How Do Vertical Contracts Affect Product Availability? An Empirical Study of the Grocery Industry

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Abstract

Producers frequently provide financial incentives to retailers in order to gain distribution for their products. These payments often take the form of vendor allowances: lump-sum transfers to retailers that do not directly depend on volume. To quantify the size of vendor allowances and their effects on product assortments and welfare, I develop a framework to identify lump-sum transfers using only data on retail prices, sales, and assortments. Without making any assumptions about producer and retailer bargaining, set estimates of vendor allowances are recovered. Additionally, by assuming that producers make take-it-or-leave-it offers, point estimates can be obtained. Lower bounds from set estimates imply that, on average, vendor allowances amount to at least 4.7% of retailer revenues. I apply model estimates to simulate how market outcomes change in the absence of vendor allowances. Counterfactual simulations predict that retailers fare worse, product variety is reduced as retailers replace "niche" products with "mainstream" options, but consumers nevertheless are better off. Small producers, which offer high-velocity products, increase market distribution and profits, but, absent marginal cost data, consequences for large producers are uncertain.

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1 Introduction

In many industries producers reach consumers only through the retail sector, which accounts for a large fraction of the U.S. economy, totaling $5.0 trillion in 2013. Yet, due to limited shelf-space, retailers carry only a subset of all available products. Therefore, retailers' product assortment choices have large consequences for consumer welfare and firm profits. In addition to consumer preferences and retail competition, vertical contracts with producers are main determinants of retailers' product-assortment choices. Contracts between producers and retailers commonly consist of wholesale prices and vendor allowances. I define vendor allowances as lump-sum transfers to retailers that do not directly depend on volume. They can take the form of slotting fees, warehousing allowances, vendor cash discounts, allowances for damaged goods, or operating support (e.g. stocking personnel).[1] Such financial incentives are extensively used by manufacturers to gain product distribution, hence, vendor allowances likely have a direct impact on the product assortments selected by retailers.

Given their potential impact on product availability and total welfare, it is not surprising that vendor allowances have been the subject of policy discussion. Slotting fees were at the heart of Senate hearings and Federal Trade Commission (FTC) workshops in 1990's and the early 2000's, with repeated attempts from small business organizations to implement bans on slotting allowances.[2] Nevertheless, there is little consensus about the equilibrium effects of vendor allowances on product assortments or welfare of market participants. Theorists have presented models in which vendor allowances are either anti-competitive or efficiency-enhancing. In fact, the FTC abstains from providing clear guidelines on the use of slotting fees, citing unclear theoretical predictions and scarce empirical evidence as a rationale. Unfortunately, the proprietary nature of vertical contracts and firm costs has been an impediment to empirical analysis that could resolve these conflicting narratives.

Taking into account these challenges, this paper addresses two main questions. First, how large are unobserved vendor allowances? To answer this question, I develop a general framework to identify vendor allowances when only limited data are available, including information on retailers' prices, sales, and assortments. Importantly, the analysis does not require data on vertical contracts or firm costs, which are typically unobserved. Instead, by exploiting the information from the observed retailers' assortment choices, vendor allowances are estimated using a revealed preference approach. I apply the framework to the U.S. yogurt grocery market and find that, on average, vendor allowances are at least 4.7% of retailers' revenues, and that these transfers are larger for new

[1] The IRS broadly defines "vendor allowances" as payments "intended to offset retailer's costs of selling the vendor's products in its stores". In practice, this could also include payments, such as promotional allowances, which are calculated on a per-unit basis rather than a fixed lump-sum.

Initially, the term slotting fees was used to refer to one-time payments from producers to retailers to place a product in retailers' stores. The term is now broadly used to refer to a variety of vertical arrangements, in which producers make lump-sum payments to retailers (Federal Trade Commission (2014)).

[2] See Bloom et al. (2000), Federal Trade Commission (2001), Federal Trade Commission (2003).

products. The second question asks: what are the equilibrium consequences of vendor allowances on product availability and welfare? I use model estimates to simulate U.S. grocery yogurt market outcomes in a counterfactual scenario that eliminates vendor allowances. Results show that, in the absence of vendor allowances, retailers' profits decrease, whereas small producers increase the number of products they supply in the market.

It is worth noting that, while vertical contracts and product availability have been examined in the empirical industrial organization and marketing literatures, the two topics have largely been considered separately. In contrast, a contribution of the empirical model is that it integrates both vertical contracting and product assortment choices into the same framework. This proves essential for quantifying vendor allowances and studying their effects on market outcomes.

The empirical framework integrates vertical negotiations with retailers' product assortment choices and retail price competition. The setup is static, taking the identities and characteristics of products, retailers, and markets as given. Interactions between producers, retailers, and consumers are modeled as a four-stage game. First, producers and retailers negotiate over product-specific wholesale prices and vendor allowances. In the second stage, retailers simultaneously choose product assortments, which is followed by retail price competition modeled as a differentiated-product Bertrand-Nash game.[3] Last, consumers observe retail assortments and prices, and choose utility maximizing product-retailer pairs. I develop two versions of the model that differ in the assumptions introduced at the negotiations stage only. The general version makes no assumptions about producer and retailer bargaining power and delivers set estimates of vendor allowances. The second version assumes that producers have all bargaining power and make take-it-or-leave-it wholesale price and vendor allowance offers to retailers. The additional structure to the negotiations stage allows me to recover point estimates of vendor allowances up to a normalization for one product.

I apply the framework to the U.S. grocery yogurt market between 2004 and 2010 using the IRI academic dataset. The yogurt market presents a good setup for studying vendor allowances and their consequences for product assortments for at least two reasons. First, the yogurt category is characterized by a proliferation of differentiated product options, limited shelf space, and high costs of holding inventories due to refrigeration. Thus, only a small fraction of all product options are supplied by each individual retailer and retailer assortment choices substantially restrict consumer choice and total welfare. Second, vendor allowances are known to play an important role for most segments of the grocery industry, and especially for refrigerated categories.

The model is estimated in two steps. First, standard techniques, as in Berry et al. (1995), are applied to consumer demand and retail pricing analyses: demand is estimated using the random-coefficients logit model, while chain markups are recovered from the optimality conditions prescribed by the Bertrand-Nash game. In the second step, the general and second versions of the model are taken to the data. In both strategies vendor allowances are inferred as the transfers necessary to ratio-

[3] Interviews with industry representatives confirmed that grocery chains have final decision rights over the yogurt assortments supplied.

nalize observed assortments. The estimation exploits retailer incentive compatibility conditions: if observed product choices are an equilibrium, then no chain can unilaterally increase its expected profits by changing its product assortment.

A simple example illustrates how bounds on vendor allowances can be inferred from retailers' product assortment choices. Suppose retailer 1 carries *Yoplait Trix* but it could switch to *Breyers Light*, leaving the rest of its assortment unchanged. Retailer 1's variable profit under its observed product offerings is \$20,500 per store and its variable profits under the alternative assortment would have been \$20,600. Then the estimation infers that the vendor allowance received for *Yoplait Trix* must be at least \$100 per store. The point-identification technique utilizes the same deviations. However, the assumption that producers make take-it-or-leave-it offers necessitates that, under equilibrium contracts, retailers' incentive compatibility conditions are exactly satisfied.

The separation of retail assortment decisions and price competition allows me to separately identify wholesale prices and vendor allowances. Conditional on product assortment choices, retail pricing and demand analyses identify downstream variable profits. Then, using the observed retailer assortment choices, I identify vendor allowances as the transfers needed to satisfy retail incentive compatibility conditions. To ensure consistency of first-step parameter estimates, I assume that retailers' assortment choices are based on observables: retailers choose assortments before the realization of structural shocks to demand and retailer marginal costs. The assumption is credible because grocery chains alter assortments at only a few predetermined occasions due to high fixed costs of these changes. In contrast, prices can be easily adjusted as market conditions change; thus, structural shocks are allowed to affect retailers' pricing decisions. I use cost-based instrumental variables to address price endogeneity.

Model estimates suggest median consumer price elasticity of -3.5 and median retailer variable profit margins on the order of 43%. The distribution of vendor allowances' lower bounds implies that paid transfers constitute at least 4.7% of retailer revenues. Under the assumption that producers make take-it-or-leave-it offers, producers pay higher vendor allowances for new products. In addition, estimates show substantial heterogeneity in the vendor allowances paid across products: retailers receive higher vendor allowances as compensation for supplying low-velocity ("niche") products, such as soy yogurts.[4]

Next, I simulate a counterfactual scenario in which vendor allowances are eliminated. Keeping retailer shelf space and wholesale prices fixed, I find new equilibrium assortments and prices.[5] Results for five markets show that, absent vendor allowances, consumer surplus increases by 2.4% on average. This benefit amounts to an average yearly increase of \$3.3 million in consumer surplus for the selected markets. Retail markups and prices decrease, as the new assortments consist of high-velocity and low wholesale price products. In addition, competing chains carry more homogenous

[4]Product velocity refers to the sales of the product. For example, low-velocity products are slow-moving products, which record few sales in a time period.

[5]The estimation approach does not allow me to recover producer marginal costs. As a result, the counterfactual analysis keeps wholesale prices fixed.

assortments, replacing "niche" products with "mainstream" options. These findings suggest that producers employ vendor allowances to obtain distribution for "niche" products; consequently, these financial incentives lead to increased product variety in a market.[6] Retailers' variable profits are, on average, 3% higher; however, this increase is not sufficient to counteract the loss of vendor allowances' profits. Small producers, which primarily offer low wholesale price and high-velocity products, expand their market distribution, leading to increased revenues (and profits). However, without product-specific marginal cost estimates, I cannot determine the change in profitability for large producers.

Two producers lose market coverage for some of their products in the counterfactual: Dean Foods and Groupe Danone. The operational structure of Dean Foods implies that a large component of the vendor allowances paid by the producer is in the form of cost savings from distributing other product categories.[7] Thus, it is optimal for Dean Foods to supply yogurt products because it is able to exploit economies of scope in distribution. Groupe Danone may be using vendor allowances to supply high-margin products, or to exclude products that compete with its "mainstream" offerings. Assuming producers' margins are the same across products implies that Groupe Danone pays vendor allowances to exclude competitors. However, without marginal cost data, it is not possible to rule out large differentials across products' marginal costs, which would imply that the observed assortment maximizes total vertical profits. Nevertheless, the paper provides a road map for analyzing exclusionary incentives in future work if marginal cost data can be obtained.

The rest of the paper proceeds as follows. Section 2 describes related literature. Section 3 describes the data. I outline both versions of the model in Section 4, and Section 5 discusses the details for the empirical strategies. Section 6 reports results from demand and vendor allowances estimation. Counterfactual experiments and implications are described in Section 7. Section 8 concludes.

2 Related Literature

Even though manufacturers rely extensively on financial incentives to gain product distribution, theoretical predictions do not give clear guidance on the welfare effects of vendor allowances. On the one hand, the use of vendor allowances may lead to anti-competitive practices. Shaffer (1991) shows that lump-sum transfers from producers to retailers increase market prices. In addition, vendor allowances may be used to foreclose a competitor (Shaffer (2005), Marx and Shaffer (2007), Asker and Bar-Isaac (2014)), or may affect disproportionately smaller producers (Innes and Hamilton (2006), Shaffer (2005)). Marx and Shaffer (2010) show that powerful retailers may find it optimal to limit shelf space in order to extract higher rents from producers. On the other hand, vendor

[6] I refer to "product variety" as the number of unique products offered in a market.

[7] Dean Foods distributes its products through a wide direct-store-delivery system, and this system was developed to accommodate its core milk business.

allowances may arise as a mechanism for the efficient allocation of scarce shelf space (Sullivan (1997)). Other welfare-enhancing mechanisms include the use of vendor allowances to signal product quality (Lariviere and Padmanabhan (1997)), to increase product variety (Kuksov and Pazgal (2007), Innes and Hamilton (2013)), to ensure that the assortment which maximizes vertical profits is supplied (Aydin and Hausman (2009)), and to coordinate non-contractible manufacturer sales effort (Foros et al. (2009)).

A few empirical studies have investigated some of these competitive effects in the context of new product introductions. Sudhir and Rao (2006) use proprietary data on whether slotting fees were offered to a single grocery chain and find that slotting fees arise due to retailer opportunity costs. They also find support for the signaling efficiency hypothesis. Bloom et al. (2000) use a survey of retailers and manufacturers and find that both upstream and downstream firms agree that slotting fees influence assortments and that these payments are associated with the exercise of retailer market power. However, the authors find that producers and retailers disagree on the effect of lump-sum payments on producer profitability and on the differential impact across small and large producers. I extend this literature by investigating the effect of lump-sum transfers on product availability and by quantifying the welfare effects for market participants.

To that end, I connect two largely disparate empirical literatures, those on endogenous product choice and vertical relationships. The endogenous product choice papers incorporate both product assortment decisions and price competition in the analysis of differentiated product markets. Misra (2008) investigates the assortment decisions across grocery stores within a chain. Draganska et al. (2009b) focus on producer market distribution of ice-cream flavors and show that welfare implications can differ significantly once strategic product assortment choices are taken into account. Eizenberg (2014) studies the personal computer market and investigates how innovation affects producer choice of product assortment. Berry and Waldfogel (1999) and Berry et al. (2014) analyze optimal variety in the radio industry, while Thomas (2011) looks at optimal product variety offered by multinational laundry detergent manufacturers. These works show that counterfactual changes in the underlying demand, firm costs, or market conditions can affect both equilibrium offerings and prices. However, this literature does not address the effects of vertical arrangements on product availability.

Papers in the vertical relations literature investigate the effects of firm bargaining power on equilibrium terms of trade, while taking the assortment decisions as exogenous to the model. Papers examining vertical contracts in the grocery sector include Sudhir (2001), Villas-Boas (2007), Draganska et al. (2009a), Bonnet and Dubois (2010), Bonnet and Dubois (2015). When the assortment decision is endogenized, producer profit functions become discontinuous in wholesale prices. Thus, I cannot use the techniques developed in these vertical relations' papers to back out vendor allowances and producer marginal costs. As a result, this paper focuses on the assortment decision and takes an agnostic stand on producer competition. Analyses of vertical contracts in other industries include video rentals (Mortimer (2008) and Ho et al. (2012)), cable television (Crawford and Yurukoglu (2012)), and medical device market (Grennan (2013)).

A few papers investigate both endogenous product choice and vertical contracts. Ho (2009) analyzes how hospital characteristics and bargaining ability may affect insurer-hospital networks using the moment inequalities of Pakes et al. (2015). Conlon and Mortimer (2014) analyze product assortment decisions in the context of a vertical rebate. Viswanathan (2012) analyzes the competitive effects of another vertical arrangement: category captaincy. The author investigates how category captains affect retail assortments when chains act as local monopolists. Israilevich (2004) uses observed wholesale prices to infer slotting fees and analyzes the effect of slotting fees on the number of products supplied in a chain. A strength of this paper is that the framework does not require data on wholesale prices as they are rarely available to researchers, and, in contrast to Israilevich (2004), the model endogenizes retailer price competition.

3 Industry and Data

The extensive use of vendor allowances in the grocery industry makes it a good context to study the effects of these payments on welfare and product availability. The median vendor allowance receipts, reported by public grocery chains, correspond to 7% of retailer revenues.[8] In addition, brick-and-mortar stores are faced with constrained shelf space, which highlights the importance of assortment decisions for firm profits and consumer surplus. Within the grocery industry, I apply the framework to yogurt products. The category offers several advantages as a context to study product assortment decisions and vertical contracts. First, it is characterized by a proliferation of products, while retailers carry only a small number of the product options available. For the analyzed sample the average retailer offers 31 yogurt product lines selected from more than 100 non-private label options. Second, two producers, Groupe Danone and General Mills, control the majority of market sales. These producers capture, on average, 70% of yogurt sales during the sample period. At the same time, the industry is populated with a number of small and regional producers who compete to place their products on grocers' shelves. As a result, I can investigate whether the use of vendor allowances affects small producers disproportionately. Last, yogurts' perishability alleviates consumer-stockpiling considerations, which allows me to employ static demand techniques for the consumer demand estimation.

The model is applied to the academic Information Resources Inc. (IRI) dataset, using data on grocery chains' quarterly sales and units sold in 42 geographical markets in the U.S. for the sample period 2004-2010.[9] I supplement the IRI dataset with information on grocery chains and market

[8] I collect data on reported vendor allowances from public U.S. grocery companies' annual reports. Vendor incentives reported in accounting statements include promotional allowances, product placement allowances, cash discounts, warehouse allowances, slotting allowances, swell allowances for damaged goods, vendor rebates and credits, wage reimbursements, long-term contract incentives.

[9] For more information on the IRI dataset see Bronnenberg et al. (2008) who provide a detailed description of the

Table 1: Dataset Summary Statistics

	mean	median	sd	min	max
Market population (millions)	3.8	2.9	3.5	0.5	19.5
Yogurt consumption (servings)	27.3	28.5	5.90	18.7	36
Observed # of chains (in a market)	4	4	1.9	1	11
Chain market sales ($ millions)	192	159	168	5	1,147
Price	0.8	0.8	0.29	0.2	4.2
Flavors	5.6	4	5.8	1	50

Notes: Yogurt consumption is measured as yearly per capita yogurt consumption in 6oz servings. Data are obtained from USDA Per Capita Consumption of Major Food Commodities Table.

characteristics obtained from ReferenceUSA. Producer and retailer input and operations costs are collected from government agencies such as the U.S. Energy Information Administration, the Bureau of Labor Statistics, and the U.S. Department of Agriculture. Table 1 shows key descriptive statistics, while additional information is available in Appendix A.

The academic dataset is drawn from IRI's national sample of stores, and it covers 74 distinct grocery retailers. On average, I observe 4 retailers in a market, and I can identify the same retailer across 3 markets. Concerns that I observe only a subsample of all retailers in a market are alleviated for two reasons. First, I observe the main grocery competitors in a market, which account for 50% of market sales on average. Second, demand estimation results show that retailers do not compete heavily in the yogurt category.

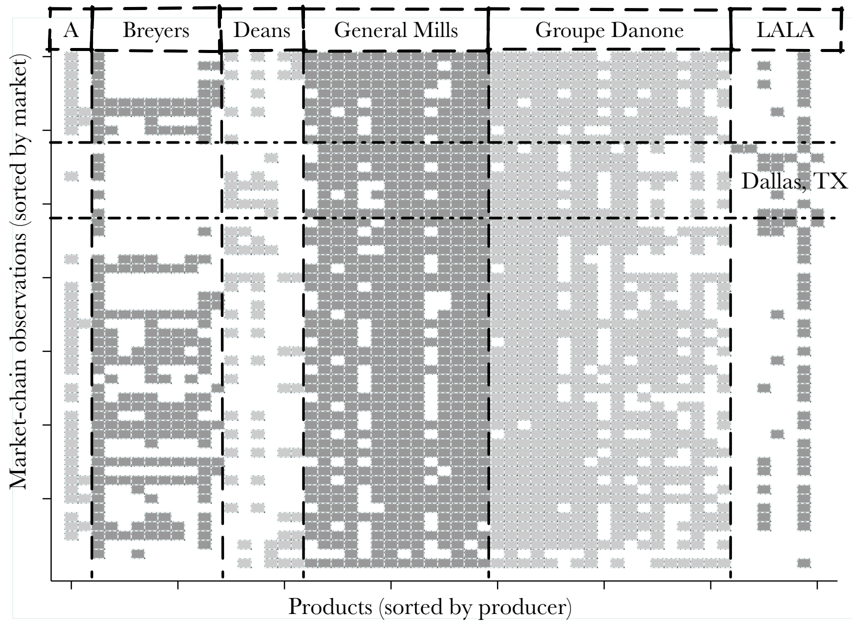
In the structural model, the unit of analysis is 'product line'-retailer-market-quarter. A product line (e.g. *Stonyfield Smooth & Creamy, 6 oz*) includes a variety of flavors (e.g. *Stonyfield Smooth & Creamy, 6 oz, french vanilla*). I aggregate to the product line level because (according to industry practitioners) assortment decisions and contracts are determined at the product line.[10] I infer that a product is supplied in the retailer if it records non-zero sales for the period. Concerns about a situation in which a product is on the shelf and records zero sales are alleviated by the data aggregation.

Following Villas-Boas (2007), quantity sold is measured by the number of 6-ounce servings sold. Price per serving is constructed as total sales divided by quantity sold. I define five product characteristics: natural, marketed for children, creamy, light, or soy. During the sample period soy yogurts may be characterized as "niche" offerings: soy yogurts are offered by only two of the producers, they are supplied by only some of the retailers, and they are low-velocity items, generating low sales as compared to other products. As the number of flavors varies across product lines and retailers supply a subset of these options, I use the number of flavors offered to account for the variation in shelf space occupied by product lines across retailers.

data.

[10] Throughout the paper I refer to 'product line' and 'product' interchangeably.

Figure 1: Assortment Snapshot: South census region 2010q1



Notes: Assortment snapshot of markets in the South census region for 2010q1. Vertical axis goes over observed chains in each market (sorted by market - e.g. Dallas, TX). Horizontal axis identifies products. Products separated by producers in the following order: Agro Farma, Breyers, Dean Foods, General Mills, Groupe Danone, and LALA Foods. The remaining producers are not observed in the markets for the selected quarter. White blocks correspond to instances in which the product is not offered in the retailer.

To identify vendor allowances, I exploit variation in observed assortments across grocery chains and markets. In particular, if all retailers carry the same products, then these assortments will provide no information about vendor allowances. To investigate the variation in product offerings, Figure 1 shows a snapshot of market assortments for the first quarter of 2010 for the 12 markets observed in the South census region. The vertical axis goes over the retailers in each market (e.g. Dallas Texas), while the horizontal axis shows the product offerings, ordered by producer (Agro Farma, Breyers, Dean Foods, General Mills, Groupe Danone, and LALA Foods). Each filled box implies that the product-retailer pair is observed in the data, while white blocks correspond to instances in which the product is not offered by the retailer. Figure 1 highlights that there is substantial variation in the assortments selected by grocery chains both across markets and within markets. Notice that some products are supplied in most retailers (Draganska et al. (2009b) refer to these staple products), while the availability of other products varies markedly across retailers and markets (Draganska et al. (2009b) define these as optional products). For example, only six products gained universal distribution in the South census region for 2010q1: 4 of General Mills' and 2 of Groupe Danone's products.

The estimation methodology addresses retail price endogeneity by employing cost shifters as instrumental variables. Table 2 summarizes the cost data collected and their sources. Additional to wage and energy costs, I create a "distance" measure to capture transportation costs from each

Table 2: Market and Input Costs Data

Variable	source	level of variation	mean	st. dev.
Retail Costs				
Ave retail price of electricity (cents per kilowatthour)	U.S. Energy Information Administration	Quarter -Market	10	2.47
Ave weekly wage	Bureau of Labor Statistics	Quarter-Market	800.9	169.35
Gasoline ($ / barrel)	U.S. Energy Information Administration	Quarter-PAD	61.4	27.36
Distance from closest production facility to market : nautical miles				
Distance is calculated at the brand rather than producer level when only some plants produce the brand.				
Agro Farma	own calculation	Market	828	631
Anderson-Erickson	own calculation	Market	679	343
Breyers	own calculation	Market	848	639
Dean Foods	own calculation	Market	855	623
Yoplait (General Mills)	own calculation	Market	379	200
Colombo (General Mills)	own calculation	Market	965	670
Danone (Groupe Danone)	own calculation	Market	354	160
Stonyfield Farm (Groupe Danone)	own calculation	Market	960	668
Brown Cow (Groupe Danone)	own calculation	Market	1485	630
Crowley Foods	own calculation	Market	762	450
LALA Foods	own calculation	Market	1010	452
Johanna Foods	own calculation	Market	826	652
Prairie Farms	own calculation	Market	508	333
Springfield Creamery	own calculation	Market	1507	596
Tillamook County Creamery	own calculation	Market	1539	591

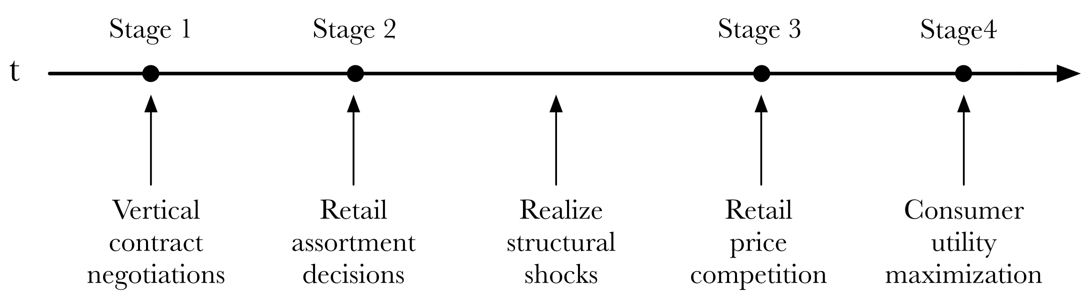
Notes: PAD - Petroleum Administration for Defense District.

producer's manufacturing facility to each market. I locate yogurt plants in the U.S. that were used during the sample period. Then, using geographic distances and gas prices, I calculate a proxy for transportation costs between plants and each market.

4 Model

Supply-side decisions and consumer behavior are modeled as the outcome of a four-stage, full-information game. Figure 2 presents the timeline for the game. First, producers and retailers simultaneously negotiate over contract terms. Next, given wholesale prices and vendor allowances, retailers simultaneously choose assortments. Structural shocks are realized and retailers take these shocks into account in the price competition stage. Last, consumers choose the product-retailer pair that gives them the highest utility level. Below I describe each stage in reverse order.

Figure 2: Timeline of the Game



Stage 4. Consumer Demand: Consumer demand is modeled using the random-coefficients logit, which describes products as bundles of characteristics and consumers as utility maximizers. In each market-quarter, $\{m, t\}$, consumers observe the full set of product offerings ($A_{m,t}$) and select the product-retailer pair that maximizes their utility. I define consumer i's utility from choosing product j in retailer r as:

$$u_{i,j,r} = X_{j,r}\beta_i - \alpha_i p_{j,r} + \xi_{j,r} + \epsilon_{i,j,r} \tag{1}$$

where market and time subscripts are omitted for ease of readability. The utility function depends on prices ($p_{j,r}$), observed product, retailer, and market characteristics ($X_{j,r}$), and a component not observed by the researcher but considered by consumers when making their choices ($\xi_{j,r}$). The model allows for two types of consumer heterogeneity: (α_i, β_i) are individual-specific taste parameters, while $\epsilon_{i,j,r}$ are idiosyncratic shocks modeled as i.i.d. extreme value type I error terms. The unobservable shocks to demand ($\xi_{j,r}$) create both a potential source of price endogeneity (Berry (1994), Berry et al. (1995)) and a classic selection problem. The estimation section discusses the methods and assumptions used to overcome these concerns.

To complete the demand model, the outside option is defined as the choice not to purchase yogurt from the observed grocery chains in the market.[11] The mean utility of the outside option is normalized to 0 since it cannot be separately identified:

$$u_{i,0} = \epsilon_{i,0}$$

[11] Without an outside option, a homogenous price increase (relative to all other sectors) of all products does not change quantities purchased.

The static setup is justified by the perishability of the product, which alleviates most stockpiling considerations. The logit model imposes that individuals can purchase one yogurt in a quarter, while in reality consumers may buy multiple yogurts. I do not observe individual consumer purchases, hence, I cannot allow for multi-unit shopping behavior as modeled by Hendel (1999) and Dubé (2004). The logit assumption implies that multi-unit purchases are either for different members of the household or for independent consumption occasions.

The utility maximization assumption, along with the logit stochastic shock, implies that predicted market shares for each product-retailer pair in the market ($\{j, r\} \in A$) are given by:

$$s_{j,r} = \int \frac{\exp(X_{j,r}\beta_i - \alpha_i p_{j,r} + \xi_{j,r})}{1 + \sum_{l,k \in A} \exp(X_{l,k}\beta_i - \alpha_i p_{l,k} + \xi_{l,k})} dF(\nu) d\hat{F}(D) \tag{2}$$

where A is the collection of products offered by all retailers in the market.

Stage 3. Retail Price Competition: Vendor allowances are defined as lump-sum transfers that do not affect retailers' sales. Thus, conditional on retail assortments, these payments are not part of a retailer's variable profit, which, in turn, renders vendor allowances irrelevant for third-stage pricing analysis. Given market assortments (A), parameters that govern consumer utility ($\theta_D = (\alpha_i, \beta_i)$), shocks to demand ($\xi$), and retailer marginal costs (w), retailer r's variable profits $\pi_r(A, \theta_D, \xi, w)$ are calculated as:

$$\pi_r(A, \theta_D, \xi, w) = \sum_{j \in A_r} (p_{j,r} - w_{j,r}) M s_{j,r}(A, \theta_D, \xi, p) \tag{3}$$

where the summation goes over the products supplied by retailer r (A_r) and M stands for market size.[12] Notice that retailer r's sales of product j ($M s_{j,r}(A, \theta_D, \xi, w)$) depend on its own assortment and its competitors' offerings. The main component of grocery chains' marginal costs is wholesale prices paid to producers. In the paper I refer to retailer marginal costs and wholesale prices interchangeably as the two cannot be separately identified given the data available and the distinction does not affect the analysis.

Bertrand-Nash competition requires that equilibrium prices satisfy the first-order conditions:

$$s_{j,r}(A, \theta_D, \xi, w) + \sum_{k \in A_r} (p_{k,r} - w_{k,r}) \frac{\partial s_{k,r}(A, \theta_D, \xi, w)}{\partial p_{j,r}} = 0$$

As in Nevo (2001), I assume that, conditional on assortments, prices are uniquely determined in a pure-strategy interior Bertrand-Nash equilibrium.

[12] Market and quarter subscripts are again omitted for readability.

Stage 2. Retail Assortment Decisions: Grocery chains have final decision rights over the yogurt assortments supplied so the model implements this industry practice. Retail assortment decisions are determined by consumer demand, wholesale prices, and vendor allowances. If a market assortment is an equilibrium, then chain incentive compatibility conditions should hold. In particular, let $\text{VA}_{j,r}$ be the vendor allowance that retailer r receives for supplying product j, then retailer r's expected profits equal:

$$E[\Pi_r(A)] = E[\pi_r(A) + \sum_{j \in A_r} \text{VA}_{j,r} - FC_r] = E[\pi_r(A)] + \sum_{j \in A_r} \text{VA}_{j,r} - FC_r \tag{4}$$

where FC_r captures the cost of supplying A_r if the retailer incurs all expenses. I assume that FC_r can vary with assortment size but is invariant to the identities of the products supplied. As a result, vendor distribution support, which decreases the cost borne by the retailer, is captured by the vendor allowance transfers. Retail assortment decisions are made prior to the realization of structural shocks to demand and retail marginal costs. However, the expectations operator in equation (4) reflects the fact that retailers form expectations over these shocks when choosing assortments.

Assuming that retailers are risk neutral, the following retailer incentive compatibility conditions should be satisfied in equilibrium. If a market assortment (A) is an equilibrium outcome of the game, then no retailer can increase its total profits by unilaterally altering its assortment:

$$E[\Pi_r(A)] \geq E[\Pi_r(A')] \tag{5}$$

where A' is any counterfactual assortment in which retailer r unilaterally deviates from the equilibrium assortment. These retailer incentive compatibility conditions are exploited for the estimation of vendor allowances.

Stage 1. Vertical Negotiations: I pursue two approaches in modeling the negotiations stage. The general version of the model does not impose assumptions on the bargaining protocol, while the second approach assumes that producers simultaneously make take-it-or-leave-it offers to retailers. For both strategies, a contract is defined as product-specific wholesale price and vendor allowance. The contract structure does not allow for bundling because the practice is not common for the yogurt category. The no-bundling assumption allows me to identify product-specific vendor allowances. In line with industry practices, I assume that the parties cannot contract over chain prices at the negotiations stage.

For the general strategy, equation (5) cannot be further simplified. These deviations imply upper and lower bounds on vendor allowances. The second approach implies that, in equilibrium, producer contract offers put retailers at their participation constraints. In particular, when A' is retailer r's best outside option, then the assumption about producer take-it-or-leave-it offers implies that condition (5) is exactly satisfied:

$$E[\Pi_r(A)] = E[\Pi_r(A')] \tag{6}$$

This paper focuses on retailer assortment decisions, hence, I do not attempt to model and analyze dynamic decisions about product innovation or retailer long-term strategies. The above setup assumes that manufacturers' product introduction decisions and brand positioning, together with retailers' choice of location and characteristics, are exogenous to the model as they are made prior to the negotiations stage.

5 Empirical Analysis

The model is estimated in two steps. First, standard techniques, as in Berry et al. (1995), are applied to consumer demand and retail pricing analyses. Then, using demand and wholesale price parameters, I estimate vendor allowances with a revealed preference approach. The separation of the retail assortment and pricing decisions allows me to separately identify wholesale prices and vendor allowances. The assumption is justified because assortment choices are "stickier" than retail prices.

Step 1. Demand and Retailer Price Competition: In order to investigate retailer assortment decisions, the empirical analysis requires a rich demand model, which allows for flexible variation in consumer preferences. To that end, a flexible fixed-effects parameterization is used to characterize consumer utility and wholesale prices. I include product-region-year intercepts, which capture product mean valuations across census regions and the change in these valuations over time.[13] Retailer-market-specific constants and quarter fixed effects account for differences in consumer valuations across grocery chains and seasonal changes in yogurt preferences. In addition, the demand specification includes interactions between product characteristics and retailer fixed effects. The characteristics used are dummy variables indicating whether a product is natural, marketed for children, creamy, light, or soy. These interactions capture the idea that a product characteristic may be perceived differently across chains, that is, consumers may regard healthy products to be of higher quality when bought in Whole Foods than at a discount grocery chain.

Due to data aggregation, weekly promotions lead to lower retail prices, which translate into lower estimates of wholesale prices. Producers cover most promotional activities, and these discounts will be captured by the wholesale price estimates. Product shelf location and number of facings can also affect consumer demand. Unfortunately, I do not observe either variable. However, I include the log of number of flavors supplied by the retailer as a proxy for the shelf space occupied by each product line. The estimation includes random coefficients on price, flavors, and the constant

[13] The Census divides the U.S. in four regions: Northeast, Midwest, South, and West. These are the regions used for estimation.

term. Market size is constructed as market population multiplied by quarterly per capita yogurt consumption, which is obtained from the USDA per capita consumption data.

Wholesale prices are described by observed characteristics $W_{j,r}$ and an additive error term $\omega_{j,r}$:

$$\log(w_{j,r}) = W_{j,r}\theta_w + \omega_{j,r}$$

The estimated parameters in $W_{j,r}$ are product-region-year intercepts, retailer-market fixed effects, as well as market energy costs and transportation costs interacted with retailer-specific constants.

By endogenizing retailers' assortment decisions, I encounter a classic selection problem: firms supply products with anticipated high profits. Specifically, retailers may choose assortments based on high demand, low wholesale prices, or high vendor allowances. Selection on demand and wholesale prices places a concern for demand and wholesale price parameter estimates and this issue is addressed below. Selection on vendor allowances affects the estimates of these lump-sum payments only, so I address the issue in the discussion of the vendor allowance estimation.

Selection on demand and wholesale prices implies that the observed sample is not a random sample from the underlying distribution of product characteristics. To address this concern, the estimation strategy assumes that product assortments and non-price characteristics are determined prior to the realization of the demand and retail marginal cost shocks (ξ, ω). If assortment decisions are based on observables only, then the selection considerations do not affect the consistency of the demand and wholesale price parameter estimates. The assumption is credible for two reasons. First, the estimation controls for product-region-year unobservables, retailer-specific intercepts, as well as chain interactions with product characteristics. Thus, the unobservable shocks to demand and retailer marginal costs do not capture systematic components that retailers are likely to know prior to their assortment choices. Second, the assortment decisions are "sticky". Changing an assortment requires coordination across stores and involves large fixed costs; in consequence, grocery chains typically adjust product selections at only a few predetermined occasions during the year.

Unlike assortment decisions, prices are easily adjusted as market conditions change, thus, I allow retailers to select optimal prices once they observe demand and cost shocks. To the extent that retailers observe these shocks and condition on them when setting prices, retail prices are endogenous. For example, the unobservable demand shock may be decomposed as:

$$\xi_{j,r,m,t} = \xi_{j,region,y} + \xi_{r,m} + \Delta\xi_{j,r,m,t}$$

The fixed effects included in the estimation capture both $\xi_{j,region,y}$ - the product-region-specific time-varying vertical component (varying over years); and $\xi_{r,m}$ - the retailer-market unobservable. The econometric error that remains in $\Delta\xi_{j,r,m,t}$ includes a time-varying deviation around the unobservable mean for retailers' valuations, as well as a product-retailer unobservable component. Following Villas-Boas (2007), I employ cost-based instruments. The instruments capture direct components of retailer market costs (energy and transportation costs) interacted with retailer fixed effects. The intuition is that prices depend on retailers' costs of operation, but these costs are not correlated with unobservables.[14]

Demand parameters are estimated using a Mathematical Program with Equilibrium Constraints (MPEC) algorithm. The MPEC computational algorithm is preferred to the nested fixed-point (NFP) method as it avoids the numerical issues associated with nested inner loops (Dubé et al. (2012)). At the same time, the MPEC and NFP algorithms generate the same estimator (shown by Su and Judd (2012)), hence, the statistical properties of the Berry et al. (1995) estimator apply to both NFP and MPEC.

Step 2. Vendor Allowances: The estimation identifies vendor allowances as retailers' opportunity costs of shelf space. Without imposing additional structure on the bargaining game, I identify bounds on vendor allowances. The second version of the model assumes that producers make take-it-or-leave-it contract offers, which allows for point identification of paid product-specific vendor allowances for the sample of selected products.

Both strategies are based on the assumption that observed assortments and prices constitute a Subgame Perfect Nash Equilibrium of the game described in Section 4. In particular, for each retailer its observed assortment must yield weakly higher expected profits than any feasible alternative, holding other retailers' assortments fixed. I construct retailer unilateral deviations as counterfactual scenarios in which a retailer switches one product at a time.[15] If retailer r switches a product it supplies $j \in A_r$ with a product it does not supply $l \notin A_r$, then retailer incentive compatibility requires that:

$$E[\Pi_r(A)] \geq E[\Pi_r(A'_{(l,-j,r)})] \qquad \text{for } \forall j \in A_r \text{ and } \forall l \notin A_r \tag{7}$$

where $A'_{(l,-j,r)}$ is the counterfactual assortment in which product j is replaced by l in retailer r. Substituting the profit equation (4) in equation (7), yields that for all products j supplied in r and all non-offered products l the following condition holds:

$$E[\pi_r(A)] + (\textstyle\sum_{k\in A_r} \mathrm{VA}_{k,r}) - FC_r \geq E[\pi_r(A'_{(l,-j,r)})] + (\textstyle\sum_{k\in A'_{r,(l,-j,r)}} \mathrm{VA}_{k,r}) - FC_r$$

The FC_r term reflects the fixed cost associated with supplying an assortment if the retailer bears all expenses. These costs can vary with assortment size but are assumed to be invariant to the identities of the products offered. The counterfactual product assortment holds fixed the number of products supplied by the retailer, hence these fixed costs remain unchanged across the two assortments considered. Notice that the vendor incentives can take the form of both cash transfers

[14] Eizenberg (2014) presents an informal argument about the assumptions needed for point identification of demand parameters. The method requires that demand and marginal cost shocks are mean-independent for the set of all potential products that may be offered in the market.

[15] Naturally, retailers have additional unilateral deviations. For example, the retailer can switch multiple products at a time or it can add a new product by, instead, decreasing the shelf space of a different product category (e.g. cream cheese). I employ one-product deviations as these allow me to identify product-specific vendor allowances, while keeping yogurt shelf space constant.

and retailer cost savings. As a result, if a producer offers operations support (e.g. the producer uses a direct-store-delivery system), then the resulting cost savings for the retailer are associated with a vendor allowance transfer.

The vertical contract assumes that wholesale prices and vendor allowances are not conditional on retail assortments, so the following holds:

$$(\textstyle\sum_{k \in A_r} \mathrm{VA}_{k,r}) - \mathrm{VA}_{j,r} = (\textstyle\sum_{k \in A'_{r,(l,-j,r)}} \mathrm{VA}_{k,r}) - \mathrm{VA}_{l,r}$$

and the condition implies that:

$$E[\pi_r(A)] + \mathrm{VA}_{j,r} \geq E[\pi_r(A'_{(l,-j,r)})] + \mathrm{VA}_{l,r} \qquad \text{for } \forall j \in A_r \text{ and } \forall l \notin A_r \tag{8}$$

Notice that vendor allowances affect retailer total profits but do not affect demand.[16]

Equation (8) is used for the estimation of both versions of the model. First, I discuss the assumptions for the bounds estimates. The second model allows me to recover point estimates of vendor allowances for offered products up to a normalization of one product's vendor allowance. The main difference between the two strategies is the treatment of the vendor allowance of the counterfactually added product ($\mathrm{VA}_{l,r}$). In the general model, $\mathrm{VA}_{l,r}$ is set to the edge of its support to derive the most conservative bounds, while in the second model, $\mathrm{VA}_{l,r}$ is differenced out. The latter option is only possible when the bargaining power assumption implies that equation (8) is exactly satisfied.

(1) Bounds: To set-identify vendor allowances, I impose a bounded support assumption, which implies that $\mathrm{VA}_{j,r} \in [\mathrm{VA}^{LB}_{j,r}, \mathrm{VA}^{UB}_{j,r}]$, with $\mathrm{VA}^{LB}_{j,r} > -\infty$ and $\mathrm{VA}^{UB}_{j,r} < \infty$. In the grocery industry, lump-sum payments flow from producers to retailers, so industry practices provide a natural lower bound on vendor allowances: $\mathrm{VA}_{j,r} \geq 0$.[17] For the upper bound I rely on producer individual rationality, which imposes that a product's vendor allowance cannot exceed the additional producer profits generated by supplying the product in the chain. Unfortunately, I do not observe producer marginal costs, thus, I use the change in producer revenues to construct the upper bound on the support. The use of producer revenues instead of variable profits (or profits) to construct $\mathrm{VA}^{UB}_{j,r}$ widens the estimated bounds.[18]

Bounds on vendor allowances are estimated by combining the bounded support assumption with the retailer incentive compatibility conditions described in equation (8). In particular, for all products

[16] Vendor incentives, such as promotional allowances, which are paid per unit sold, are not captured by the vendor allowances' estimate.

[17] Other forms of retailer efforts, which might differ across products and might be construed to be part of the vendor allowances, are assumed to be not material enough to violate the non-negativity assumption.

[18] Here the distinction between wholesale prices and chain marginal costs matters. However, as long as chain marginal costs less wholesale prices are lower than producer marginal costs, the constructed producer revenues are higher than the unobserved producer variable profits. Then, the constructed measure of producer individual rationality is conservative.

offered in the market, the equilibrium conditions prescribe a lower bound on vendor allowances:

$$\text{VA}_{j,r} \geq -E[\pi_r(A) - \pi_r(A'_{(l,-j,r)})] + \text{VA}_{l,r} \qquad \text{for } \forall j \in A_r \text{ and } \forall l \notin A_r \tag{9}$$

While, if product j is not supplied by the chain, I construct an upper bound on its vendor allowance:

$$\text{VA}_{j,r} \leq E[\pi_r(A) - \pi_r(A'_{(j,-k,r)})] + \text{VA}_{k,r} \qquad \text{for } \forall j \notin A_r \text{ and } \forall k \in A_r \tag{10}$$

where product k is displaced by product j and the retailer loses any vendor allowances received for product k: $\text{VA}_{k,r}$. As described below, the estimation obtains the tightest bounds by using the deviations that render the highest retailer variable profits.

Demand and wholesale price parameter estimates, along with the assumption of retailer price competition, allow me to simulate expected retailer variable profits under the observed and counterfactual scenarios. However, I do not have estimates for the vendor allowances on the right-hand side of the inequalities ($\text{VA}_{l,r}$ and $\text{VA}_{k,r}$). To circumvent this problem, I construct conservative bounds employing the support of $\text{VA}_{l,r}$ and $\text{VA}_{k,r}$. For all observed product-retailer pairs I obtain the lowest lower bound for $\text{VA}_{j,r}$ by setting $\text{VA}_{l,r} = \text{VA}^{LB}_{l,r} = 0$. Then equation (9) becomes:

$$\text{VA}_{j,r} \geq \max(-E[\pi_r(A) - \pi_r(A'_{(l,-j,r)})] + 0, \text{VA}^{LB}_{j,r}) \equiv \underline{\text{VA}}_{j,r}, \qquad \text{for } \forall j \in A_r \text{ and } \forall l \notin A_r \tag{11}$$

For all non-observed product-retailer pairs, the highest upper bound for $\text{VA}_{j,r}$ is constructed by setting $\text{VA}_{k,r}$ to its upper bound, $\text{VA}_{k,r} = \text{VA}^{UB}_{k,r}$:

$$\text{VA}_{j,r} \leq \min(E[\pi_r(A) - \pi_r(A'_{(j,-k,r)})] + \text{VA}^{UB}_{k,r}, \text{VA}^{UB}_{j,r}) \equiv \overline{\text{VA}}_{j,r}, \qquad \text{for } \forall j \notin A_r \text{ and } \forall k \in A_r \tag{12}$$

Notice that lower and upper bounds are constructed for different sets of products: for all offered products I construct a lower bound, while upper bounds are created for all non-offered products. This refers to the selection issue discussed, where retailers may choose to supply products with higher vendor allowances. To account for this issue, I follow Eizenberg (2014) and use the support of vendor allowances to fill in the "missing" bounds.

For example, the complete set of lower bound deviations combines the lower bound conditions constructed for all offered products ($\underline{\text{VA}}_{j,r}\ \forall j \in A_r$) and the lower bounds from the support of vendor allowances for all non-offered products ($\text{VA}^{LB}_{j,r}\ \forall j \notin A_r$). Analogously, the set of upper bound deviations is constructed from the support for all offered products ($\text{VA}^{UB}_{j,r}\ \forall j \in A_r$) and retailer incentive compatibility conditions for all non-offered products ($\overline{\text{VA}}_{j,r}\ \forall j \notin A_r$).

$$L_{jr} = \begin{cases} \underline{\text{VA}}_{j,r}, & \text{if } j \in A_r \\ \text{VA}^{LB}_{j,r}, & \text{if } j \notin A_r \end{cases} \qquad\qquad U_{jr} = \begin{cases} \text{VA}^{UB}_{j,r}, & \text{if } j \in A_r \\ \overline{\text{VA}}_{j,r}, & \text{if } j \notin A_r \end{cases}$$

The approach further widens the bounds. The results section shows the product-specific empirical distribution of the constructed bounds (L_{jr}, U_{jr}).

(2) Point identification: The second version of the model imposes that producers make take-it-or-leave-it wholesale price and vendor allowance offers. This setup assumes that producers have all bargaining power, while retailers have final decision rights over assortments. It is worth noting that retailers' ability to supply alternative assortments allows them to extract surplus from producers. In equilibrium, contract offers are such that retailer incentive compatibility conditions are exactly satisfied. As a result, vendor allowances reflect the shadow price of shelf space. I approximate the shadow price of shelf space with the additional retailer variable profits generated by switching each product with its best replacement. In particular, the point identification strategy assumes that equation (8) holds with equality when product l is the best replacement product for product j in retailer r:

$$\text{VA}_{j,r} - \text{VA}_{l,r} = E[\pi_r(A'_{(l,-j,r)}) - \pi_r(A)] \qquad \text{for } \forall j \in A_r \tag{13}$$

Taking equation (13) to the data leads to selection issues, as the vendor allowance offer for product j may be higher than the offer for product l. To circumvent this issue, I difference out $\text{VA}_{l,r}$ using pairs of retailer deviations in which the same product l is the best replacement option. If retailer r supplies both j and k, and for both products the best replacement option is l, then the following two conditions hold:

$$\text{VA}_{j,r} - \text{VA}_{l,r} = E[\pi_r(A'_{(l,-j,r)}) - \pi_r(A)] \tag{14}$$

$$\text{VA}_{k,r} - \text{VA}_{l,r} = E[\pi_r(A'_{(l,-k,r)}) - \pi_r(A)] \tag{15}$$

Using conditions (14) and (15), $\text{VA}_{l,r}$ can be differenced out :

$$\text{VA}_{j,r} - \text{VA}_{k,r} = E[\pi_r(A'_{(l,-j,r)})] - E[\pi_r(A'_{(l,-k,r)})] \tag{16}$$

Now both products j and k are offered by retailer r. In order to take condition (16) to the data, I define $\text{VA}_{j,r} = \text{VA}_j + \alpha New_{j,m} + v_{j,r}$, where VA_j is a product specific constant and $New_{j,m}$ tracks if the product was introduced in the market in the given year. Substituting this parameterization in equation (16) yields:

$$(\text{VA}_j - \text{VA}_k) + \alpha(\Delta New_{j,k,m}) + \Delta v_{j,k,r} = E[\pi_r(A'_{(l,-j,r)})] - E[\pi_r(A'_{(l,-k,r)})] \tag{17}$$

where $\Delta New_{j,k,m} = New_{j,m} - New_{k,m}$ and $\Delta v_{j,k,r} = v_{j,r} - v_{k,r}$. The parameter estimates (VA_j's, α) are estimated for the sample of offered products. The error term ($\Delta v_{j,k,r}$) is assumed to be white noise as any product-, retailer-, and market-specific components are differenced out. Due to the differencing nature of equation (17), I need to normalize the value of one product's vendor allowance.

Construction of deviations explained by example: To construct the deviations described above, I define the set of potential product offerings for each grocery chain in a market as the collection of products that are observed in the market combined with all products the retailer carries in other markets during the quarter. These restrictions guarantee that producers actually distribute the potential products at the time period and that the retailer can supply the counterfactual product without incurring disproportionately large supply costs. In addition, I avoid deviations in which regional brands are counterfactually supplied in other census regions, e.g. a deviation in which Tillamook (a regional West coast producer) is offered in an East coast market. The resulting set of potential products includes, on average, 14 replacement options for each retailer.

Two types of deviations are constructed: (i) *drop each product from the observed assortment with replacement*, (ii) *add a new product to a retailer's portfolio with displacement*. These unilateral deviations keep fixed the shelf space occupied by the yogurt category, both in terms of number of products and number of flavors offered. For *drop* deviations I replace the dropped product with the counterfactual option that renders the highest variable retailer profits. By using the best replacement product, the *drop* deviations lead to the tightest bound on $(\mathrm{VA}_{j,r} - \mathrm{VA}_{l,r})$, and respectively on $\mathrm{VA}_{j,r}$. Analogously, the estimation strategy for the producer take-it-or-leave-it offers' model approximates the shadow price of shelf space with the additional retailer variable profits generated by switching each product with its best replacement.

To present the method used to construct these deviations, consider the Boston market for the 2010q1 period and suppose that retailer 1 in Boston, $\{r1\}$, supplies *Yoplait Trix*, $\{trix\}$. First, I construct retailer 1's expected variable profits under the observed assortment, $E[\pi_r(A)] = 20,500$. The next step is to construct retailer 1's expected variable profits after removing *Yoplait Trix* and replacing it with each product from its potential product deviations set. For simplicity, suppose that there are three products in retailer 1's potential offerings set: $\{$*Breyers Light*, *Stonyfield Farm Yobaby*, *Weight Watchers*$\}$. The expected variable profits per store for each deviation equal:

$$E[\pi_r(A'_{bl,-trix,r1})] = 20,600, \quad E[\pi_r(A'_{sfy,-trix,r1})] = 20,540, \text{ and } \quad E[\pi_r(A'_{ww,-trix,r1})] = 20,300;$$

These estimates imply that the best replacement for *Yoplait Trix* in retailer 1 is *Breyers Light* at 20,600, so I use the *drop Yoplait Trix, replace with Breyers Light* deviation. This deviation is used for both the general model and the second approach. The deviation allows me to construct a lower bound on the vendor allowance for *Yoplait Trix*, $\underline{\mathrm{VA}}_{trix,r1}$. Note that the deviation yields that:

$$E[\pi_r(A)] + \mathrm{VA}_{trix,r1} \geq E[\pi_r(A'_{bl,-trix,r1})] + \mathrm{VA}_{bl,r1} \implies \mathrm{VA}_{trix,r1} \geq 100 + \mathrm{VA}_{bl,r1} \qquad (18)$$

I substitute $\mathrm{VA}_{bl,r1} = \mathrm{VA}^{LB}_{bl,r1} = 0$ to obtain that $\mathrm{VA}_{trix,r1} \geq \underline{\mathrm{VA}}_{trix,r1} = 100$.

The second strategy uses pairs of product deviations in which the same non-offered product is the best replacement option. Suppose that retailer 1 also carries *Stonyfield Farm*, $\{sf\}$, and that its best replacement product is again *Breyers Light*. Let the variable profits under the counterfactual assortment be $E[\pi_r(A'_{bl,-sf,r1})] = 20,550$. Then the two deviations, along with the producer take-it-or-leave-it offers assumption, imply that:

$$E[\pi_r(A)] + \text{VA}_{trix,r1} = E[\pi_r(A'_{bl,-trix,r1})] + \text{VA}_{bl,r1}$$

$$E[\pi_r(A)] + \text{VA}_{sf,r1} = E[\pi_r(A'_{bl,-sf,r1})] + \text{VA}_{bl,r1}$$

These conditions allow me to difference out $\text{VA}_{bl,r1}$:

$$\text{VA}_{trix,r1} - \text{VA}_{sf,r1} = E[\pi_r(A'_{bl,-trix,r1})] - E[\pi_r(A'_{bl,-sf,r1})] = 20,600 - 20,550 = 50 \tag{19}$$

Add deviations are constructed in an analogous way and these are used by the general model only. The deviation adds each product in the potential offerings set and removes the observed product that leads to the smallest decrease in retailer variable profits. For example, to construct an upper bound on the vendor allowance for *Breyers Light* in retailer 1, $\overline{\text{VA}}_{bl,r1}$, I first compute retailer 1's expected variable profits under the observed assortment: $E[\pi_r(A)] = 20,500$. Then I construct retailer 1's expected variable profits from adding *Breyers Light* and displacing each of the products retailer 1 carries in its observed assortment, e.g. {*Yoplait Trix*, *Stonyfield Farm*, *Silk*}:

$$E[\pi_r(A'_{bl,-trix,r1})] = 20,600\ , \quad E[\pi_r(A'_{bl,-sf,r1})] = 20,550\ , \text{ and } \quad E[\pi_r(A'_{bl,-s,r1})] = 20,650;$$

The best displacement product when *Breyers Light* is added is *Silk*, so I use the *add Breyers Light, displace Silk* deviation to construct $\overline{\text{VA}}_{bl,r1}$:

$$E[\pi_r(A)] + \text{VA}_{s,r1} \geq E[\pi_r(A'_{bl,-s,r1})] + \text{VA}_{bl,r1} \implies \text{VA}_{bl,r1} \leq -150 + \text{VA}_{s,r1}$$

Finally, calculating $\text{VA}_{s,r1} = \text{VA}^{UB}_{s,r1} = 300$ implies that $\overline{\text{VA}}_{bl,r1} = 150$.

Note that the deviations are constructed using expected retailer variable profits and producer revenues. Even though retailers (and producers) do not observe demand and retailer marginal cost shocks at the negotiations and assortment stages, agents' form expectations over these shocks. I use the empirical distribution of the structural shocks to simulate expected variable profits from observed and counterfactual portfolios. The results presented are based on 100 simulations, while future work will expand this number to 1000 simulations. Preliminary checks against 500 simulations show stable estimates. In addition, for all simulations and counterfactual assortment changes, I allow retailers to re-optimize market prices according to the Bertrand-Nash competition assumption. As it is unreasonable to assume that private label products pay vendor allowances, the deviations are constructed for non-private-label products only.

6 Results

Demand and Retailer Price Competition: Consumer demand is estimated with the random-coefficients logit, which captures the effect of consumer heterogeneity in price sensitivity and preferences for product characteristics. The individual-specific taste parameter on price is drawn from the empirical income distribution, while the random coefficients on flavors ($\log(\#flavors)$) and the constant term are estimated using draws from the i.i.d. standard normal distribution.

To investigate price endogeneity concerns, it is instructive to look at the estimates predicted by a simple logit model, which imposes a value of 1 for the random coefficient parameters. Table 3 reports results from an OLS and an instrumental variables approach where estimates of product characteristics are calculated as projections on the estimated product-region-year intercepts.[19] The 2SLS estimation relies on instruments comprised of market energy prices and producer transportation costs interacted with retailer fixed effects. The results highlight the importance of accounting for price endogeneity. Even though own-price elasticities are negative in both specifications, the instrumental variables approach leads to larger (in absolute terms) price-sensitivity estimates and to fewer own-price elasticities that are higher than -1 (1% of the observations with IV compared to 25% in the OLS setup).

The results from the full demand system parameterization are reported in Table 4. The estimates align with expectations: demand is downward sloping, while the random coefficient on price implies that consumer price sensitivity decreases with income. In addition, consumers prefer natural, children's, and light products, while they value less soy and creamy products. Consumers value products with more flavor options offered in the chain; however, there is substantial heterogeneity in individual preference for flavors. The last panel of Table 4 shows how consumer mean valuations vary across producers. The excluded brand is retailer private labels, and the results show the presence of substantial heterogeneity in consumer preferences across producers.

Projections of retailer wholesale price parameter estimates on product characteristics show that products with each of the characteristics are more expensive than their counterparts. As expected, the estimated wholesale prices for private labels' are lower than the retailers' costs of selling branded products.

Demand estimates imply median consumer own-price elasticities of -3.45. The distribution of estimated individual own-price elasticities is shown in Figure 3. Table 5 reports that none of the calculated own-price elasticities are positive, and only 3.14% of the estimates suggest individuals on the elastic part of their demands. The assumption about retail price competition leads to estimated median retailer markups of 33 cents and median variable profit margins of 44%.[20] To analyze how well the model matches the observed margins in the grocery chain industry, I collect information on variable profit margins reported by public grocery retailers in their accounting statements. I

[19] The procedure is described in Nevo (2001).

[20] Margins are calculated as the ratio of variable profits to total sales.

Table 3: Preliminary Results: Logit Estimates

	Logit Estimates		**IV Estimates**	
	estimate	st.er.	estimate	st.er.
Constant	-10.713	0.006	-10.087	0.006
Price	-1.635	0.020	-2.661	0.057
Light	0.143	0.008	0.107	0.008
Child	0.342	0.010	0.225	0.010
Natural	0.269	0.011	0.171	0.011
Creamy	-0.019	0.006	-0.046	0.006
Soy	-0.335	0.005	-0.320	0.005
Flavors	1.037	0.005	1.020	0.005
Q2	0.010	0.003	0.018	0.004
Q3	-0.031	0.004	-0.032	0.004
Q4	-0.195	0.004	-0.189	0.004
2005	-0.024	0.002	-0.008	0.002
2006	-0.022	0.002	-0.002	0.002
2007	-0.044	0.002	-0.025	0.002
2008	-0.006	0.002	0.009	0.002
2009	-0.023	0.002	-0.005	0.002
2010	-0.104	0.002	-0.085	0.002
Agro Farma	0.737	0.012	0.717	0.013
Anderson-Erickson	-0.412	0.040	-0.456	0.040
Breyers	-0.021	0.003	-0.051	0.004
Dean Foods	-0.361	0.005	-0.416	0.005
General Mills	0.221	0.003	0.196	0.003
Groupe Danone	0.229	0.003	0.193	0.003
LALA Foods	-0.400	0.008	-0.446	0.008
Johanna Foods	-0.144	0.004	-0.183	0.004
Prairie Farms	-0.402	0.023	-0.403	0.022
Springfield Creamery	-0.597	0.014	-0.625	0.014
Tillamook County	0.491	0.018	0.561	0.017
mean(elasticity)	-1.3470	-	-2.1921	-
(elasticity)> 0	0	-	0	-
(elasticity)> -1	0.250	-	0.012	-

Notes: Product characteristics are projected on product-region-year dummies. Other variables include retailer-market intercepts, characteristics interacted with retailer fixed effects, and quarter dummies. Instruments are based on cost shifters. Sample size is 162,707.

Table 4: Demand and Wholesale Price Estimates

	Demand Estimates				**Wholesale Price**	
	estimate	st.er.	r.c.	st.er.	estimate	st.er.
Constant	-9.678	0.006	0.118	0.189	-0.842	0.000
Price	-6.205	0.164	2.636	0.085	-	-
Natural	0.136	0.010	-	-	0.007	0.000
Children	0.142	0.010	-	-	0.188	0.000
Creamy	-0.100	0.006	-	-	0.095	0.000
Light	0.132	0.008	-	-	0.104	0.000
Soy	-0.289	0.005	-	-	0.253	0.001
Flavors	0.813	0.017	0.527	0.022	-	-
Q2	0.010	0.004	-	-	0.010	0.001
Q3	-0.057	0.004	-	-	-0.009	0.001
Q4	-0.258	0.005	-	-	-0.003	0.001
2005	-0.063	0.002	-	-	-0.067	0.000
2006	-0.041	0.002	-	-	-0.091	0.000
2007	-0.099	0.002	-	-	-0.093	0.000
2008	-0.073	0.002	-	-	-0.092	0.000
2009	-0.088	0.002	-	-	-0.023	0.000
2010	-0.165	0.002	-	-	-0.096	0.000
Agro Farma	0.545	0.008	-	-	0.840	0.002
Anderson-Erickson	-0.498	0.031	-	-	0.463	0.002
Breyers	-0.140	0.003	-	-	0.392	0.000
Dean Foods	-0.427	0.005	-	-	0.586	0.001
General Mills	0.108	0.003	-	-	0.460	0.000
Groupe Danone	0.131	0.003	-	-	0.466	0.000
LALA Foods	-0.526	0.008	-	-	0.296	0.001
Johanna Foods	-0.244	0.004	-	-	0.452	0.001
Prairie Farms	-0.611	0.018	-	-	0.305	0.002
Springfield Creamery	-0.768	0.010	-	-	0.453	0.001
Tillamook County	0.241	0.016	-	-	0.736	0.002

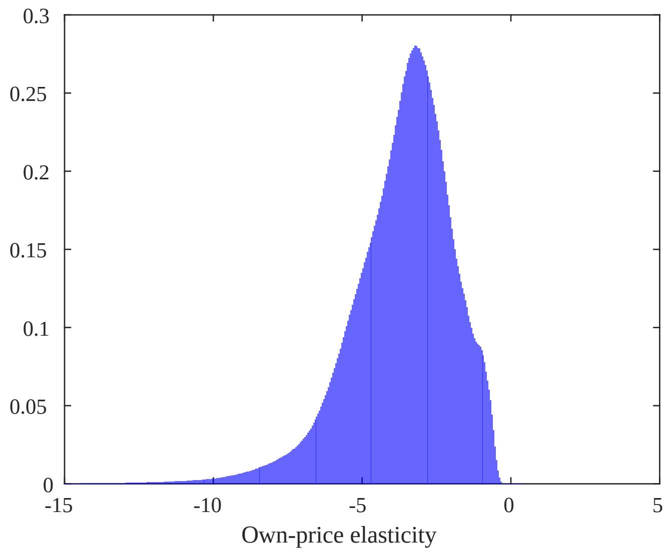
Notes: Random coefficient estimates correspond to the choice probabilities described in Section 4. Results are obtained using the MPEC algorithm. The random coefficient on price is drawn from empirical income distribution, while the standard normal distribution is used to estimated the random coefficients on flavors and the outside option. Product characteristics are projected on product-region-year dummies. Other variables include retailer-market intercepts, characteristics interacted with retailer fixed effects, and quarter dummies. Sample size is 162,707.

Table 5: Implications from Demand and Retailer Price Competition Results

Median own-price elasticity	-3.436
% own-price elasticity > 0	0.000
% own-price elasticity > -1	3.144
Median markup=(p-w) (in $)	0.332
Median margin=(p-w)/p	0.437

Notes: Implications are derived for the full random-coefficients logit estimates presented in table 4. Markups are derived under the assumption of retailer price competition. Variable profit margins are calculated as variable profits divided by total sales.

Figure 3: Estimated Own-Price Elasticities



Notes: The graph shows the empirical density of the estimated individual own-price elasticities. Own-price elasticities are derived for the full random-coefficients logit estimates.

find that the median reported variable profit margins equals 27% for the sample period analyzed. Grocery chains report margins as sales minus cost of sales. The cost of sales measure includes inventory costs as well as warehousing and transportation costs. The difference between reported and estimated retail margins may be driven by the inclusion of fixed costs in the reported variable profit margins.

Vendor Allowances Using demand and wholesale price estimates, I construct counterfactual unilateral deviations for each product. These deviations yield empirical distributions of constructed upper and lower bounds for 141 non-private label products. Most products follow a similar pattern, thus, Figure 4 shows the constructed distributions for a representative product *Dannon Light 'n Fit Carb & Sugar Control*. An exception to these patterns is presented by Dean Foods' products due to the binding of the producer individual rationality constraints. I report some unique features of Dean Foods and present a rationale that reconciles the pattern at the end of the section.

Figure 4 contains two graphs: the left panel shows the empirical cumulative distribution (EDF) of upper and lower bounds using $L_{j,r}$ and $U_{j,r}$, and the right panel shows the EDFs using the bounds from constructed deviations only: $\underline{\mathrm{VA}}_{j,r}$ and $\overline{\mathrm{VA}}_{j,r}$. Lower bounds' EDFs are displayed with solid lines while dashed lines trace upper bounds. As expected, the estimated distributions widen when "missing" bounds are filled with estimates of the support of vendor allowances. Also because *add* and *drop* deviations are constructed for different sets of retailers and markets, it is expected that $\underline{\mathrm{VA}}_{j,r}$ and $\overline{\mathrm{VA}}_{j,r}$ may cross.

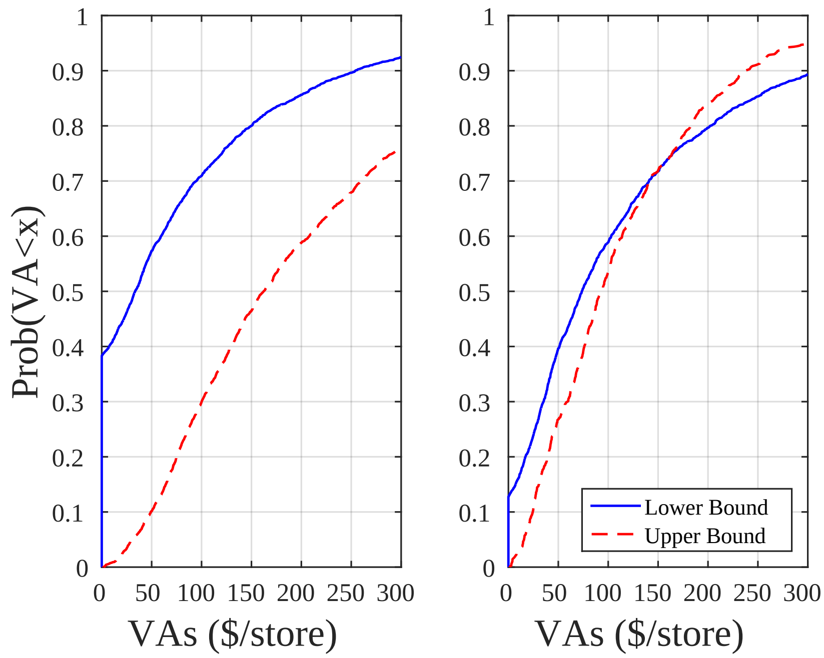
The EDFs show *Dannon Light 'n Fit Carb & Sugar Control*'s vendor allowances per store and quarter. For example, the cumulative distribution of the lower bounds ($L_{j,r}$) implies that 50% of the constructed lower bounds are less than \$33.[21] The transfer of \$33 per store translates into 0.1% of revenues for the median retailer. The distribution of the upper bounds establishes that 50% of these deviations are less than \$162, which imply a payment equal to 0.5% of revenues for the median retailer.

To gain perspective on the significance of vendor allowances for retailers' profitability, I compare the amount of received vendor allowances to retailer sales and variable profits. The constructed *drop* deviations for observed products provide lower bounds on paid vendor allowances ($\underline{\mathrm{VA}}_{j,r}$). The estimates suggest that, on average, the vendor allowances received by grocery chains represent at least 4.7% of retailers' revenues and 10% of retailers' variable profits. These payments are likely important for retailer profitability, given that public grocery chains in the U.S. report profit margins on the order of 2-4% of revenues.

The closest accounting statement metric is the vendor allowance payments reported in retailer 10-K filings. The median of these reported vendor allowance payments corresponds to 7% of their revenues. The closeness between estimated and reported vendor allowances is reassuring, but should be interpreted with caution, recognizing the distinction between the two measures. The estimated vendor allowances are designed to reflect retailer opportunity costs. As a result, the estimates capture vendor support in the form of distribution cost savings, a transfer that is not recorded in accounting statements. Alternatively, reported vendor allowances from accounting statements include payments, such as promotional allowances, which are paid on a per-unit basis rather than

[21] $L_{j,r}$ is inflated with zeros for all *add* deviations constructed. In addition, as shown in the right panel, for 13% of the product's *drop* deviations, I did not find any profitable unilateral deviations (when vendor allowances for the non-offered products are constrained to zero).

Figure 4: Vendor Allowance Cumulative Empirical Distribution:
Dannon Light 'n Fit Carb & Sugar Control



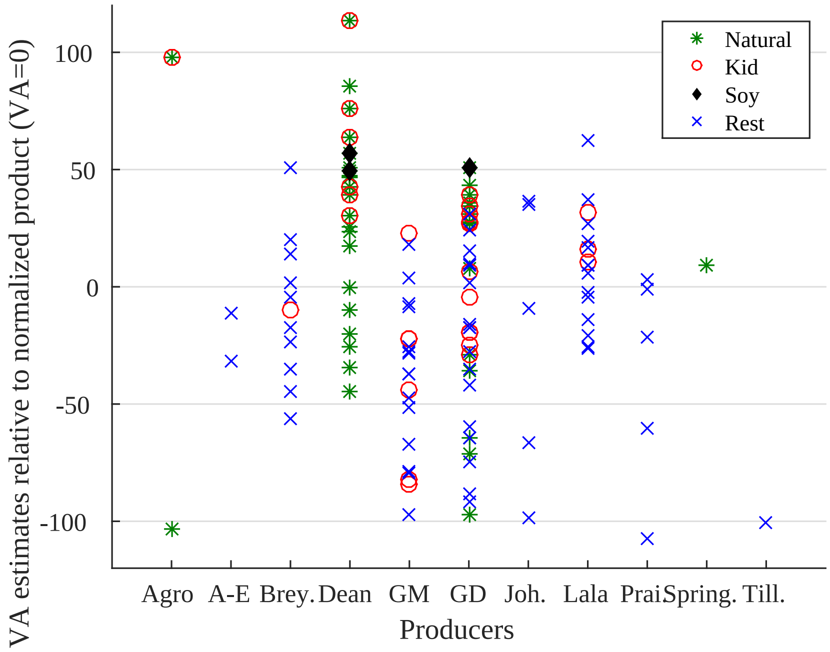
Notes: The cumulative empirical distribution corresponds to the chain unilateral deviations described in Section 5. The left panel shows the empirical cumulative distribution of upper and lower bounds using $L_{j,r}$ and $U_{j,r}$, and the right panel shows the distributions obtained from constructed deviations only: $\underline{V}_{j,r}$ and $\overline{V}_{j,r}$. The estimates reflect the vendor allowance offered per store and per flavor for the product. Results are based on 100 simulations.

as a fixed lump sum. These vendor incentives would not be included in the vendor allowance estimates, rather they would be captured by the wholesale price analysis.

To compare the vendor allowance payments across products, I rely on the point-identification technique described in Section 5. Figure 5 shows the relative differences in paid vendor allowances for offered products. The excluded product is *Dannon Light 'n Fit Carb & Sugar Control* and its vendor allowance is normalized to zero. The *x-axis* sorts the products by brand, while different symbols identify product characteristics: natural products are marked by a star, a circle identifies products marketed for children, etc. The results show that even within the same producer, there is substantial heterogeneity in the vendor allowances paid across products. For example, the two extreme vendor allowance estimates paid by Groupe Danone, indicate that each quarter the producer pays $148 more per store and flavor for *Stonyfield O'Soy* than for *Dannon All Natural*. This result aligns with industry narratives in which producers refuse to pay slotting fees for staple products, and pay high lump-sum transfers for products that may be profitably replaced by the retailer.

The counterfactual simulations presented in the next section finds that soy and some natural-children's products are eliminated in the absence of vendor allowances. Figure 5 identifies soy products with a diamond shape and natural-children's products with a star surrounded by a circle.

Figure 5: Comparison between Vendor Allowances Paid for Offered Products



Notes: The reference product is *Dannon Light'n Fit Carb & Sugar Control* and its vendor allowances is normalized to 0. The estimates reflect relative differences in the vendor allowance paid per store and flavor. Results are based on 100 simulations.

The relative vendor allowances paid for these products are higher than the financial incentives provided for most other products offered by the retailers. The implied higher differentials between retailer marginal benefit and opportunity cost for these offerings explain why retailers do not supply these products without the vendor allowance incentives.

The point-identification strategy also investigates whether retailers receive larger transfers for new products. To do so, I include a dummy variable that captures whether this is the first year in which a product is introduced in the market. Results show that in their first year of distribution, products pay $21 more per store and flavor. This transfer implies that in the first year of distribution, products pay, on average, 50% higher vendor allowance than in any subsequent year. As a result, the estimation implies that retailers need to be compensated with higher vendor allowances to supply new products. The model assumes that retailers are risk neutral, thus, at the assortment decision retailers consider expected profits, not their variance. Hence, the higher vendor allowances for new products imply that new products generate lower expected sales in their first year than other products supplied.

The case of Dean Foods: A special case that requires further attention is Dean Foods. The constructed producer individual rationality constraints bind for 80% of Dean Foods' unilateral deviations. Dean Foods is characterized by some unique features that distinguish the producer from its competitors. Dean Foods is an international food manufacturer that specializes in dairy products. During the sample period of 2004-2010, the firm produces a wide variety of local and national brands such as *Alta Dena*, *Land O'Lakes*, *Garelick*, *Silk*, etc. Even though the company distributes a number of yogurt products, its most popular dairy products are in the milk category. Over the sample period milk products represent more than 70% of all offerings supplied by the manufacturer. Moreover, Dean Foods completed the sale of all yogurt operations in 2011 in order to "focus on core dairy products". In addition, the manufacturer distributes its products through a wide direct-store-delivery system, which is developed to accommodate its core milk business.[22] As a result, the milk category may affect the profitability of distributing yogurt products.

In particular, Dean Foods may choose to supply yogurt products because the producer is able to "transfer vendor allowances" from its milk category. Vendor allowances capture any lump-sum transfers from producers to retailers. Therefore, if a producer covers some of the distribution costs typically incurred by the retailer, then these retailer cost savings will be reflected in higher vendor allowances paid by the producer. In the model, vendor allowances capture economic transfers from producers to retailers. Hence, the estimates for Dean Foods consist of both cash transfers and provision of stocking service. In addition, Dean Foods' operations convey that, because of its economies of scope in distribution, the producer may be able to deliver yogurt products at little or no additional costs. The estimated vendor allowances are derived from retailer incentive compatibility conditions. These estimates capture retailers' value of the transfer, which overstates the cost of the vendor allowance to Dean Foods.

7 Counterfactual Analysis

The vendor allowance estimates indicate that these transfers represent a substantial component of retailer revenues and variable profits. I investigate how vendor allowances affect market outcomes with a counterfactual simulation that eliminates these lump-sum payments. In practice, the elimination of vendor allowances may affect equilibrium product assortments, retail and wholesale prices, and the number of products offered. The equilibrium analysis considers optimal retailer product assortments and allows retailers to re-optimize prices to take into account new market assortments. However, due to computational limitations, the analysis holds shelf space and wholesale prices fixed.

The shelf-space assumption imposes that each retailer offers the same number of yogurts as in its observed assortment, so that retailers' fixed costs remain unchanged. In practice, if vendor allowances

[22]Direct-store-delivery is common practice in the milk category while I could not find evidence that other yogurt producers have in place such a system.

were eliminated for yogurts, retailers could reallocate space across other product categories. However, in order to allow for such adjustments, I would need data on retailers' category-specific fixed costs, along with estimates of consumer preferences, wholesale prices, and vendor allowances for other refrigerated categories. The assumption of fixed wholesale prices is necessary because the estimation approach does not allow me to recover producer marginal costs.

It is worth highlighting that the implemented counterfactual eliminates vendor allowances so the simulation does not require an assumption on where the vendor allowances lie between the estimated lower and upper bound distributions. The vendor allowance estimates capture both cash payments from producers and incentives in the form of retailer cost savings. As a result, the counterfactual eliminates both channels. It would be instructive to analyze a scenario in which distribution cost savigns are preserved, while only cash payments are eliminated. However, such an analysis requires data on retailers' distribution costs.

Finding the new equilibrium assortments in a market presents a combinatorial problem. The typical grocery chain in the sample chooses 31 products from 45 options, which yields more than 100 billion possible assortments. In addition, the average-sized market contains data on 4 chains, which raises the dimensionality of the problem to the fourth power. Consequently, I employ a three-step approach to find the new equilibrium market assortments. The first step involves an iterative algorithm that finds potential new equilibrium assortments. Each retailer's assortment is constructed by sequentially adding the most profitable product until the number of products equals the observed assortment size. The function iterates over retailers in the market until no retailer would find it profitable to alter its assortment. The second step takes the prescribed new assortment and checks retailer unilateral deviations. For many of the retailers I am able to check all possible deviations. However, for retailers with possible deviations exceeding 2 million, I use the fact that some products are highly profitable in the market and all retailers supply these products (staple products) in order to decrease the dimensionality of the problem. In particular, I fix staple products and search over the remaining offerings. On average, there are 12 staple products in a market, so the assortment problem reduces to the problem of choosing 19 products from 31 options. The last step searches for other potential equilibria. For each market, one million potential assortments are picked at random and the algorithm checks whether these assortments constitute an equilibrium. Even though a unique equilibrium is not guaranteed, the brute-force search over assortments identifies a single equilibrium in assortments and prices.

The analysis is conducted for a sample of 5 markets for the period from 2005q1 to 2008q4, resulting in a total of 80 market-quarter pairs. Markets in which I observe a large number of retailers are difficult to analyze due to the computational burden each retailer adds. Alternatively, very small markets have less interesting effects on assortment changes. As a result, I choose medium-sized markets with 3 to 6 grocery chains, in which the assortment and welfare implications of vendor allowances may be readily explored. The selected markets are Birmingham, AL, Buffalo, NY, Indianapolis, IN, Richmond, VA, and St. Louis, MO. The counterfactual experiment is conducted

Table 6: Counterfactual Analysis: Results (in % changes)

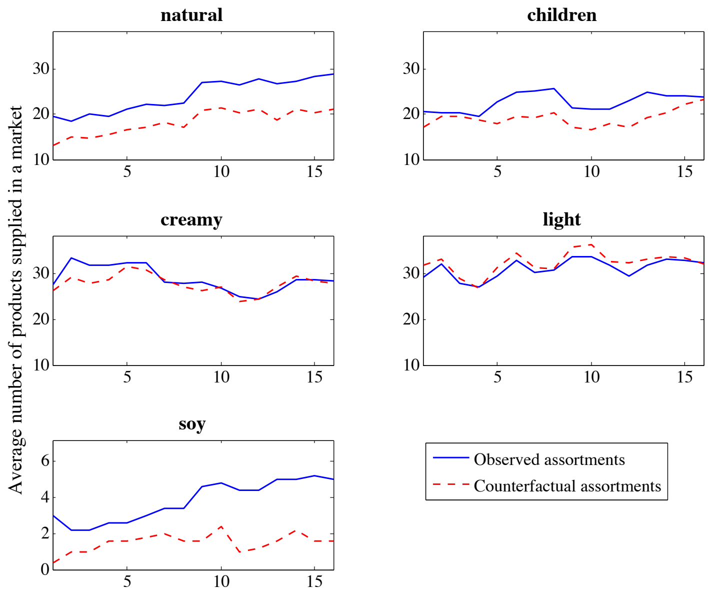
	2005	2006	2007	2008
Consumer Surplus	2.36	2.44	2.44	2.53
Prices	-5.08	-5.92	-5.31	-4.67
Prices (unchanged)	-0.03	-0.04	-0.03	-0.04
Prices (switched)	-25.82	-30.23	-29.39	-24.44
Retailer mc (switched)	-30.90	-36.05	-35.24	-28.87
Chain variable profits	2.89	2.96	2.76	2.70
By characteristic:				
Natural	-23.31	-20.29	-22.08	-25.98
Children	-7.16	-21.07	-20.85	-12.02
Light	4.44	3.74	7.00	3.18
Creamy	-9.04	-0.40	-1.42	1.51
Soy	-51.83	-27.33	-59.83	-61.67
Producer revenues:				
Breyers	22.56	26.35	19.98	30.59
Dean Foods	-92.11	-79.81	-72.18	-75.35
General Mills	-0.21	-0.64	0.70	1.76
Groupe Danone	-1.77	-0.57	-1.31	-1.04
Johana Foods	155.17	174.44	149.97	123.66
LALA Foods	7.97	9.43	10.91	8.16
Prairie Farms	10.12	5.80	8.12	6.75
Private Label	-1.22	-1.30	-1.11	-1.39

Notes: Table presents summary statistics for changes in market variables under the counterfactual scenario of no vendor allowances for yogurt products, described in Section 7. Results are reported as percent changes of key variables. The analysis is static and keeps wholesale prices and number of yogurt products supplied in each chain fixed. Retailer choose new optimal markup given the changes in market assortments.

over a time period for which product characteristics are stable. The last quarter analyzed is 2008q4 in order to exclude the rapid expansion of "greek" yogurts in 2009. The counterfactual simulations sets the structural shocks to zero.

The estimates indicate that the average consumer is predicted to be better off under all of the simulated equilibrium assortments. Consumer surplus increases by 2.4% and the gains amount to a $3.3 million yearly increase for the five markets. Table 6 reports the percentage change for key variables. Average retail prices decrease by 5.2%; however, this drop is not attributed to increased price competition across retailers. Rather, prices fall because the new assortments consist of products with lower average wholesale prices. For products supplied in both the observed and counterfactual scenarios (unchanged products) average prices fall by 0.04%; whereas the difference in average prices between dropped and added products (switched products) is in the order of 25-30%. This suggests that, in the counterfactual, retailers shift towards low-markup and high-volume products. Under the new assortments, retailer variable profits increase; however, these gains are overshadowed by the loss of vendor allowances. In particular, retailer variable profits increase by 3%, while the distribution of vendor allowances' lower bounds implies that paid lump-sum

Figure 6: Change in Number of Unique Products by Characteristic



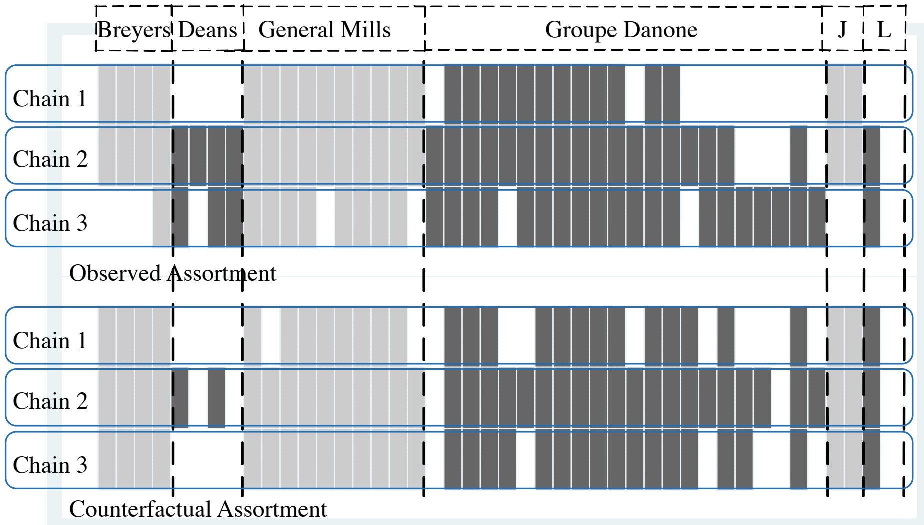
Notes: Each graph shows the average number of products under the observed and counterfactual assortments, separately for each characteristic. If a product line is offered in two retailers in the market, I count it as two products. These graphs seek to highlight changes in market assortments. The counterfactual assortments correspond to new equilibrium assortments when vendor allowances are eliminated.

transfers constitute at least 10% of retailer variable profits. Consequently, retailers fare worse in the counterfactual.

The second panel of Table 6 reports how assortments adjust in the counterfactual, and Figure 6 shows these changes over time. Although natural and children's products are predicted to lose 10-20% of their market distribution, all retailers continue to offer at least one of these products; and, on average, retailers supply 5 products with each characteristic. As a result, in the counterfactual all retailers continue to offer consumers a variety of natural and children's product options. In contrast, soy products lose distribution in at least one retailer for 61% of the computed assortments. Moreover, in the counterfactual soy yogurts are not supplied in Indianapolis, IN during 2005 and 2006, while in Richmond, VA the products disappear in 2008. Soy products may be characterized as "niche" products in the yogurt industry, implying that retailers tailor their assortments towards more "mainstream" products in the absence of vendor allowances.

Consequently, in the counterfactual, grocery chains position themselves closer to their competitors in terms of assortments. To gain insight into assortment changes, one can examine results from a representative market. Table 7 lists the products supplied under the observed and counterfactual assortments in Buffalo, NY for the fourth quarter of 2007. The third column displays the number of chains that carry the product line in the observed assortment, and the fourth column reports the statistic for the counterfactual assortment. Under the observed market assortment, there are 43

Figure 7: Changes in Assortments for the Buffalo-2007q4 market



Notes: The figure shows assortment snapshots for the Buffalo-2007q4 market. Vertical axis goes over observed chains in the market. Horizontal axis identifies products. Products are ordered by brand: Breyers, Dean Foods, General Mills, Groupe Danone, Johanna Foods, and LALA Foods. Private label products are excluded from the graph as the counterfactual simulation keeps private label assortments fixed. White blocks correspond to instances in which the product is not offered in the retailer-market pair. The counterfactual assortments correspond to new equilibrium assortments when vendor allowances are eliminated.

unique branded product lines supplied in the market, while in the simulated assortment, consumers may choose from 39 product lines. In line with the characteristics' changes described above, the excluded products are: Horizon Organic Yogurt Tubes (Dean Foods' natural and children's product), Silk Live (Dean Foods' soy product), Brown cow (Groupe Danone's natural product), and Stonyfield Farm Squeezers (Groupe Danone's natural and children's product).

To analyze assortment changes across chains, Figure 7 shows a snapshot of the observed and counterfactual assortments in Buffalo, NY for the fourth quarter of 2007. The first panel presents the product offerings under the observed assortment and the second panel shows the counterfactual choices. The vertical axis goes over the three retailers in the market and the horizontal axis identifies products, sorted by producers. Figure 7 highlights that, absent vendor allowances, small producers, who offer low-cost "mainstream" options, gain distribution in the market. In particular, Breyers, Johanna Foods, and LALA Foods increase their total number of "shelf spots" by 3, 2, and 1 products respectively.[23] This increase is at the expense of Dean Foods, who loses 5 shelf spots in this market, while Groupe Danone's offerings decrease by 1. The total number of products supplied by General Mills in the market does not change.

The increased market distribution for small producers results in higher total sales and revenues for their products. This increase in market revenues, combined with the decrease in producer fixed

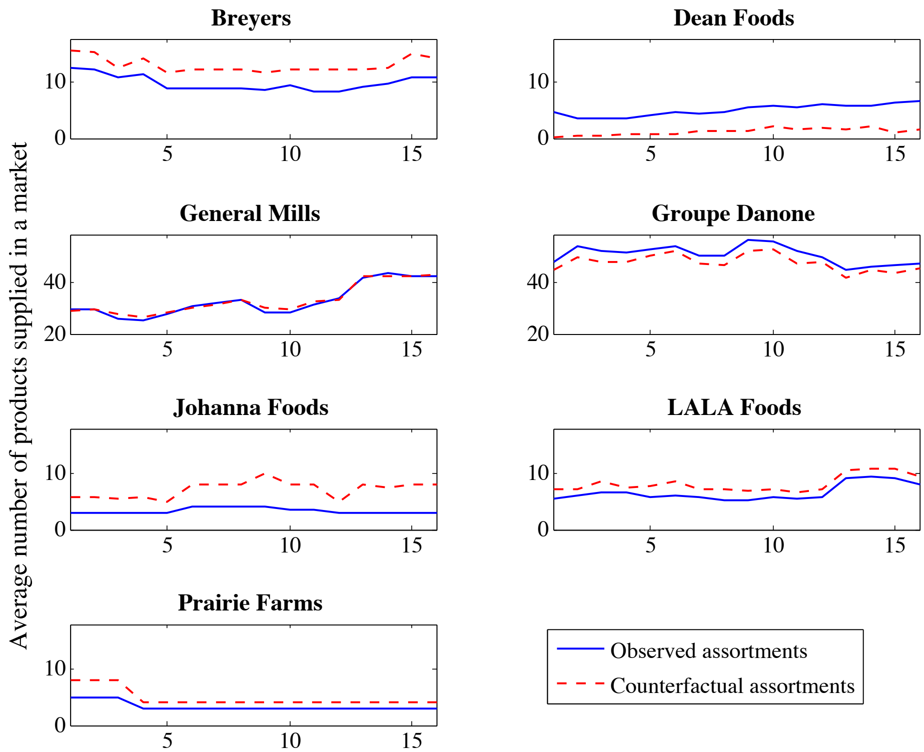
[23]Breyers yogurt producer should not be confused with the ice-cream maker. During the sample period the brand was first owned by CoolBrands International and then by Healthy Food Holdings.

Table 7: Changes in Assortments for the Buffalo-2007q4 market

Producer	Product Line	# chains observed	# chains counterfactual
Breyers	Breyers	2	3
	Breyers Creme Savers	2	3
	Breyers Light	2	3
	YoFarm YoCrunch	3	3
Dean Foods	Horizon Organic	2	1
	Horizon Organic Yogurt Tubes	1	-
	Silk	2	1
	Silk Live	2	-
General Mills	Yoplait Go Gurt	3	3
	Yoplait Go Gurt Fizzixx	3	2
	Yoplait Kids	3	3
	Yoplait Light	3	3
	Yoplait Light Thick and Creamy	2	3
	Yoplait Original	3	3
	Yoplait Thick and Creamy	3	3
	Yoplait Trix	3	3
	Yoplait Whips	3	3
	Yoplait Yo Plus	2	2
Groupe Danone	Brown Cow	2	-
	Dannon Activia	3	3
	Dannon Activia Light	3	3
	Dannon All Natural	3	3
	Dannon Creamy Fruit Blends	2	2
	Dannon Danimals	3	1
	Dannon Fat Free	3	3
	Dannon Fruit on the Bottom	3	3
	Dannon La Creme	3	3
	Dannon Light 'n Fit Carb & Sugar Control	3	3
	Dannon Light 'n Fit	3	3
	Dannon Light 'n Fit Creamy	2	2
	Dannon Natural	3	3
	Dannon Natural Flavors	3	3
	Dannon Premium	1	3
	Dannon Sprinklings	2	1
	Stonyfield Farm	2	3
	Stonyfield Farm Kids	1	2
	Stonyfield Farm O'Soy	1	1
	Stonyfield Farm Squeezers	1	-
	Stonyfield Farm Yobaby	2	3
	Stonyfield Farm Yokids	1	1
Johanna Foods	La Yogurt	2	3
	La Yogurt Custard Classics	2	3
LALA Foods	Weight Watchers	2	3
	Private Labels	2	2

Notes: Table presents summary statistics for the assortment changes in Buffalo for the 4th quarter of 2007. The third column shows the number of chains that supply the product in the observed assortment, and the 4th column shows the number in the counterfactual assortment.

Figure 8: Change in Number of Unique Products by Producer



Notes: Each graph shows the average number of products under the observed and counterfactual assortments, separately for each brand. If a product line is offered in two retailers in the market, I count it as two products. These graphs seek to highlight changes in market assortments. The counterfactual assortments correspond to new equilibrium assortments when vendor allowances are eliminated.

costs from the elimination of vendor allowance payments, implies that these producers are better off in the absence of vendor allowances.[24] In the counterfactual, General Mills' assortments and revenues change only slightly. The direction of the change vary by location: General Mills gains distribution and revenues in Richmond, VA and Buffalo, NY; while the producer is worse off in Birmingham, AL and St. Louis, MO. Groupe Danone's revenues fall by 1.2% on average, and the producer supplies fewer products in 70% of the counterfactual market-quarter pairs. Dean Foods suffers a 80% decrease in revenues; moreover, the producer loses distribution for all of its products in 40% of the analyzed market-quarter pairs. The patterns continue both across markets and over time. Figure 8 shows the average number of product offerings across markets under the observed and counterfactual assortments for each brand over time.

One may ask why Dean Foods and Groupe Danone pay vendor allowances to supply "niche" products. The discussion at the end of Section 6 shows that the vendor allowances paid by Dean Foods

[24] In order to contradict this implication, producer marginal costs of supplying to different retailers in the same market must vary drastically. The conclusion is also violated if small producers have increasing marginal costs of production.

consist of both a cash transfer and provision of stocking service. Thus, economies of scope in distribution may rationalize Dean Foods' supply decisions. The counterfactual analysis assumes that all vendor allowance transfers are eliminated. However, if only cash transfers are eliminated, while allowing for potential cost savings through the use of producer direct-store-delivery systems, then Dean Foods' product distribution and revenues might not change. To allow for such a counterfactual, I would need data on retailers' distribution costs.

Vendor allowances arise due to retailers' opportunity costs of shelf space, hence, they may be used as a means to allocate a scarce resource to its best available use.[25] Thus, Groupe Danone may pay vendor allowances for "niche" products because of high profit margins for these offerings. Under this efficiency rationale, the observed assortment of Groupe Danone may maximize total vertical profits, achieving the optimal assortment through the use of vendor allowances. Alternatively, Groupe Danone may be using vendor allowances to protect its "mainstream" offerings. In that case, Groupe Danone supplies "niche" products to the market in order to prevent the entry of competitors' products, which are close substitutes with its "mainstream" offerings.

These alternative strategies relate to the efficiency and exclusionary rationales discussed in the debate about the effects of vendor allowances on product availability. Distinguishing between the two rationales requires additional information about producers' marginal costs. If one assumes that producers' margins are the same across all products, then the results support exclusion rather than efficiency: total producer profits are higher under the observed assortment, but total vertical profits are lower. However, if Groupe Danone's cost function exhibits large discrepancies in costs across products, or non-linearities, or gains in efficiency from producing some of the products together, then the efficiency rationale may be supported. Hence, distinguishing between the two strategies requires product-level data on producer marginal costs and remains a challenge for future work.

[25] Due to concerns about violations of the Robinson-Patman Act, wholesale prices differ across retailers only on the basis of cost differences.

8 Conclusion

Despite the widespread use of vendor allowances in the retail sector, the Federal Trade Commission does not have a conclusive position on the market effects of vendor allowances. This paper seeks to further our understanding on the competitive implications of this vertical contract. Due to lack of data on the size of vendor allowances received by retailers, I first quantify vendor allowances and assess their importance for retailer profitability in the grocery industry using data on yogurt products. The framework incorporates both retail price competition and endogenous product assortment decisions. Using a revealed preference approach, I identify the empirical distribution functions of vendor allowances' lower and upper bounds. Lower bound estimates for paid vendor allowances imply that these transfers amount to 4.7% of estimated retailer revenues. When the negotiations stage is modeled as producer take-it-or-leave-it offers, I find that paid vendor allowances are higher for new products in the market. In addition, results show that there is substantial heterogeneity in the paid vendor allowances across offered products and these transfers are larger for "niche" products such as soy yogurts.

Next, I investigate the changes in market assortments, prices, and revenues in a counterfactual scenario in which vendor allowances are eliminated. I find that vendor allowances benefit grocery chains, while the effects on profitability of large producers are unclear. Without vendor allowances consumer surplus increases as new assortment choices are tailored towards "mainstream" products while eliminating "niche" products. In the counterfactual analysis, small producers increase both their distribution and market sales. This expansion is primarily at the expense of Dean Foods and Groupe Danone.

Dean Foods absorbs the distribution costs for its products by using its milk direct-store delivery system to supply yogurts. The vendor allowance estimates capture lump-sum payments from producers to retailer, which do not affect retailer sales. Hence, the counterfactual analysis eliminates both cash payments from producers and incentives in the form of retailer cost savings. It would be instructive to analyze a scenario in which distribution cost savigns are preserved, while only cash payments are eliminated. However, such an analysis requires data on retailers' distribution costs.

Groupe Danone's strategy may be explained using both efficiency and anticompetitive rationales. Under the assumption that producers' margins are the same across product, the results imply vendor allowances have an exclusionary effect. However, without marginal cost data, it is not possible to rule out large variations in producer marginal costs across products that would imply Danone's use of vendor allowances promotes efficiency. Nevertheless, the paper shows how the framework can be used to settle the debate in future work if marginal cost data can be obtained.

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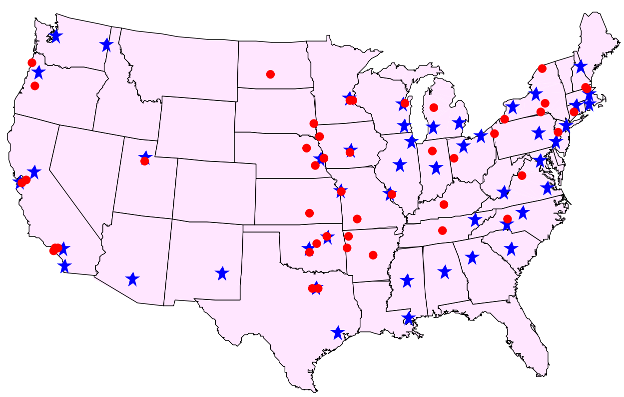
A Data Appendix

The data are obtained from the academic Information Resources Inc. (IRI) dataset that contains information on grocery chains' weekly sales and units sold in 47 distinct geographical markets in the U.S. for the period of 2001-2011. Markets cover major metropolitan areas (e.g. Boston, MA) or regions (e.g. New England). As shown in Figure A1, IRI market locations are scattered across the U.S..

Figure A1: Locations of Markets and Producer Plants



Notes: Stars identify market locations, while red dots show the locations of producer manufacturing facilities.

The academic dataset is drawn from the IRI's national sample of stores; IRI samples supermarkets with annual sales of more than $2 million. The academic dataset includes information on a sample of grocery and drug stores, hence, mass merchandisers, such as Walmart, are not included in the sample. In the analysis I use data on grocery chains only. As a result, I observe between 4% and 16% of all stores in a geographic market, for a total of 74 grocery chains in the sample.[26] For each chain in the sample, the dataset contains information on an average of 25% of its stores. On average, I observe 4 chains in a market, and each chain appears in the data in an average of 3 markets. Chains vary in size; their estimated market yearly sales range from $5 million to $1,147 million. Most of the chains in the IRI dataset are among the main competitors in their respective markets. For each market I observe at least 2 and, on average, 3 to 4 of the 5 major grocery chains. The five main competitors in a market account for 50-94% of sales in the grocery sector for the analyzed markets.

In the analysis, I use 42 markets in which I observe information for at least two chains in the market at any given quarter. The sample used covers seven years, 2004-2010, in order to match the data

[26]Information on all stores and their estimated yearly sales is gathered from ReferenceUSA data on U.S. Businesses. ReferenceUSA collects data on U.S. businesses and continuously updates the information. The data are assembled through public sources along with regular phone interviews with stores' managers to verify the information and collect additional data on businesses.

To calculate the reported measures, I use information on grocery stores with sales of more than $2 million a year.

collected from ReferenceUSA. The unit of analysis is 'product line'-retailer-market-quarter. As a result, a product is defined at the product line (e.g. *Stonyfield Smooth & Creamy, 6 oz*), which includes a variety of flavors (e.g. Stonyfield Smooth & Creamy, 6 oz, french vanilla). I aggregate to the product line level because (according to industry practitioners) assortment decisions and contracts are determined at the product line. I infer that a product line is supplied in a retailer if it records non-zeros sales for the period. Concerns about a situation in which a product is on the shelf and records zero sales are alleviated by the data aggregation at the quarter-retailer-market level.

Following Villas-Boas (2007), quantity sold is measured by the number of 6-ounce servings sold. Per-serving prices are constructed by dividing total sales by number of units sold. Prices are converted to constant 2010 dollars using the Consumer Price Index by region. The average price of a 6oz cup of yogurt is $0.80. Most of the price variation is across products and retailers. The price variation over time due to temporary promotions is wiped out due to the aggregation at the quarter level. Retail prices do not vary across flavors.

I define five product characteristics: natural, marketed for children, creamy, light, or soy. Over the sample period the ingredients for most products change and a number of products are discontinued. As a result, I rely on dummy variables to describe yogurts. These characteristics are neither comprehensive nor exclusive, that is, a product can have none of the characteristics or it may be defined as, for example, both natural and marketed for children. The natural characteristic identifies organic products, or products which are marketed as using only natural ingredients.[27] To categorize products as creamy, light, or children's, I inspect product line names and use key words. The soy products in the dataset are *Silk*, *Silk Live*, and *Stonyfield Farm O'Soy*.

Markets offer a variety of natural, children's, creamy, and light options: usually more than 20 product-retailer offerings with each of these characteristics are available. The only exception is soy products as only 2-3 product-retailer options are offered in a market. Groupe Danone and Dean Foods are the main producers of natural products and the only distributors of soy products. Products marketed for children are offered by six of the producers analyzed. Price variation across the product categories is shown in Table A1. The average price of natural and children's products are higher than their non-natural and non-children's products. Natural, children's, and creamy products account for 8-11% of market sales each. Light products are responsible for, on average, 32% of market sales, while soy products are characterized by very low sales.

Following Draganska et al. (2009b), the estimation sample includes a producer if its market share is at least 5% in at least 5 quarter-market pairs. As a result the sample consists of 12 national and regional producers and 30 private label brands. Table A2 shows market shares and market presence by producer. During the sample period the two main competitors are Groupe Danone and

[27]The products which are identified as natural are product lines under following brands: *Brown Cow* (Groupe Danone), *Chiobani* (Agro Farma), *Danone Natural* (Groupe Danone), *Horizon Organic* (Dean Foods), *Mountain High* (Dean Foods), *Nancy's* (Springfield Creamery), *Silk* (Dean Foods), *Stonyfield Farm* (Groupe Danone).

Table A1: Product characteristics: prices and sales

	mean price	sd price	market share (%)	sd market share (%)
Nat=0	0.80	0.26	88.62	4.73
Nat=1	0.95	0.40	11.38	4.73
Children's=0	0.80	0.30	91.41	2.38
Children's=1	0.95	0.29	8.59	2.38
Creamy=0	0.82	0.31	88.18	5.56
Creamy=1	0.88	0.28	11.82	5.56
Light=0	0.84	0.32	68.24	6.96
Light=1	0.82	0.27	31.76	6.96
Soy=0	0.83	0.30	99.72	0.21
Soy=1	1.02	0.25	0.28	0.21

Notes: Table shows summary statistics for market prices and sales by characteristic. Market shares are calculated as the fraction of units sold that are attributed to products described with each of the characteristics (expressed in percent).

Table A2: Producer market shares and distribution

	mean	median	sd	min	max	#markets	#retailers
Breyers	0.05	0.02	0.05	0.00	0.24	42	70
Dean Foods	0.02	0.01	0.03	0.00	0.09	42	65
General Mills	0.41	0.41	0.09	0.19	0.64	42	74
Groupe Danone	0.34	0.35	0.10	0.09	0.52	42	74
Johanna Foods	0.02	0.01	0.02	0.00	0.08	16	20
LALA Foods	0.03	0.02	0.04	0.00	0.28	42	73
Prairie Farms	0.03	0.01	0.04	0.00	0.15	9	16
Private Labels	0.14	0.13	0.07	0.01	0.33	39	29

Notes: Market shares are calculated before data cleanup. # markets column shows the number of markets in which the producer is available in any year; analogously for # retailers. Smaller producers are not included in the table. The regional producers included in the estimation but not shown on the table are: Agro Farma, Anderson-Erickson Dairy, Crowley Foods, Springfield Creamery, and Tillamook County Creamery.

Table A3: Producer Supply across Retailers

	total	mean	median	sd	min	max
Breyers	10	4	4	2.1	1	10
Dean Foods	18	3	3	1.7	1	10
General Mills	17	10	11	2.2	3	16
Groupe Danone	26	15	15	3.4	3	24
Johanna Foods	5	3	3	1.0	1	5
LALA Foods	9	3	2	1.5	1	8
Prairie Farms	4	1	1	0.4	1	2

Notes: The variable total displays the average number of product options available each a year.

General Mills who collectively control, on average, 70% of yogurt sales. Groupe Danone produces the *Dannon*, *Stonyfield farm*, and *Brown cow* brands, while General Mills distributes the *Yoplait* and *Colombo* brands. Private labels are offered by 30 of the 74 chains and these products account for 14% of market sales. The data do not differentiate across private label products to ensure chain confidentiality. As a result, the private label products are aggregated to the chain level. Even though the largest of 10 smaller competitor controls, on average, less than 6% of market sales, there is substantial variation across markets. For example, Breyers accounts for 20% of yogurt sales in Charlotte in 2004 while LALA Foods is the second biggest producer in the Omaha market. Notice that the sample includes both 5 producers, which distribute products in all 42 markets, and 37 regional producers (including private labels), whose products are sold in only some of the markets.

Variation in the number of products supplied by producer is shown in Table A3. The average chain in the sample offers 31 products selected from more than 71 non-private label possible options. In terms of number of existing products, Groupe Danone produces the most product options from which chains can select offerings: an average of 26 in a year; followed by Dean Foods (with 18 product options) and General Mills (17). On average, I observe 7 producers in a market who offer 43 unique products. Groupe Danone and General Mills supply more than half of their products to grocery chains.

The estimation methodology addresses retail price endogeneity by employing cost shifters as instrumental variables. Table 2 summarizes the cost data collected and their sources. In addition, I create a "distance" variable to account for transportation costs from producer manufacturing facility to each market. I locate yogurt plants in the U.S. which were used during the sample period; Figure A1 shows manufacturing facilities' locations. Using geographic distances, I calculate a proxy for the travel distance between plants and each market. When a brand is produced in more than one plant, I use the geographic coordinates of the closest facility.[28] For private labels, I assign the value of the closest plant to the market. These travel distances are interacted with gas prices to obtain a proxy for transportation costs.

[28]This strategy assumes that all products under the brand umbrella are manufactured in all plants.