Vertical Contracts and Endogenous Product Selections: An Empirical Analysis of Vendor Allowance Contracts*

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Abstract

Vertical contracts cannot be understood in isolation from endogenous product selections. Strategic retailers choose assortments taking into account consumer preferences, downstream competition, and vertical contracts. Producers frequently provide retailers financial incentives 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 quantity sold. I develop a framework to quantify lump-sum transfers using only data on retail prices, sales, and assortments. Model estimates imply that vendor allowances correspond to 4.18% of retailer revenues. To understand how vendor allowances affect market outcomes, a counterfactual analysis restricts contracts to include only wholesale prices. Simulations predict a decrease in retailer profits even though total vertical surplus increases. Moreover, the change in the vertical contract affects equilibrium product availability. Retailers adjust assortments to include products, which were previously used as credible replacement threats and allowed them to extract favorable terms of trade from producers.

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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, retailer product selections have large consequences for consumer welfare and firm profits. In addition to consumer preferences and retail competition, vertical contracts with producers are important determinants of retailer assortment. As a result, vertical contracts cannot be fully understood without recognizing their effect on product availability. This paper seeks to further our understanding of vertical contracts by endogenizing retailer product selections.

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 lump-sum transfers have been the subject of policy discussion.[2] Nevertheless, there is little consensus about the equilibrium effects of vendor allowances on market outcomes. In fact, the FTC abstains from providing clear guidelines on the use of slotting fees, citing conflicting 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.

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

Taking into account these challenges, this paper analyzes the equilibrium consequences of the vendor allowance contract when product assortments are endogenous by addressing two main questions. First, how large are unobserved vendor allowances? To answer this question, I develop a framework to identify vendor allowances when only limited data are available: retailer prices, sales, and assortments. The analysis does not require data on vertical contracts or firm costs, which are typically unobserved. Instead, by exploiting the information from the observed retailer product selections, vendor allowances are estimated as the payments needed to rationalize observed assortments. I apply the framework to the U.S. yogurt grocery market and find that vendor allowances amount to 4.18% of retailer revenues. The second question asks: how does the vendor allowance contract affect market outcomes? I use model estimates to simulate a counterfactual scenario that restricts the vertical contract to consist of only linear wholesale prices. Simulations suggest that total vertical surplus increases; however, retailer profits are predicted to decrease. Remarkably, both equilibrium wholesale prices and product assortments change. These results illustrate that the type of vertical contract may influence product availability.

The framework describes interactions between producers, retailers, and consumers as a five-stage game. Grocery chains select the yogurt assortments supplied and the model implements this industry practice. First, retailers choose the set of products they would like to supply and initiate negotiations over these selected products. Negotiations are modeled as producer simultaneous take-it-or-leave-it offers of product-specific wholesale prices and vendor allowances. Importantly, retailers have an outside option: if a product offer is rejected, the retailer may supply an alternative "non-offered" product in its place. These non-offered products serve as credible threats and allow retailers to demand favorable contracts from producers.[3] Conditional on assortments and contracts, retailer price competition is modeled as a differentiated-product Bertrand-Nash game. Last, consumers observe market assortments and prices, and choose utility maximizing product-retailer pairs.

I apply the framework to the U.S. grocery yogurt market for the 2001-2010 period us-

[3] The framework may be recast as a Nash-in-Nash bargaining game with the extension that retailers may exercise an outside options of terminating negotiations and supplying an alternative product. Section 5 discusses how the model fits in a Nash-in-Nash bargaining setup. Lump-sum transfers may not be separately identified from the bargaining power parameter. Instead, this project investigates the equilibrium consequences of the vendor allowance contract when retailer product assortments are endogenous.

ing the IRI academic dataset. Vendor allowances are known to play an important role for most segments of the grocery industry, and especially for refrigerated categories. In addition, 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, retailer strategic assortment choices may substantially impact vertical contracts, consumer choice, and total welfare.

Estimation proceeds in two steps. First, standard techniques, as in Berry et al. (1995), are applied to consumer demand and retailer pricing analyses: demand is estimated using the random-coefficients logit model, while retailer markups are recovered from the optimality conditions prescribed by the Bertrand-Nash game. Next, vendor allowances are inferred using retailer incentive compatibility conditions: in equilibrium, no retailer may increase its expected profits by unilaterally altering its product assortment. To my knowledge, this is the first paper to exploit the identities of observed retail product selections to infer information about vertical contracts.

A simple example illustrates how vendor allowances may be inferred from retailer 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 the observed product offering is \$20,500 per store and its variable profits under the alternative assortment would have been \$20,600. This suggests that the vendor allowance received for *Yoplait Trix* must be at least \$100 per store. Vendor allowance transfers reflect retailer shadow price of shelf space, which is approximated as the additional retailer profits generated by switching a product with its most profitable replacement. The assumption of producer take-it-or-leave-it offers implies that contract offers place retailers on their participation constraints.

The separation of product assortment decisions and retail price competition allows for the separate identification of wholesale prices and vendor allowances. Conditional on assortments, retail pricing and demand analyses identify downstream variable profits. Then, using the observed assortment choices, I identify vendor allowances as the transfers needed to satisfy retailer incentive compatibility conditions. To ensure consistency of first-step parameter estimates, I assume that product selection is based on observables: retailers choose assortments before the realization of structural shocks to demand. 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, retail prices can be easily adjusted as market conditions change; thus, structural shocks are allowed to affect retailer pricing decisions. I use cost-based instrumental variables to address price endogeneity.

Model estimates suggest median consumer price elasticity of −4.3 and median retailer variable profit margins of 27.5%. These estimates align closely with the 27% median variable profit margins reported by public grocery chains during the analyzed period. Constructed vendor allowances suggest that lump-sum transfers are likely important for firm profitability. Estimated payments constitute on average 4.18% of retailer revenues and 13.33% of retailer variable profits.[4] By accounting for retailer endogenous product choices, I recover an additional component of retailer profits, which was previously disregarded.

Next, I investigate how the vendor allowance contract affects market outcomes; and, in particular, whether the contract affects product availability. The counterfactual restricts contracts to include only wholesale prices. When the contract is thus restricted, both wholesale prices and retailer product assortments may change. Keeping retailer shelf space fixed, the simulation finds new equilibrium assortments, contracts, and retailer prices. Discontinuities in producer profit functions prevent the estimation of producer marginal costs. The simulation calibrates producer marginal costs with a set of assumptions of uniform producer margins.[5] The implications for firm profitability and strategic product selections are stable across these calibrations.

Results for Toledo, OH predict that, absent vendor allowances, retailer profits decrease even though total vertical profits increase. Importantly, product assortments change in all counterfactual simulations. The model prescribes that retailers use non-offered products as credible threats in contract negotiations to extract lower wholesale prices. This implies that equilibrium wholesale prices are influenced by non-offered products. Thus, a retailer may strategically exclude a product in order to use it as a credible replacement threat in negotiations. Such incentives to distort assortments depend on the structure of the vertical contract.

[4] Public grocery chains report vendor allowances, and the median chain reports transfers that correspond to 7% of revenues. The accounting term differs from the opportunity cost estimates in two important ways. On the one hand, the IRS definition also includes promotional allowances, which are paid on a per-unit basis. On the other hand, estimated transfers would also capture vendor distribution support.

[5] Marginal costs are constructed using uniform producer margins of 20, 30, and 40 percent.

Simulations reveal that the observed assortment could not be supported by the restricted contract. The wholesale price decreases, necessary to satisfy retailer participation constraints, violate at least one producer's individual rationality. This result extends to all assortments that imply high retailer outside options. Instead, simulated assortments change to accommodate 59% of the previously excluded products that governed retailer most profitable deviations. These changes lead to decreases in retailer outside option values. As a result, equilibrium wholesale prices move closer to unconstrained producer take-it-or-leave-it offers. These findings suggest that retailer ability to strategically exclude of a product and extract rents from producers might be weakened in the absence of vendor allowances.

The vendor allowance and counterfactual analyses highlight that vertical contracts, retailer markups, and product assortments cannot be viewed independently. While vertical contracts and product availability have been examined in the empirical industrial organization literature, the two questions have largely been considered separately. In contrast, a contribution of the empirical framework is that it integrates retailer endogenous product selection with vertical negotiations. This proves essential for quantifying vendor allowances and studying how these contracts affect market outcomes.

The rest of the paper proceeds as follows. Section 2 describes related literature. Section 3 describes the data. I outline the model in Section 4, and Section 5 discusses the details for the empirical strategy. 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 anticompetitive practices. Shaffer (1991) shows that lump-sum transfers from producers to retailers increase market prices.[6] In addition, vendor allowances may be used

[6]Piccolo and Miklós-Thal (2012) show that vendor allowances may facilitate price collusion by homogenous retailers in a repeated game.

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 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. Payments in the form of warehousing allowances, vendor cash discounts, allowances for damaged goods, or operating support persist after the successful introduction of a product. I extend this literature by investigating the effect of continued vendor support 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. On the one hand, 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. (2016) analyze optimal variety in the radio industry, while Fan and Yang (2017) look at the effects of competition on the number and the composition of smartphone offerings. 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.

On the other hand, papers in the vertical relations literature investigate the effects of market structure on equilibrium terms of trade, while treating product availability as exogenous to the model. Papers examining vertical contracts in the grocery sector include Sudhir (2001), Villas-Boas (2007), Bonnet and Dubois (2010), Bonnet and Dubois (2015). Additionally, bargaining models, based on Horn and Wolinsky (1988), have been applied to study vertical markets: Draganska et al. (2009a), Crawford and Yurukoglu (2012), Grennan (2013), Gowrisankaran et al. (2015). A feature of the Nash-bargaining solution is that non-offered products may not influence the negotiated terms of trade. This assumption, however, is unreasonable for the retail sector as retailers can credibly replace an offered product with an alternative option. Two recent papers, Ho and Lee (2017) and Ghili (2017), highlight the issue when modeling network formation in insurer-hospital negotiations. The model developed in this paper explicitly accounts for retailer's ability to select different products; and it may be recast as a Nash-in-Nash bargaining problem that incorporates retailer credible threat of terminating a negotiation and supplying an alternative product. Binmore et al. (1989) show that the strategic use of an outside option in a Nash-bargaining framework acts as a constraint on the minimum payoffs obtained by the agent. This would impose a lower bound on vendor allowances. If retailer outside options are large, then retailer incentive compatibility conditions determine the equilibrium payoffs of the bargaining game. Lump-sum transfers cannot be separately identified from the bargaining power parameter. As a result, this paper focuses on vendor allowances because of their wide use, importance for firm profitability, and scarce empirical evidence.

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 (2017) 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 retailers 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 by a retailer. A strength of my framework is that it does not require data on wholesale prices as they are rarely available to researchers, and the model endogenizes retailer and producer competition.

3 Industry and Data

The extensive use of vendor allowances in the grocery sector 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.[7] 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, the framework is applied 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 29 yogurt product lines selected from on average 85 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. 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, which includes data on grocery chains' quarterly sales and units sold in 44 geograph-

[7] 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.

Table 1: Dataset Summary Statistics

	mean	median	sd	min	max
Market population (millions)	3.9	2.9	3.5	0.5	19.5
Yogurt consumption (servings)	27.9	29.3	5.5	18.7	36
Observed # of chains (in a market)	4.2	4	1.7	1	11
Chain market sales ($ millions)	187	155	161	5	1,147
Price	0.8	0.8	0.3	0.2	4.2
Flavors	5.6	4	5.8	1	50

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.

ical markets in the U.S. for the sample period 2001-2010.[8] I supplement the IRI dataset with information on grocery chains and market 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. I create a "distance" measure to capture transportation costs from each 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.

The unit of analysis is 'product line'-retailer-market-quarter. A product line (e.g. *Stonyfield Smooth & Creamy, 6 ounce*) includes a variety of flavors (e.g. *Stonyfield Smooth & Creamy, 6 ounce, french vanilla*). The aggregation to a product line matches the level of contracting in the grocery sector.[9] 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 three 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.

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

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

Table 2: Market and Input Costs Data

Variable	source	level of variation	mean	st. dev.
Input costs				
Gasoline ($ / barrel)	U.S. Energy Information Administration	Quarter -PAD	59.5	26.4
Ave weekly wage	Bureau of Labor Statistics	Quarter -Market	840.6	196.2
Distance from closest production facility to market : nautical miles				
Distance is calculated at the brand level when only some plants produce the brand.				
Agro Farma	own calculation	Market	828	636
Anderson-Erickson	own calculation	Market	679	343
Auburn Dairy	own calculation	Market	1496	563
Belfonte	own calculation	Market	683	345
Breyers	own calculation	Market	890	640
Cabot Creamery	own calculation	Market	953	645
Cascade Fresh	own calculation	Market	1504	559
Crowley Foods	own calculation	Market	804	633
Dean Foods	own calculation	Market	739	424
Fage USA Corp.	own calculation	Market	863	643
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	635
Johanna Foods	own calculation	Market	826	652
Kalona Organics	own calculation	Market	656	369
LALA Foods	own calculation	Market	1010	452
Northwest Dairy	own calculation	Market	1443	555
Old Home Foods	own calculation	Market	738	331
Prairie Farms	own calculation	Market	725	344
Purist Foods	own calculation	Market	929	365
Springfield Creamery	own calculation	Market	1507	596
Sun Valley Dairy.	own calculation	Market	1416	604
Tillamook County Creamery	own calculation	Market	1539	591
Wallaby Yogurt Company.	own calculation	Market	1502	638
Whole Soy	own calculation	Market	1459	627

PAD - Petroleum Administration for Defense District.

Figure 1: Assortment Snapshot: South Census Region 2010q1

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.

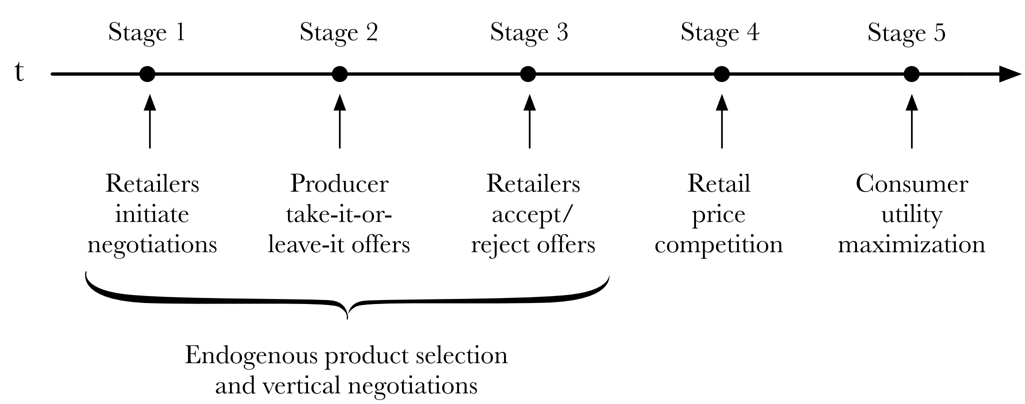
To identify vendor allowances, I exploit variation in observed assortments across grocery chains and markets. In particular, if all retailers carry the same products, then these assortments will provide no information about vendor allowances. To investigate the variation in product offerings, Figure 1 shows a snapshot of market assortments for the top 6 brands supplied in the first quarter of 2010 in the South census region. The vertical axis tracks retailers in the 12 markets (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).

4 Model

The model draws from key institutional features and blueprints the determination of product assortments, vertical contracts, and retail prices. Figure 2 presents the timeline for the game. First, retailers select the set of products they would like to supply and initiate negotiations over these products. Contract negotiations are modeled as producer simultaneous take-it-or-leave-it offers. The last two stages describe retailer price competition and consumer choice of the product-retailer pair that gives them the highest utility level. The setup is static, taking the identities and characteristics of products, retailers, and markets as given. I describe each stage in reverse order.

Figure 2: Timeline of the Game



4.1 Consumer Demand:

Consumer demand is modeled using a random utility framework, describing products as bundles of characteristics. 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: $\theta_D = (\alpha_i, \beta_i)$ 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, an outside option is defined as the choice not to purchase yogurt from the observed grocery chains in the market. The mean utility of the outside option is normalized to 0 as it cannot be separately identified. The utility maximization assumption, along with the logit stochastic shock, implies that predicted shares for each product-retailer pair in the market are given by:

$$s_{j,r}(A, \theta_D, \xi, X, p) = \int \frac{\exp(X_{j,r}\beta_i - \alpha_i p_{j,r} + \xi_{j,r})}{1 + \sum_{l,k \in A} \exp(X_{l,k}\beta_i - \alpha_i p_{l,k} + \xi_{l,k})} dF(\theta_D) \tag{2}$$

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

The indirect utility defined in equation (1) can be derived from a quasilinear utility function that is free of income effects. This is a reasonable assumption in the yogurt market as the product represents a small fraction of consumers' income. The static setup is justified by the perishability of the product, which alleviates stockpiling considerations. The model imposes that individuals would select one yogurt in a quarter, while in reality consumers may buy multiple yogurts. I do not observe individual consumer purchases, therefore, I cannot allow for multi-unit shopping behavior as modeled by Hendel (1999) and Kim et al. (2002). The model assumption implies that multi-unit purchases are either for different members of a household or for independent consumption occasions.

4.2 Retail Price Competition:

Vendor allowances are defined as lump-sum transfers that do not affect retailer sales. Conditional on retail assortments, these payments do not affect retailer variable profits; thus, vendor allowances are irrelevant for retailer pricing analysis. Given market assortments (A), parameters that govern consumer utility ($\theta_D = (\alpha, \beta)$), 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.[10] Notice that retailer r's sales of product j ($M s_{j,r}(A, \theta_D, \xi, p)$) depend on its own assortment and its competitors' offerings. The main component of grocery chains' marginal costs is wholesale prices. I refer to retailer marginal costs and wholesale prices interchangeably as the two cannot be separately identified given the available data. The distinction does not affect the analysis of vendor allowances.

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

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

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

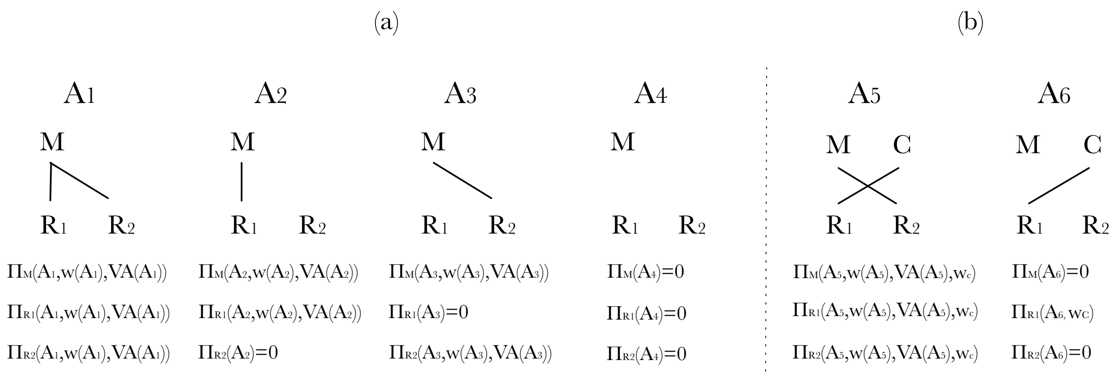
4.3 Vertical Negotiations and Retailer Product Selection:

Interviews with industry representatives confirmed that grocery chains select the yogurt assortments supplied and the model implements this industry practice. The determination of product offerings and vertical contracts is modeled in steps: retailers announce assortments that they would like to supply, followed by producer simultaneous take-it-or-leave-it offers. If a retailer rejects a product offer, it may supply an alternative product in its place. 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.[11] In line with industry practices, I assume that the parties may not contract over retail prices.

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

[11] The no-bundling assumption allows for the identification of product-specific vendor allowances.

Figure 3: Stylized Example: Possible Assortments and Payoffs



Next, I present a stylized example to illustrate the relationship between retailer endogenous product selections, outside options, and equilibrium vertical contracts. Then I describe the general equilibrium conditions prescribed by the model.

Stylized example: Consider a market with one producer and two symmetric, horizontally differentiated retailers. Each retailer may supply only one product. The vertical contract consists of a wholesale price and a vendor allowance cash payment from producer to retailers.[12]

As a base case, assume that retailers may only carry producer M's product. Panel (a) of Figure 3 shows the four potential market assortments and payoffs. The game proceeds following the stages described above: retailers decide whether to initiate negotiations with the monopolist; negotiations are modeled as producer take-it-or-leave-it offers. If a retailer rejects an offer, it supplies no products and generates zero profits. Once contracts and assortments are determined, retailers select prices in a Bertrand-Nash game and the last stage describes consumer demand. In equilibrium both retailers initiate negotiations with the monopolist. Wholesale price offers maximize producer profits subject to non-negative retailer payoffs; vendor allowances are zero.

To extend the base case, suppose that retailer 1 has access to products from a competitive fringe (C). These products may be procured at a pre-determined wholesale price of w_C. The additional market assortments and payoffs are shown in panel (b) of

[12]The implications of restricting the contract to linear wholesale prices are discussed in Section 7.

Figure 4: Stylized Example: Equilibrium Assortments and Payoffs

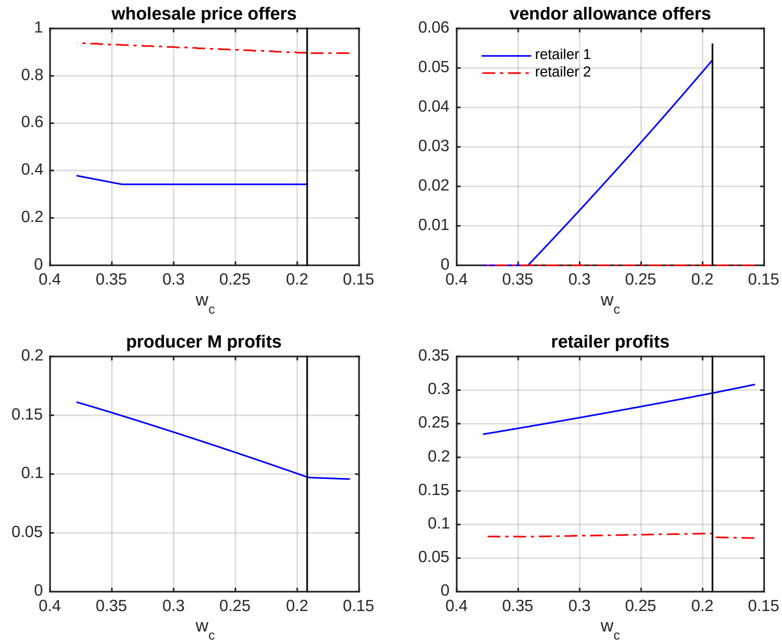


Figure 3. If retailer 1 initiates negotiations with M, its outside option is *reject M's offer and supply product C at w_C*. If products M and C are imperfect substitutes, then contract offers by M (w, VA) depend on w_C. Similarly, the value of retailer 1's outside option to supply product C depends on the wholesale price offer received by retailer 2.

The equilibrium of the game changes with w_C. To show this, suppose producer M's marginal cost is 0.2. Let consumer i's utility from purchasing product j in retailer r be: $u_{i,j,r} = 0.8 - 2p_{j,r} + \varepsilon_{i,j,r}$, where $\epsilon_{i,r}$ is an i.i.d extreme value type I error term; individuals may also choose an outside option and obtain $u_{i,0} = \varepsilon_{i,0}$.

Figure 4 illustrates the change in equilibrium market assortments, contracts, and firm payoffs as the value of retailer 1's outside option increases (w_C decreases). The solid vertical line in all graphs marks the change in equilibrium assortments: A_1 if $w_C \geq 0.19$; and A_5 if $w_C < 0.19$. Figure 4 shows that a retailer with an outside option may command better terms of trade from M; these may be in the form of lower wholesale prices or vendor allowances. In this example, vendor allowance payments emerge as w_C decreases. Due to retail competition, producer M finds it optimal to maintain higher wholesale prices and match retailer 1's participation constraint with a lump-sum transfer. In general, vendor allowance contracts may emerge in markets where competing retailers have credible outside options. The example highlights that equilibrium terms of trade change once the model accounts for endogenous product selections. Thus, non-offered products influence equilibrium contracts and firm payoffs.

General setup: The yogurt market is characterized by multi-product producers and retailers and the discussion below extends the example to reflect this. Let A be the set of products with initiated negotiations; and, for all product-retailer pairs ($\{j, r\} \in A$), let $(w_{j,r}, \mathrm{VA}_{j,r})$ be the contract offer that retailer r receives for supplying product j. Retailer r's expected profit from supplying assortment A_r equals:

$$E_\xi[\Pi_r(A, w, \mathrm{VA})] = E_\xi[\pi_r(A, w) + \sum_{j \in A_r} \mathrm{VA}_{j,r} - C_r] = E_\xi[\pi_r(A, w)] + \sum_{j \in A_r} \mathrm{VA}_{j,r} - C_r \quad (4)$$

where C_r captures the cost of supplying A_r if the retailer incurs all expenses. I assume that C_r may vary with assortment size but is invariant to the identities of the products supplied. As a result, vendor distribution support, which decreases fixed costs borne by the retailer, is captured by the vendor allowance transfers. Retailer product selections and contract negotiations are completed prior to the realization of structural shocks and the expectations operator in equation (4) reflects that firms form expectations over these shocks. Notice that vendor allowances affect retailer total profits; however, given retailer assortments, they do not affect retailer variable profits.[13]

Similarly, producer p's expected profits from supplying A_p are described as:

$$E_\xi[\Pi_p(A, w, \mathrm{VA})] = E_\xi[\pi_p(A, w)] + \sum_{\{j,r\} \in A_p} VA_{j,r} \quad (5)$$

The negotiations stage implies that, conditional on the set of products with initiated negotiations (A), producers choose contracts to maximize profits subject to retailer participation constraints. These participation constraints reflect retailer outside op-

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

tions of rejecting a product offer and supplying an alternative product in its place. Thus, with risk neutral retailers, equilibrium conditions require that no retailer may increase its total profits by unilaterally altering its assortment:

$$E_\xi[\Pi_r(A, w, \mathrm{VA})] \geq E_\xi[\Pi_r(A', w', \mathrm{VA}')] \tag{6}$$

where A' is any counterfactual assortment in which retailer r unilaterally deviates from the equilibrium assortment; and (w', VA') reflects retailer r's costs of supplying the counterfactually added products in A'. These deviations assume that retailers may procure non-offered products from a wholesaler or another intermediary at a cost of w' and zero vendor allowances. These retailer incentive compatibility conditions are exploited for the estimation of vendor allowances.

The credible threat of rejecting an offer and supplying alternative assortments A' allows retailers to extract a higher fraction of the vertical surplus. The producer may adjust wholesale prices as well as vendor allowances to satisfy retailer participation constraints. The stylized example shows that in markets with downstream competition, producers may find it optimal to maintain higher wholesale prices match retailer outside options with positive lump-sum transfers.

Vendor allowances reflect both cash payments from producers and incentives in the form of retailer cost savings such as distribution support. Thus, the vendor allowance costs to producers might be lower than the benefits captured by retailers. This would occur if producers provide operations support at lower costs than those incurred by retailers. One such example is described in Section 6: due to economies of scope in distribution, Dean Foods may be able to provide distribution support for yogurt products at little or no additional costs. Vendor allowances are estimated as retailer opportunity costs of shelf space; therefore, they reflect the value of these transfers to the retailer.

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, vendor allowances are inferred as the payments needed to rationalize observed assortments.

The separation of retailer assortment and pricing decisions allows me to separately identify wholesale prices and vendor allowances. The assumption is credible because grocery chains alter assortments at only a few predetermined occasions. In contrast, retail prices can be easily adjusted as market conditions change.

5.1 Step 1. Demand and Retailer Price Competition:

The analysis of retailer assortment decisions 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. I include product-year intercepts, which capture how product mean valuations change over time. Retailer-market-specific constants and quarter fixed effects account for differences in consumer valuations across grocery chains and seasonal changes in yogurt preferences. 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 possibility that a product characteristic may be perceived differently across retailers; that is, consumers may regard healthy products to be of higher quality when bought in Whole Foods than at a discount grocery chain. Product shelf location and number of facings may 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, product characteristics, flavors, and the constant 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.

As most demand analyses, I encounter a classic selection problem: firms supply products with anticipated high profits. This 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 structural shocks to demand. If assortment decisions are based on observables only, then demand parameters are consistency estimated. The assumption is credible for two reasons. First, the estimation controls for time-varying product-specific unobservables, retailer-specific intercepts, as well as chain interactions with product characteristics. Thus, the unobservable shocks do not capture systematic components that are likely known prior to the assortment choices and contract negotiations. Second, assortment decisions are "sticky". Changing an assortment requires coordination across stores; 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 shocks. To the extent that retailers observe these shocks and condition on them when setting prices, retail prices are endogenous. To address endogeneity concerns, I employ cost-based instruments. The instruments capture direct components of retailer market costs, such as transportation costs, interacted with retailer fixed effects. The intuition is that prices depend on retailer 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.

5.2 Step 2. Vendor Allowances:

Vendor allowances are inferred as retailer opportunity costs of shelf space. The strategy assumes that observed assortment yield weakly higher expected retailer profits than switching each of its products with any feasible alternative.[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

[14]Eizenberg (2014) presents an informal argument about the assumptions needed for point identification of demand parameters. The method requires that 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.

retailer incentive compatibility requires that:

$$E_\xi[\Pi_r(A, w, \text{VA})] \geq E_\xi[\Pi_r(A'_{(-j,l,r)}, w'_{(-j,l,r)}, \text{VA}'_{(-j,l,r)})] \quad \text{for } \forall j \in A_r, \forall l \notin A_r \tag{7}$$

For the observed market assortment (A), retailer wholesale prices and vendor allowances are: $w = [w_{-j,r}, w_{j,r}]$ and $VA = [VA_{-j,r}, VA_{j,r}]$. For the counterfactual assortment ($A'_{(-j,l,r)}$), the new contract ($w'_{(-j,l,r)}, \text{VA}'_{(-j,l,r)}$) reflects the change in retailer r's costs from supplying product l instead of j: $w'_{(-j,l,r)} = [w_{-j,r}, w_l]$ and $VA'_{(-j,l,r)} = [VA_{-j,r}, VA_l]$. The deviations assume that retailer r may procure non-offered products $l \notin A_r$ from a wholesaler or another intermediary. The contract for product l is not negotiated and $\text{VA}_l = 0$. To construct w_l, I use the highest inferred wholesale price for product l in that census region.[16]

Substituting retailer profits from equation (4) in equation (7), yields that for all products j supplied in r and all non-offered products l the following condition holds:

$$E_\xi[\pi_r(A, w)] + \sum_{k \in A_r} \text{VA}_{k,r} - C_r \geq E_\xi[\pi_r(A'_{(-j,l,r)}, w'_{(-j,l,r)})] + \sum_{k \in A'_{(-j,l,r)}} \text{VA}_{k,r} - C_r \tag{8}$$

The C_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 are the same across the two assortments considered. Vendor incentives may take the form of both cash transfers 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.

Retailer outside options imply that:

$$E_\xi[\pi_r(A, w)] + \sum_{k \in A_{-j,r}} \text{VA}_{k,r} + \text{VA}_{j,r} \geq E_\xi[\pi_r(A'_{(-j,l,r)}, w'_{(-j,l,r)})] + \sum_{k \in A_{-j,r}} \text{VA}_{k,r} \tag{9}$$

[16] The model implies that w_l do not depend on A and $w_{j,r}$. For example, w_l are determined by producer negotiations with wholesalers (Costco) and mass merchandisers (Walmart), which are not included in the data.

which leads to:

$$\text{VA}_{j,r} \geq E_\xi[\pi_r(A'_{(-j,l,r)}, w'_{(-j,l,r)})] - E_\xi[\pi_r(A, w)] \quad \text{ for } \forall j \in A_r \text{ and } \forall l \notin A_r \tag{10}$$

In the grocery industry, lump-sum payments flow from producers to retailers, so industry practices provide a natural lower bound on vendor allowances: $\text{VA}_{j,r} \geq 0$.[17] Additionally, producer profit maximization requires that if $\text{VA}_{j,r} > 0$, then contract offers are such that retailer incentive compatibility conditions are exactly satisfied. Vendor allowances reflect the shadow price of shelf space, which is approximated as the additional retailer profits generated by switching each product with its best replacement. In particular, given a profitable retailer deviation, equation (10) holds with equality for the most profitable replacement option of product j in retailer r:

$$\text{VA}_{j,r} = \max\{0, \max_{l \notin A_r}\{E_\xi[\pi_r(A'_{(-j,l,r)}, w'_{(-j,l,r)})] - E_\xi[\pi_r(A, w)]\}\} \quad \text{ for } \forall j \in A_r \tag{11}$$

These deviations are used to infer vendor allowances for all products in the observed market assortment.

Note that the model may be recast as a Nash-in-Nash bargaining problem with the extension that retailers have an outside option of terminating a negotiation and supplying an alternative product. The standard Nash-in-Nash model does not allow non-offered products to affect negotiations. In particular, the disagreement payoffs for each negotiating pair ($\{j, r\}$) are derived by dropping $\{j, r\}$ and keeping the rest of the assortment fixed. As a result, these payoffs do not account for retailer r's outside option to supply a non-offered product instead of product j. Binmore et al. (1989) relax these conditions and show that the strategic use of an outside option in a Nash-bargaining framework acts as a constraint on the minimum payoffs obtained by the agent. These constraints are identical to the retailer incentive compatibility conditions defined in equation (10), and they prescribe a lower bound on the vendor allowances received by retailers. However, if retailer outside options are large, then retailer participation constraints determine the equilibrium payoffs of the bargaining game. In such cases, the vendor allowance conditions in equation (10) are identical to

[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.

those prescribed by a Nash-in-Nash bargaining game. Unfortunately, lump-sum transfers may not be separately identified from bargaining power parameters. This paper focuses on analyzing how the vendor allowance contract affects outcomes in markets with endogenous product selections. These effects are important to study because the contract is wide-spread in the retail industry, whereas its impact on equilibrium product availability is unclear.

The model accounts for retailer endogenous product selections and the corresponding retailer incentive compatibility conditions are sufficient for the estimation of vendor allowances. Product substitutability implies that producer profit functions are discontinuous in wholesale prices. The wholesale price of one product affects the profitability of all other products in the market, as well as the value of the respective outside options. Consequently, conditional on competitors' contracts, a small change in the wholesale price of one product may lead to discrete changes in retailer assortments. As a result, the framework does not recover producer marginal costs.

Construction of deviations explained by example: The set of potential product offerings for each retailer in a market is defined 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 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.

The deviations constructed are: ***drop*** *each product from the observed assortment with replacement*. 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. To estimate retailer opportunity cost of shelf space, I replace the dropped product with the counterfactual option that renders the highest variable retailer profits.

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, $E_\xi[\pi_r(A)] = 20,500$. 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:

$$E_\xi[\pi_r(A'_{-trix,bl,r1})] = 20,600,\ E_\xi[\pi_r(A'_{-trix,sfy,r1})] = 20,540,\ E_\xi[\pi_r(A'_{-trix,ww,r1})] = 20,300$$

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. Given producer take-it-or-leave-it offers, the deviation yields that:

$$E_\xi[\pi_r(A)] + \mathrm{VA}_{trix,r1} \geq E_\xi[\pi_r(A'_{-trix,bl,r1})] \implies \mathrm{VA}_{trix,r1} = \min\{0, 100\} = 100$$

Expected retailer variable profits are simulated using the empirical distribution of structural shocks. For all simulations and counterfactual assortment changes retailer prices are re-optimized 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 estimation allows for 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 product characteristics (marketed for children, natural, soy, log flavors) and the constant term are estimated using draws from the i.i.d. standard normal distribution.

Results from the demand parameterization are reported in Table 3 where estimates of product characteristics are calculated as projections on the estimated product-year intercepts.[18] 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 children's and creamy products, while they value less soy and light products. Consumers value products with more flavor

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

Table 3: Demand Estimates

	estimate	standard error
Constant	-7.366	0.200
Constant (r.coef.)	0.249	0.567
Price	-6.947	0.425
Price (r.coef.)	1.960	0.227
Light	-0.279	0.021
Creamy	0.146	0.003
Child	7.087	0.179
Child (r.coef.)	1.897	1.043
Natural	0.048	0.041
Natural (r.coef.)	0.119	1.227
Soy	-15.363	0.823
Soy (r.coef.)	0.682	4.038
Flavors	0.773	0.084
Flavors (r.coef.)	0.662	0.074
Q2	0.043	0.004
Q3	-0.045	0.006
Q4	-0.222	0.009
2002	-0.058	-0.058
2003	-0.110	-0.110
2004	-0.149	-0.149
2005	-0.187	-0.187
2006	-0.154	-0.154
2007	-0.233	-0.233
2008	-0.150	-0.150
2009	-0.188	-0.188
2010	-0.283	-0.283

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 product characteristics and the outside option. Product characteristics are projected on product-year dummies. Other variables include retailer-market intercepts, characteristics interacted with retailer fixed effects, and quarter dummies. Price instruments are based on cost shifters: producer transportation costs interacted with retailer fixed effects. Sample size is 230,679.

Table 4: Implications from Demand and Retailer Price Competition Analysez

Median own-price elasticity	-4.317
% own-price elasticity > 0	0.000
% own-price elasticity > -1	0.006
Median markup (in $)	0.211
Median margin	0.275

Markups are derived under the assumption of retailer price competition. Variable profit margins are calculated as variable profits divided by total sales.

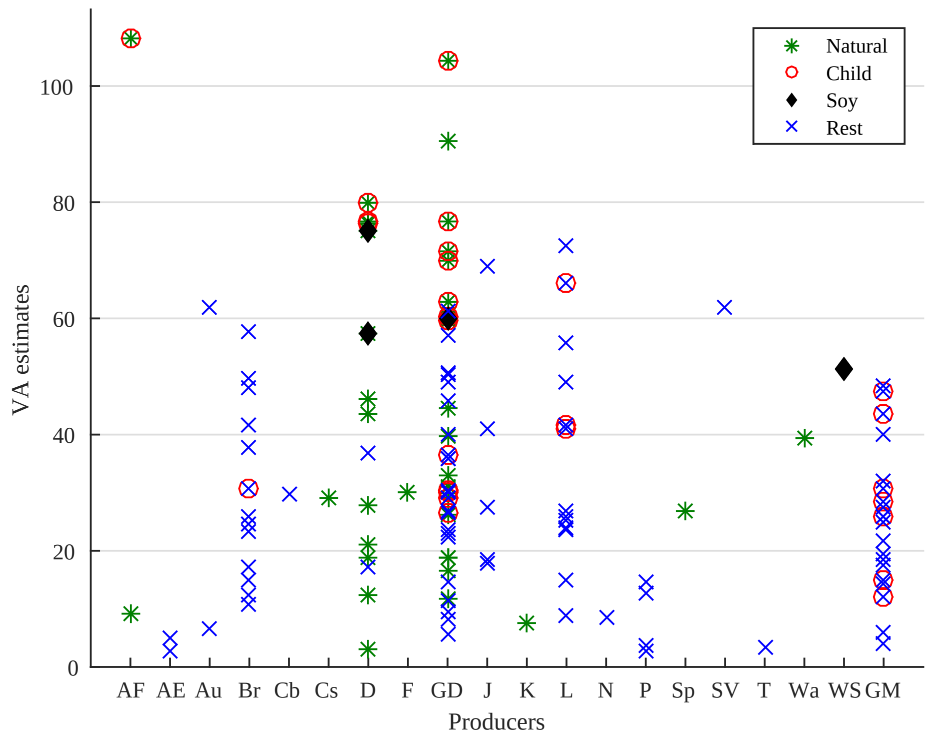
options offered by the retailer; however, there is substantial heterogeneity in individual preference for flavors.

Demand estimates imply median consumer own-price elasticities of -4.3. Table 4 reports that none of the calculated own-price elasticities are positive, and only 0.006% 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 21 cents and median variable profit margins of 27.5%. To analyze how well the model matches the observed margins in the grocery industry, I collect information on variable profit margins reported by public grocery retailers in their accounting statements. I find that median reported variable profit margin is 27% for the sample period.

Vendor allowances: To gain perspective on the importance of vendor allowances for retailer profitability, I compare the value of estimated lump-sum transfers to retailer sales and variable profits. Constructed vendor allowances suggest that, for the median grocery chain, received vendor allowances represent 4.18% of revenues and 13.33% of 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 de-

Figure 5: Comparison between Vendor Allowances



The *x-axis* sorts the products by producer: AF: Agro Farma, AE: Anderson-Erickson, Au: Auburn Dairy, Br: Breyers, Cb: Cabot Creamery, Cs: Cascade Fresh, D: Dean Foods, GD: Groupe Danone, J: Johanna Foods, K: Kalona Organics, L: LALA Foods, P: Prairie Farms, Sp: Springfield Creamery, SV: Sun Valley Dairy, Wa: Wallaby Yogurt Company, WS: Whole Soy, GM: General Mills. Results are based on 500 simulations.

signed 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 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 illustrate the differences in constructed vendor allowances across products, I project the payments prescribed by the model on product fixed effects. Figure 5 shows these estimates across producers for the 130 non-private label products supplied during the analyzed period. The *x-axis* sorts the products by producer, while different symbols identify product characteristics: natural products are marked by an asterisk, a circle identifies products marketed for children, and soy yogurts are shown with a diamond shape. Constructed vendor allowances are characterized by substantial heterogeneity across products within a producer. For example, the two extreme projections for Groupe Danone, indicate that the producer pays on average $99 more per store, quarter, and flavor for *Stonyfield Farm YoToddler* than for *Dannon Natural Flavors*. This result aligns with industry narratives that producers may refuse to pay slotting fees for staple products, but they would pay high lump-sum transfers for products that may be profitably replaced by retailers. In addition, Figure 5 displays that the vendor allowances for niche products, such as soy and natural-children's yogurts, are on average higher than the financial incentives provided for most other products offered by the retailers. Estimates suggest that the vendor allowances for soy products are $37 (st. error = 0.68) higher than the transfers for non-soy products; and natural-children's products pay $21 (0.83) more.

Even though the estimation strategy does not recover producer marginal costs, it is instructive to consider why producers may pay high vendor allowances to supply "niche" products. For example, estimates suggest that Groupe Danone provides $2,810 in benefits in order to supply *Stonyfield O'Soy* in retailer 1 in Toledo, OH 2009q4. Producer individual rationality imposes that the vendor allowance cost to the producer may not exceed the additional producer profit captured by supplying that product in the retailer.

If producer marginal revenue is calculated by dropping the product and finding new optimal market prices and quantities sold, then estimates suggest that *Stonyfield O'Soy* generates $2,055 in additional revenue for Groupe Danone. This calculation, however, ignores that the retailer may supply a non-offered product in lieu of *Stonyfield O'Soy*. In this example, the replacement product is estimated to be General Mills' *Colombo* yogurt. Once I account for endogenous retailer assortments, the additional revenue, generated from *supply Stonyfield O'Soy and keep Colombo from retailer 1's shelf*, equals $3,508. The example uses producer revenues instead of profits and assumes that the vendor allowance consists entirely of cash payments. Nevertheless, it illustrates that the benefits of supplying a product may exceed the marginal profits generated by that product when analyzing multi-product producers.

Vendor allowances as distribution support: A special case is presented by Dean

Foods. Constructed producer individual rationality constraints are lower than the prescribed vendor allowances for 60% of Dean Foods' observations, even though the calculations use marginal revenues instead of profits.[19] 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 2001-2010, 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 was developed to accommodate its core milk business.[20] 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 economic 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. The estimates for Dean Foods most likely 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 retailer value of the transfer, which may overstate the cost of the vendor allowance to producers.

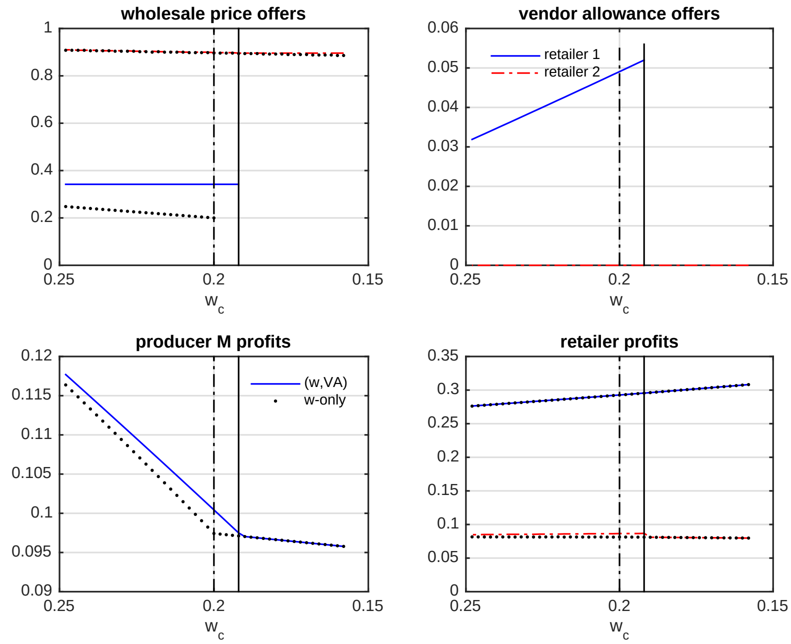
7 Counterfactual Analysis

Constructed vendor allowances indicate that these transfers represent a substantial component of retailer revenues and variable profits. Thus, it is important to under-

[19] For the remaining producers, 10% of the deviations suggest that vendor allowances are higher than the additional revenues generated from supplying the product.

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

Figure 6: Stylized Example: Equilibrium Assortments and Payoffs



stand the equilibrium consequences of the vendor allowance contract. If contracts are restricted to consist of only wholesale prices, then equilibrium product selections may change. To illustrate this, consider the stylized example from Section 4. The additional dotted lines in Figure 6 show equilibrium wholesale prices and firm payoffs if the contract is restricted to linear prices. The dashed vertical lines mark the value of w_C at which the equilibrium market assortment changes from A_1 to A_5: A_1 if $w_C \geq 0.20$; and A_5 if $w_C < 0.20$. This implies that the elimination of vendor allowances would affect product availability, along with terms of trade and firm payoffs, if $w_C \in [0.19, 0.2)$. To investigate how vendor allowances affect market outcomes in the empirical setting, a counterfactual restricts the vertical contract to include only wholesale prices.

In practice, the restriction of the vertical contract may affect equilibrium product assortments, retail and wholesale prices, the number of products offered, and the types of products developed by producers. The counterfactual takes into account adjustments in retailer assortments as well as retail and wholesale prices, holding retailer shelf space and product characteristics fixed. The shelf-space assumption imposes that each retailer offers the same number of yogurts as in its observed assortment, which keeps retailer fixed costs unchanged. If vendor allowances 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 retailer category-specific fixed costs, along with estimates of consumer preferences, wholesale prices, and vendor allowances for other refrigerated categories.

It is worth highlighting that the vendor allowance estimates capture both cash payments from producers and incentives in the form of retailer cost savings. The simulation eliminates both economic transfers. It would be instructive to analyze a scenario in which distribution cost savings are preserved, while only cash payments are eliminated. Unfortunately, such an analysis requires data on retailer and producer distribution costs.

The model prescribes that, conditional on the set of products with initiated negotiations (A), wholesale price offers maximize producer profits subject to retailer participation constraints. For each producer p these conditions are given by:

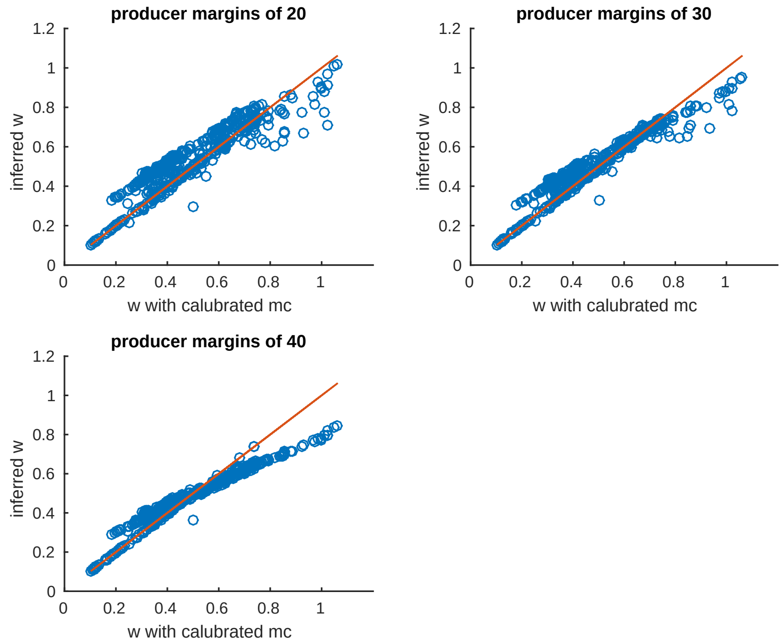
$$\max_{w} E_{\xi}[\Pi_p(A, w)] \quad \text{subject to}$$

$$E_{\xi}[\Pi_r(A, w)] \geq E_{\xi}[\Pi_r(A', w')]$$

In this optimization problem, wholesale prices have three effects. First, wholesale prices affect producer variable profits through their direct effect on retail prices and quantities sold in the market ($E_{\xi}[\Pi_p(A, w)]$). Second, conditional on retailer outside option values, wholesale prices are the only tool available to the producer to match these participation constraints through $E_{\xi}[\Pi_r(A, w)]$. Finally, wholesale prices influence the value of retailer outside options ($E_{\xi}[\Pi_r(A', w')]$) and the replacement products that determine these outside options A'. To account for changes in the profitability of non-offered products, I recalculate retailer outside options at each wholesale price iteration. Retailer marginal costs of private labels are not adjusted.

Another challenge is presented by the combinatorial problem of finding new equilibrium assortments in a market. The analysis is conducted for Toledo, OH for the period from 2006q1 to 2006q4, where I observe two grocery chains. On average grocery chains in this market choose 34 products from 40 options, which yields about

Figure 7: Comparison between Inferred and Simulated Wholesale Prices



four million possible assortments.[21] Finding wholesale prices for a market assortment is computationally taxing because the algorithm iterates over producer first order conditions, and recalculates retailer outside options at each wholesale price iteration. As a result, 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 number of potential retailer assortments. In particular, I fix staple products and simulate on average six thousand assortments for each retailer in the market.[22] The function iterates over retailers in the market until no retailer would find it profitable to alter its assortment. Even though a unique equilibrium is not guaranteed, the brute-force search over assortments identifies one equilibrium in assortments and prices. Structural shocks are set to zero due to computation complexity.

[21]The set of potential product offerings for each grocery chain in a market is defined as the collection of products that are observed in the market combined with all products the retailer carries in other markets during the quarter.

[22]Additional checks reveal that assortments excluding staple products prescribe wholesale price decreases that violate producer individual rationality. As a result, assortments that imply large retailer outside options could not be supported with the restricted contract.

Table 5: Counterfactual Analysis: Results (in % changes)

	20%	30%	40%
vertical profits	0.78	1.72	1.87
retailer profits	-12.63	-8.08	-5.78
consumer surplus	-1.26	0.36	0.91
wholesale prices (all)	-0.92	-3.91	-4.50
wholesale prices (unchanged)	3.89	1.10	0.07
wholesale prices (switched)	-27.22	-32.15	-32.08
retailer prices (all)	-0.66	-2.86	-3.20
retailer prices (unchanged)	2.89	0.82	0.08
retailer prices (switched)	-21.53	-25.47	-24.79
# switched products	7.5	7.5	7
# products	65	65	65

This table shows 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 estimation approach does not recover producer marginal costs. Marginal costs used in the simulation are constructed under the assumption of uniform producer margins of 20, 30, and 40 percent. I use the calibrated marginal costs and find optimal producer wholesale prices conditional on observed product assortment and vendor allowance estimates. The match between the inferred and thus simulated wholesale prices is shown in Figure 7. For each margin assumption, I compare counterfactual market outcomes with those implied by simulated wholesale prices. Both simulations are based on the same producer marginal costs and optimization strategy; thus, the only difference is the restriction imposed on the vertical contract.

The implications for retailer profitability and strategic product selections are stable across specifications. Table 5 reports counterfactual changes for key variables for each marginal cost calibration. Even though vertical profits are predicted to increase, retailers are worse off in all simulations. For example, column (2) shows that, with a 30% producer margin assumption, simulated assortments and contracts lead to an average decrease in retailer profits of 8.08%, while total vertical profits increase by 1.72%.

Moreover, the change in the vertical contract affects product availability. Counterfac-

Table 6: Role of Retailer Outside Option Values: Results (in % changes)

	20%		30%		40%	
	(i)	(ii)	(i)	(ii)	(i)	(ii)
vertical profits	0.08	-1.21	0.03	-0.48	0.01	0.02
retailer profits	0.42	19.49	0.16	12.82	0.07	8.30
consumer surplus	0.20	7.01	0.09	5.11	0.04	3.55
wholesale prices (all)	-1.01	-14.68	-0.38	-11.37	-0.19	-8.50
retailer prices (all)	-0.77	-11.14	-0.28	-8.42	-0.14	-6.12
# switched products	0	0	0	0	0	0
# products	65	65	65	65	65	65

Table presents changes in market variables between the simulated vertical contract and producer take-it-or-leave-it offers that do not take into account retailer participation constraints. Columns (i) use the counterfactual assortments, and (ii) report the changes under the observed assortment. Results are reported as percent changes of key variables.

tual assortments are constructed by changing on average 7.5 products in a quarter-market pair. This suggests that retailer product selections cannot be understood in isolation from vertical contract negotiations. Contract offers determine the profitability of individual products for retailers. Similarly, equilibrium offers depend on the set of products supplied in the market. The discussion first considers how wholesale prices adjust to the change in assortments. Then, I examine the effect of the contract restriction on product selections and its implications for retailer strategies.

The second panel of Table 5 reveals that, absent vendor allowances, average wholesale prices fall; however, this drop is not uniform across products. On the one hand, wholesale prices of counterfactually added products are lower than the wholesale prices of replaced products ("switched" products). On the other hand, average wholesale prices of products supplied in both the observed and simulated assortments ("unchanged" products) increase. This increase for unchanged products is primarily driven by adjustments in retailer outside options. Counterfactual assortments lead to lower values of retailer credible threats, which alleviate the constraints on producer wholesale prices.

To illustrate how retailer outside options affect wholesale prices, Table 6 compares counterfactual wholesale prices to producer take-it-or-leave-it wholesale price offers that ignore retailer participation constraints. Columns (i) report differences between the two contracts for the counterfactual assortment; and columns (ii) compare constrained and unconstrained producer wholesale price offers for the observed market assortment. These results show that retailer outside options have a smaller effect on producer contract offers under the counterfactual assortment. For example, with a 30% producer margin assumption, counterfactual wholesale prices are 0.38% lower than unconstrained take-it-or-leave-it offers. In contrast, this difference is 11.37% for the observed market assortment. Even with decreased outside option values, retailers are able to capture on average 0.16% higher profits through the wholesale price discount, obtained by the credible threat of replacing a product. In addition, consumers benefit from facing lower average retail prices.

Next, I discuss why retailer product assortments may change. The model prescribes that strategic retailers choose product selections taking into account consumer preferences, retail competition, and vertical contracts with producers. Non-offered products influence vertical contracts and firm payoffs because these products are used as credible threats in contract negotiations. The stylized example shows that a retailer with a high outside option may command better terms of trade from its producers, which may be in the form of lower wholesale prices or higher vendor allowances. Thus, a retailer may strategically exclude products in order to use them as threats in negotiations. Counterfactual results suggest that this rent-extraction mechanism may be weakened in the absence of vendor allowances.

In particular, simulations reveal that observed assortments may not be supported by a contract consisting only of wholesale prices. Absent vendor allowances, retailer outside options require large wholesale price decreases. These decreases, however, violate at least one producer's individual rationality conditions. In fact, assortments, which exclude products that lead to large retailer outside options, could not be supported by the restricted contract. Instead, counterfactual assortments are simulated to include 59% of the products that governed the best-replacement options in the vendor allowance estimation. Thus, retailers' ability to distort assortments in order to command favorable contracts may be weakened under the restricted contract.

8 Conclusion

This projects seeks to further our understanding of the competitive implications of vertical contracts and their influence on product availability in the retail sector. Contracts between producers and retailers commonly consist of wholesale prices and vendor allowances. 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. 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. By exploiting the information from the observed retailer product selections, vendor allowances are estimated as the payments needed to rationalize observed assortments. To my knowledge, this is the first paper to exploit the identities of observed retail product selections to infer information about vertical contracts. Constructed vendor allowances suggest that these transfers correspond to 4.18% of retailer revenues. 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.

A counterfactual simulation analyzes the effects of vertical contracts on market outcomes. Results show that both product availability and wholesale prices would change if contracts were restricted to include only wholesale prices. Strategic retailers choose assortments taking into account consumer preferences, downstream competition, and vertical contracts. Thus, it is importnat to account for endogenous product selections in the analysis of vertical contracts.

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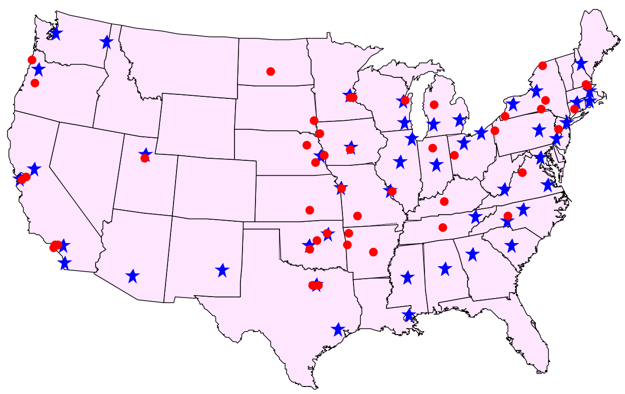
A Data Appendix

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.[23] 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

[23]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.

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 44 markets in which I observe information for at least two chains in the market at any given quarter. The sample used covers ten years, 2001-2010. 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.

Prices are converted to constant 2010 dollars using the Consumer Price Index by region. The average price of a 6 oz 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 that are marketed as using only natural ingredients. The products identified as natural are product lines under following brands: *Brown Cow* (Groupe Danone), *Cascade Fresh* (Cascade) *Chiobani* (Agro Farma), *Cultural Revolution* (Kalona Organics), *Danone Natural* (Groupe Danone), *Fage Total* (Fage USA Corp.), *Horizon Organic* (Dean Foods), *Mountain High* (Dean Foods), *Nancy's* (Springfield Creamery), *OIKOS* (Groupe Danone), *Old Home* (Old Home Foods), *Rachel's* (Dean Foods), *Silk* (Dean Foods), *Stonyfield Farm* (Groupe Danone), *Wallaby Organic* (Wallaby Yogurt), *White Mountain* (Purist Foods). To categorize prod-

Table A1: Product characteristics: prices and sales

	mean price	sd price	market share (%)	sd market share (%)
natural=1	0.94	0.42	0.12	0.07
natural=0	0.79	0.26	0.88	0.07
child=1	0.95	0.27	0.11	0.03
child=0	0.79	0.32	0.89	0.03
light=1	0.80	0.27	0.34	0.07
light=0	0.84	0.33	0.66	0.07
creamy=1	0.85	0.25	0.43	0.10
creamy=0	0.82	0.35	0.57	0.10
soy=1	1.09	0.27	0.00	0.00
soy=0	0.82	0.31	1.00	0.00

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).

ucts 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*, *Stonyfield Farm O'Soy*, and *Whole Soy*.

Markets offer a variety of natural, children's, creamy, and light options: usually more than 25 product-retailer offerings with each of these characteristics are available. The only exception is soy products as only 4 product-retailer options are offered in a market on average. Groupe Danone and Dean Foods are the main producers of natural products and soy products. Products marketed for children are offered by seven 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 and children's products account for on average 11-12% of market sales each. Light products are responsible for, on average, 32% of market sales, while soy products are characterized by very low sales.

The sample consists of 24 national and regional producers and 44 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 General Mills; they collec-

Table A2: Producer market shares and distribution

	mean	median	sd	min	max	#markets	#retailers
Agro Farma	0.03	0.02	0.04	0.00	0.21	42	53
Anderson-Erickson	0.12	0.09	0.13	0.00	0.37	4	4
Auburn Dairy	0.01	0.01	0.01	0.00	0.02	2	3
Belfonte	0.13	0.13	0.01	0.11	0.14	1	3
Breyers	0.06	0.03	0.07	0.00	0.33	44	77
Cabot Creamery	0.00	0.00	0.00	0.00	0.01	16	16
Cascade Fresh	0.00	0.00	0.01	0.00	0.05	25	25
Dean Foods	0.02	0.01	0.02	0.00	0.09	44	70
Fage USA Corp.	0.01	0.01	0.02	0.00	0.09	44	61
General Mills	0.39	0.39	0.10	0.16	0.64	44	80
Groupe Danone	0.31	0.33	0.10	0.06	0.47	44	80
Johanna Foods	0.02	0.01	0.02	0.00	0.07	20	29
Kalona Organics	0.00	0.00	0.00	0.00	0.01	4	4
LALA Foods	0.03	0.02	0.05	0.00	0.29	44	73
Northwest Dairy	0.01	0.01	0.01	0.00	0.04	4	8
Old Home Foods	0.07	0.08	0.07	0.00	0.16	2	4
Prairie Farms	0.02	0.01	0.03	0.00	0.13	13	17
Purist Foods	0.00	0.01	0.00	0.00	0.01	1	3
Springfield Creamery	0.01	0.00	0.02	0.00	0.06	24	29
Sun Valley Dairy	0.00	0.00	0.00	0.00	0.01	28	14
Tillamook Creamery	0.08	0.07	0.02	0.05	0.12	3	8
Wallaby Yogurt	0.00	0.00	0.00	0.00	0.01	30	29
Whole Soy	0.00	0.00	0.00	0.00	0.01	41	40
Private Label	0.15	0.14	0.07	0.00	0.37	44	44

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.

Table A3: Producer Supply across Retailers

	total	mean	median	sd	min	max
Agro Farma	2	1	1	0.4	1	2
Anderson-Erickson	2	2	2	0.1	1	2
Auburn Dairy	2	1	1	0.5	1	2
Belfonte	1	1	1	0.0	1	1
Breyers	11	4	4	1.9	1	10
Cabot Creamery	1	1	1	0.0	1	1
Cascade Fresh	1	1	1	0.0	1	1
Dean Foods	10	3	3	1.5	1	8
Fage USA Corp.	1	1	1	0.0	1	1
General Mills	17	10	10	2.4	3	16
Groupe Danone	26	14	14	3.4	2	23
Johanna Foods	5	3	3	0.9	1	5
Kalona Organics	1	1	1	0.0	1	1
LALA Foods	9	3	2	1.5	1	8
Northwest Dairy	1	1	1	0.0	1	1
Old Home Foods	4	3	3	0.9	1	4
Prairie Farms	3	1	1	0.2	1	2
Purist Foods	1	1	1	0.0	1	1
Springfield Creamery	1	1	1	0.0	1	1
Sun Valley Dairy	1	1	1	0.0	1	1
Tillamook Creamery	1	1	1	0.0	1	1
Wallaby Yogurt	1	1	1	0.0	1	1
Whole Soy	1	1	1	0.0	1	1

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

tively 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 44 of the 80 chains and these products account for 15% of market sales. There is substantial variation in market shares 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. The sample includes 6 branded producers that distribute products in all 44 markets; and 17 regional producers, 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 General Mills (with 17 options) and Breyers (11). On average, I observe 6 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.[24] 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.

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