i=1}^n m_l(O_i, \theta)$ and $\hat{\sigma}_l(\theta) = \sqrt{\frac{1}{n}\sum_{i=1}^n (m_l(O_i, \theta) - \bar{m}_l(O_i, \theta))^2}$ are the samples analogous to the individual swap moment and its standard deviation. According to Chernozhukov et al. (2019), this max-type test statistic has good properties in settings where the number of moment inequalities is large relative to the sample size, as in our case.

In order to obtain more accurate bounds, the critical values are computed using the bootstrap version of Chernozhukov et al. (2019)'s two-step approach. This variation uses bootstrap draws of the profit difference estimates to first infer which moment inequalities are binding, to then construct max-type test statistics for each bootstrap using only binding moments, and finally computes critical values based on the quartiles of that distribution.

Canay et al. (2023) offer a detailed description of the method. With the test statistic and critical values for a grid of θ at hand, we can construct confidence intervals simply by collecting all values of the grid of θ that do not reject the hypothesis.

E Repurchase Rates

A repurchase is defined as consumers purchasing the same product on consecutive shopping trips. We restrict it to successive trips assuming a first-order Markov process on choices. To construct the repurchase probabilities, we use the Nielsen Consumer Panel Data.

F Alternative Value of κ

With only Equation 6, we cannot separately identify κ and the marginal cost without markup instruments in subsection 4.3. Instead, we build from De Loecker and Scott (2022) and impose an equivalence condition between the average manufacturer markup estimates from a production function approach (De Loecker and Warzynski, 2012) and from a demand approach.

In our model, average manufacturer markups are a function of retail margins and observed variables. We can thus use the equivalence to compute an approximation for κ and proceed with the estimation of variable profits. Specifically, for a given production-function estimate of the average manufacturer markup during year y, $\hat{\mu}_y$,

$$\frac{\bar{p}_y - (1-\kappa)\bar{\Delta}^r_y}{\bar{p}_y - (1-\kappa)\bar{\Delta}^r_y - \bar{\Delta}^f_y(\kappa)} = \frac{\bar{w}_y}{\bar{mc}_y} \approx \hat{\mu}_y,$$

where elements with an upper bar are quantity weighted averages from the original variable.

In this version of the manuscript, we use the estimate of the average manufacturer's markup by Jaumandreu and Lopez (2024) for the food segment that is constructed using the extension of the production function approach from Doraszelski and Jaumandreu (2019). They estimate an average manufacturer markup of 1.5 for the US food manufacturing during the sample period ($\hat{\mu}_y = 1.5$), which in our case implies a κ of 0.9.