Vertical Contracts with Endogenous Product Selection: An Empirical Analysis of Vendor Allowance Contracts

Sylvia Hristakeva*

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Abstract

Producers frequently provide retailers with financial incentives to secure distribution of 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 study the equilibrium effects of the use of vendor allowances when retailers' product selections are endogenous and vertical contracts are unobserved. I find that these payments are important for retailers' profitability, corresponding to 5.9% of retailers' revenues. A counterfactual restricts contracts to consist of only wholesale prices. Simulations predict that, absent vendor allowances, retailers' ability to strategically exclude products and extract rents from producers is weakened. On the one hand, such product distortions may decrease vertical profits and consumer surplus because a "popular" product is excluded. On the other hand, retailers may also secure wholesale price discounts, increasing consumer welfare.

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1 Introduction

In many industries producers reach consumers only through a downstream retail sector. Due to limited shelf-space, most retailers choose only a subset of all possible products to carry. Therefore, retailers' product selections have large consequences for total industry profits and consumer welfare. In addition to consumer preferences and retail competition, vertical contracts with producers may be important determinants of retailers' assortments. 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. direct-store-delivery).[1] Such financial incentives are extensively used by manufacturers to secure product distribution; hence, vendor allowances likely influence the product availability observed in a market.

These payments are widely used in the grocery sector, and the new trends to "rent real estate" within stores suggest that the practice may be spreading across the retail sector (Zumbach (2016)). Considering the size of the retail sector and the potential impact of vendor allowances on product availability and total welfare, it is not surprising that lump-sum transfers have been the subject of policy discussion. Slotting fees were at the heart of Senate hearings and Federal Trade Commission (FTC) workshops in the 1990's and the early 2000's with repeated attempts from organizations representing small producers to implement bans on slotting allowances.[2] Nevertheless, the FTC abstains from providing clear guidelines on the use of slotting fees, citing conflicting theoretical predictions and scarce empirical evidence as a rationale (Sudhir and Rao (2006)).[3] The proprietary nature of vertical contracts and

[1]The IRS broadly defines vendor allowances as payments "intended to offset retailer's costs of selling the vendor's products in its stores." 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]In 2005, the California Senate Committee on Business and Professions held an informational hearing on vendor fees in the grocery industry. In 2011, the Massachusetts Senate reviewed a petition for legislation to ban certain slotting allowances. Also see Federal Trade Commission (2001), Federal Trade Commission (2003).

[3]Theorists have presented models in which vendor allowances are either anti-competitive or efficiency-enhancing. Anti-competitive examples show that vendor allowances increase market prices (Shaffer (1991), Piccolo and Miklós-Thal (2012)), or may be used to foreclose a competitor (Asker and Bar-Isaac (2014)). Marx and Shaffer (2010) show that retailers may limit shelf space to extract higher rents from producers. Alternatively, vendor allowances may arise as a mechanism for the efficient allocation of scarce shelf space (Sullivan (1997)). Deneckere et al. (1997) show that softening retailer competition may increase both producer and consumer surplus when demand is uncertain. 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

firm costs has been an impediment to empirical analysis that could resolve these conflicting narratives.

Taking these challenges into consideration, I analyze the use of lump-sum payments from producers to retailers when product selections are endogenous and vertical contracts are unobserved. I address two main questions. First, how may researchers identify the size of unobserved vendor allowances? To answer this question, I develop a framework to identify lump-sum transfers from producers to retailers when only limited data are available: retail prices, sales, and assortments. By exploiting the information from the observed retailers' 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 5.9% of retailers' revenues. The second question asks: what are the equilibrium effects of the use of vendor allowances? A counterfactual restricts the vertical contract to consist of only linear wholesale prices. Results show that both equilibrium wholesale prices and product selections change. I find that the vendor allowance contract facilitates retailers' strategies to exclude products in order to obtain favorable terms of trade from producers. These distortions in product selections, however, also lead to lower wholesale prices, and consumers benefit from lower retail prices. For the studied market, the distortion effects are larger than the price effects, and consumer surplus increases in the absence of vendor allowances. My goal is to highlight the role of firms' endogenous outside options in contract negotiations and to analyze how firms' product selection strategies may be affected by the structure of the vertical contract.

In a survey of retailers and manufacturers, Bloom et al. (2000) find that industry practitioners agree that vendor fees influence assortments and that these payments are associated with the exercise of market power by retailers. Consequently, my analysis focuses on understanding the rent-extraction mechanism stemming from retailers' control over the product assortment. I model the interactions between producers, retailers, and consumers as a five-stage game. First, retailers initiate negotiations over the products they would like to supply. The negotiations proceed as simultaneous producers' take-it-or-leave-it offers of product-specific wholesale price and vendor allowance. These offers anticipate that in stage three retailers have an outside option: if a product offer is rejected, then the retailer may supply an alternative product in its place. Conditional on assortments and contracts, the fourth stage models retail price competition as a differentiated-product Bertrand-Nash game. Last, consumers observe product availability and prices, and make purchase decisions.

I apply the framework to the U.S. grocery yogurt market for the 2001-2010 period using the IRI academic dataset. Vendor allowances are known to play an important role for most

sales effort (Foros et al. (2009)).

segments of the grocery industry. In addition, the yogurt category is characterized by a proliferation of differentiated product options and limited shelf space. Thus, the category provides a good setup to study the relationship between retailers' strategic product selections and vertical contracts.

Estimation proceeds in two steps. First, standard techniques, as in Berry (1994), are applied to consumer demand, and retailers' markups are recovered from the optimality conditions imposed by the Bertrand-Nash game. Next, I show how researchers may use retailers' and producers' optimality conditions to back out vendor transfers and producers' markups. Vendor allowances are inferred from retailers' incentive compatibility conditions: in equilibrium, no retailer may increase its expected profit by unilaterally altering its product selection. With this approach, vendor transfers reflect retailer shadow price of shelf space, which is approximated as the additional retailer profits generated by substituting a product with its most profitable replacement.[4] A simple example illustrates how vendor allowances may be inferred from observed product selections. 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 for the observed product offering is \$20,500 per store and its variable profits for 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. The assumption of producers' take-it-or-leave-it offers implies that contract offers place retailers on their participation constraints. Combining retailers' outside options with producers' optimality conditions, I back out producers' markups.

Model estimates suggest a median consumer price elasticity of -4.3 and median retailer variable profit margins of 27.5%. These estimates align with the 27% median variable profit margins reported by public grocery chains during the analyzed period. Vendor allowance estimates suggest that these payments constitute, on average, 5.9% of retailer revenues. The counterfactual analyzes how the vendor allowance contract affects equilibrium product selections and contracts. In particular, I restrict contracts to consist of only wholesale prices. Keeping the number of products offered fixed, simulations find new equilibrium assortments, contracts, and downstream prices.

Counterfactual results for Toledo, OH show that, absent vendor allowances, total vertical profits increase by, on average, 0.8%, and consumer surplus is 0.2% higher. These increases are driven by changes in product availability. In the counterfactual, retailers include the products that serve as the most profitable replacement threats for the observed assortment. The dropped products have inferred positive vendor allowances. These adjustments lead to a

[4]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 retailers' opportunity costs.

2.4% decrease in average retailers' profits, while average producers' profits increase by 5.8%.

The model highlights that retailers may extract surplus from producers by exploiting the profitability of excluded products. Thus, a retailer may strategically exclude a product in order to obtain wholesale price discounts and vendor allowances. In the counterfactual, simulations reveal that the observed assortments cannot be supported by contracts that include only wholesale prices. This occurs because the reductions in wholesale prices, necessary to satisfy retailers' participation constraints, violate at least one producer's individual rationality conditions. Instead, the counterfactual assortments include the products that determine retailers' outside options for the observed assortment. This suggests that the restricted contract limits retailers' ability to strategically exclude products and extract rents from producers. The result relates to the exclusionary mechanism highlighted in Asker and Bar-Isaac (2014), in which retailers do not accommodate entry to protect the rents obtained from the incumbent producer.

The simulation reveals that retailers' incentives to distort assortments, in order to obtain favorable contracts from producers, are larger in the presence of vendor allowances. Such strategies decrease total surplus because "popular" products are excluded. At the same time, they allow retailers to obtain both vendor transfers and wholesale price discounts. The lump-sum transfers redistribute profits between producers and retailers; however, the wholesale price discounts decrease double marginalization. In fact, I find that the wholesale prices of products supplied in both the observed and counterfactual assortments increase in the counterfactual. For the studied market, the distortion effect is larger than the price effect, and total welfare is lower when vendor allowances are used.

I study how the structure of the vertical contract may affect product availability. With endogenous product selections (or network formation), firms may use their outside options as leverage during contract negotiations. The theory and empirical findings underscore that such exclusionary incentives depend on the structure of the vertical contract. These findings are important for the analysis of vertical relations when product selections are endogenous.

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

2 Related Literature

This project connects two largely disparate empirical literatures, those on endogenous product choice and vertical relations. The first stream of papers on endogenous product choice incorporates both product assortment decisions and price competition in the analysis of differentiated product markets. Misra (2008) investigates assortment decisions across grocery stores within a chain. Draganska et al. (2009b) focus on producers' market distribution of ice-cream flavors and show that welfare implications can differ significantly once strategic product assortment choices are considered. Eizenberg (2014) studies the personal computer market and investigates how innovation affects producers' choices of product assortments. 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 may affect both equilibrium prices and product availability. In many industries, however, producers reach consumers only through a downstream sector and vertical contracts may also influence strategic product selections. I contribute to the endogenous product choice literature by studying how vertical contracts may influence product availability.

The second stream of papers on vertical relations investigates 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), and Bonnet and Dubois (2015). Additionally, bargaining models, based on Horn and Wolinsky (1988), have been applied to study vertical relations in Draganska et al. (2009a), Crawford and Yurukoglu (2012), Grennan (2013), and 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 this issue when modeling network formation in insurer-hospital negotiations. The authors incorporate insurers' incentives to exclude a hospital from their networks, showing that such exclusions may create valuable outside options for the insurers and may affect prices and welfare. Binmore et al. (1989) show that, in a Nash-bargaining framework, the strategic use of an outside option acts as a constraint on the minimum payoffs obtained by the agent. If firms' outside options are large, then these incentive compatibility conditions determine the equilibrium payoffs of the bargaining game, irrespective of bargaining parameters. I explicitly account for retailers' outside options and focus on understanding how retailers' product selection strategies may be affected by the type of vertical contract used in the market.

This paper also contributes to the sparser literature that integrates endogenous product selection with vertical relations. Ho (2009) analyzes how hospital characteristics and bargaining ability may affect insurer-hospital networks using the moment inequalities. Conlon and Mortimer (2017) study the efficiency and foreclosure effects of a vertical rebate. Viswanathan (2012) analyzes the competitive effects of another vertical arrangement: category captaincy. The author investigates how category captains affect assortments when retailers act as local monopolists. Israilevich (2004) studies how slotting fees may affect the number of products supplied by a monopoly retailer. Conditional on observed retail prices, promotions, and wholesale prices the author finds that some products may be profitably removed. The retailer's choice to supply these unprofitable products is rationalized with slotting fees. My model allows that retailers strategically choose assortments considering the effects of these product selections on consumer choices, competition, and vertical contracts. This allows me to study how a restriction on the vertical contract affects equilibrium product availability, contracts, and welfare.

3 Industry and Data

This project investigates the equilibrium effects of the use of vendor allowances when retailers' product selections are endogenous and vertical contracts are unobserved. The extensive use of vendor allowances in the grocery sector makes it a good context to analyze how the use of these payments affect welfare and product selection strategies. Average vendor allowance receipts, reported by public grocery chains, correspond to 9.5% of retailer's revenues.[5] In addition, brick-and-mortar stores are faced with constrained shelf space, which highlights the importance of assortment decisions for firm profits and consumer surplus. Within the grocery industry, I study yogurt products. This category offers several advantages for analyzing vertical contracts when product selections are endogenous. 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

[5] 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, and long-term contract incentives.

Table 1: Market Summary Statistics

	mean	median	sd	min	max
market population (millions)	3.9	2.9	3.5	0.5	19.5
observed # of chains (in a market)	4.2	4	1.7	1	11
chain market sales ($ millions)	187	155	161	5	1,147

Summary statistics for the markets and chains observed in the sample.

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 estimation of consumer demand.

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 geographical markets in the U.S. for the sample period 2001-2010.[6] Table 1 summarizes information about the markets and chains covered in the data. The observed markets vary in size, with an average population of 3.9 million. On average, I observe 4.2 chains in a market, and each chain appears in the data in an average of 3 markets. Most of the chains in the IRI dataset are among the main competitors in their respective markets with mean estimated market annual sales of $187 million.

The unit of analysis is 'product line'-retailer-market-quarter. A product line (e.g. *Dannon Fat Free, 6 ounce*) includes a variety of flavors (e.g. *Dannon Fat Free, 6 ounce, vanilla*). The aggregation to a product line matches the level of contracting in the grocery sector. Throughout the paper I refer to 'product line' and 'product' interchangeably. I define five product characteristics: natural, marketed for children, soy, creamy, or light. Table 2 reports price and market share variation across products described by each characteristic. The average price for natural products is $0.94, while non-natural products are, on average, priced at $0.79. Similarly, children's and soy products are more expensive than non-children's and non-soy options, respectively. Average market share for natural products is 12%. Light products are responsible for, on average, 32% of revenues, while average market share for soy products is 0.005%. Information on producers' distribution and market shares is available in the data appendix.

To identify vendor allowances, I exploit variation in observed assortments across grocery chains and markets. If all retailers carried the same products, then these assortments would provide little information about vendor allowances. Figure 1 shows a snapshot of market

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

Table 2: Prices and Market Shares: by Characteristic

	mean price	sd price	mean 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
soy=1	1.09	0.27	0.00	0.00
soy=0	0.82	0.31	1.00	0.00
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

Product characteristics are neither comprehensive nor exclusive. The market share comparisons are done separately for each characteristic.

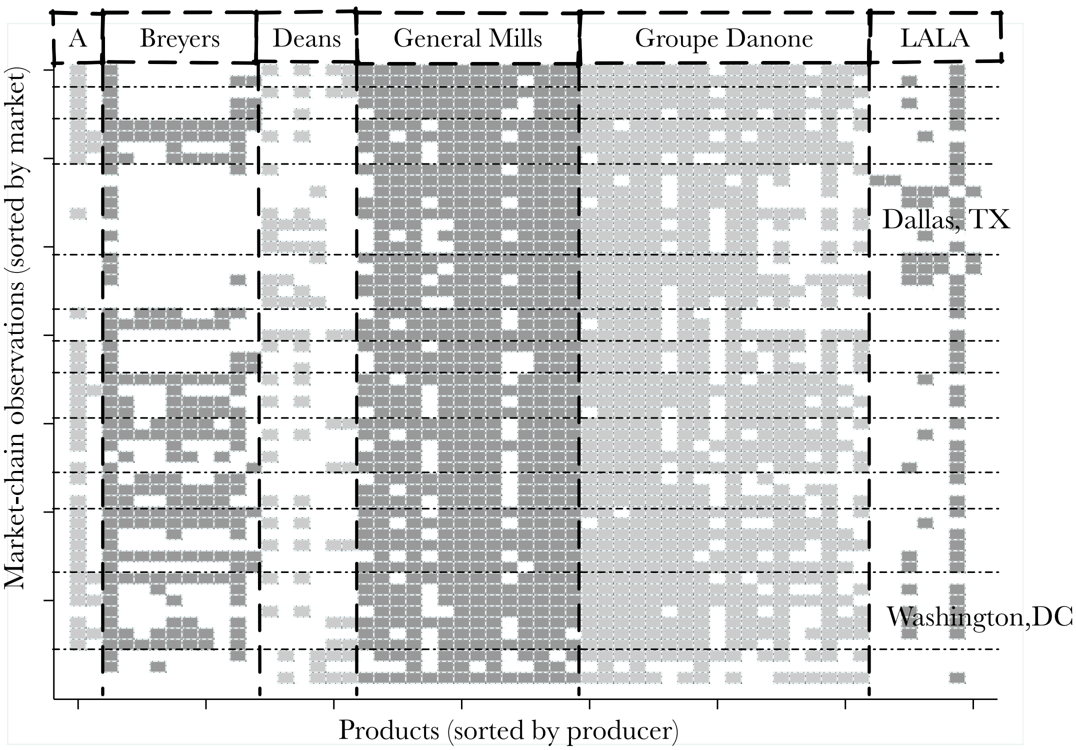
assortments for the top 6 brands supplied in the first quarter of 2010 in the South census region. The vertical axis tracks retailers in the 12 markets (e.g. Dallas, Texas, Washington, DC), while the horizontal axis shows the product offerings ordered by producer (Agro Farma, Breyers, Dean Foods, General 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 by most retailers within a market (Draganska et al. (2009b) refer to these as staple products), while the availability of other products varies markedly across retailers.

To summarize assortment differences across retailers and markets, I follow Hwang et al. (2010) and use a cosine similarity measure, which captures the fraction of overlapping products between pairs of retailers (and pairs of market). For example, let retailer i's assortment be described by vector A_i, which takes a value of 1 when the product is offered by the retailer, and 0 otherwise. The similarity between the assortments of retailers i and j is measured as:

$$\text{similarity}_{i,j} = \frac{A_i' A_j}{||A_i|| \cdot ||A_j||}$$

and it is robust to the size of assortment. If the two retailers offer the same assortments, then $\text{similarity}_{i,j}$ equals 1, and if there is no overlap between the assortments, then $\text{similarity}_{i,j} =$

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 are shown for each producer separately in the following order: Agro Farma, Breyers, Dean Foods, General Mills, Groupe Danone, and LALA Foods. White blocks correspond to instances in which the product is not offered in the retailer. Markets are separated by horizontal dashed lines. I observe the following markets in the South census region: Atlanta, Birmingham, Charlotte, Dallas, Knoxville, 'Mississippi,' Raleigh/Durham, Richmond/Norfolk, Roanoke, 'South Carolina,' Washington, DC, 'West Texas/New Mexico.'

0. Table 3 reports summary statistics of these measures. The first panel shows similarities in market assortments, and the second compares retailers' assortment choices. There is little variation in market product availability within the same census region (with mean similarity of 0.90). The lower similarity in market assortments across census regions (0.68) is due to the presence of local brands. In particular, 8 of the producers supply to fewer than 5 markets, and these are typically restricted by the location of the production facility. For example, during the sample period, Tillamook Creamery's products are only available in Portland, Spokane, and Seattle, and its plant is located in Tillamook, OR.

The second panel of table 3 summarizes assortment similarities across chains within the same market, and the similarities across markets for the same grocery chain. Similarly to the patterns observed in figure 1, 3 reveals that chains within the same market carry different assortments (with mean similarity of 0.77). Tracking the same grocery chain across markets shows that retailers' assortments do not vary across markets (with mean similarity of 0.92).

Table 3: Assortment Similarities

	mean	st. dev	25th q	50th q	75th q
market assortments					
across markets (same census)	0.90	0.06	0.85	0.91	0.95
across markets	0.68	0.17	0.53	0.69	0.82
chain assortments					
across chains (same market)	0.77	0.09	0.70	0.77	0.79
across markets (same chain)	0.92	0.08	0.88	0.94	0.98

The reported similarities summarize the closeness of assortments across markets and retailers. If similarity = 1, then there is no variation in the product availability across the analyzed dimension. For example, when summarizing product availability across markets (row 1), I construct a similarity to reflect whether the same set of products is available in the two comparison markets, irrespective of the specific chain that supply those products. Then, the statistics reported in the table summarize the constructed similarities for all possible market pairs. The comparisons are done separately for each time period.

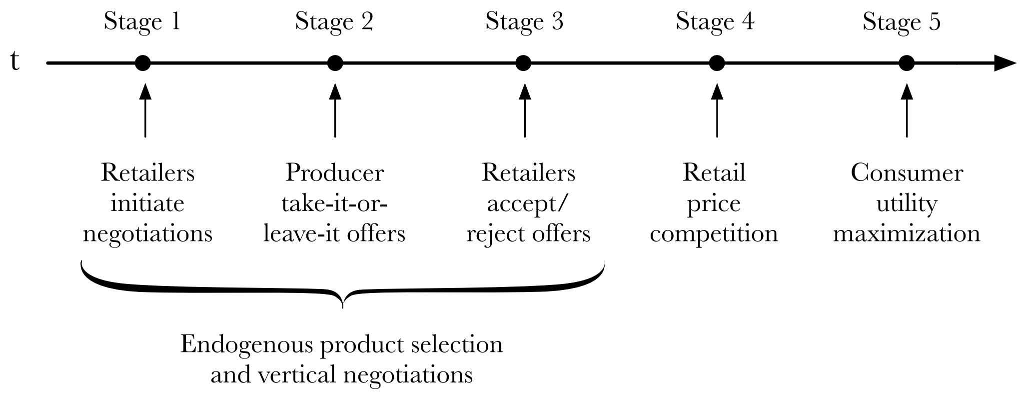
The estimation methodology addresses retail price endogeneity by employing cost shifters as instrumental variables. I create a "distance" measure to capture transportation costs from each producer's manufacturing facility to each market. I locate yogurt plants in the U.S. that were used during the sample period. The data appendix summarizes the collected geographic distance information. To calculate a proxy for transportation costs between plants and each market, I combine these geographic distances with gas prices obtained from the U.S. Energy Information Administration.

4 Model

The analysis focuses on retailers' use of credible replacement threats to secure favorable contracts from producers. The model draws from key institutional features and describes the determination of product selections, vertical contracts, and retail prices. I consider a complete information, static setup, taking the identities and characteristics of products, retailers, and markets as given. Figure 2 presents the timeline for the game. First, retailers announce the set of products they would like to supply and initiate negotiations over these products. Contract negotiations are modeled as public producers' simultaneous take-it-or-leave-it offers, which are constrained by retailers' outside options. These outside options are the ability to reject a product offer and supply an alternative product in its place. The last two stages describe retail price competition and consumer choice.

Below, I present a stylized example to develop the economic intuition behind the relationship between endogenous product selections, retailers' outside options, and vertical

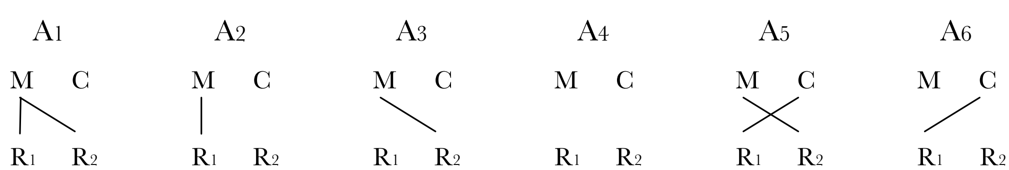
Figure 2: Timeline of the Game



contracts. Then I describe the general conditions prescribed by the model.

Stylized example: Consider a market with two symmetric, horizontally differentiated retailers. Each retailer may supply one product. There are two products in the market: a product from a dominant producer M, and a product from a competitive fringe C. Both retailers may initiate negotiations with producer M. For simplicity, suppose that only retailer 1 has access to product C, which may be procured at wholesale price of $w_C = mc_C$. Figure 3 shows the potential market assortments, given this setup. The game proceeds following the stages described in figure 2. If a retailer initiates negotiations with M, the vertical contract consists of retailer-specific wholesale price (w) and vendor allowance cash payment from the producer to its retailers (VA).[7]

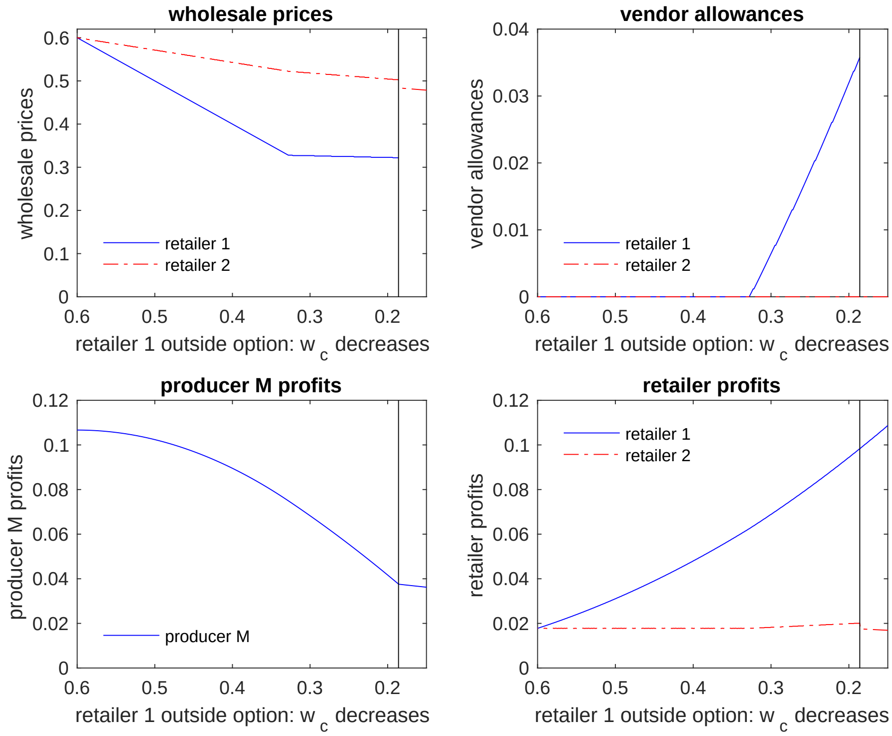
Figure 3: Possible Assortments and Payoffs



If retailer 1 initiates negotiations with producer M, its outside option is to *reject M's offer and supply product C at w_C.* This implies that equilibrium contracts depend on w_C even

[7] The example does not allow for negative transfers (that is, those from retailers to producers); however, the main intuition and results hold when negative transfers are allowed. I rule out negative transfers because such contracts are not observed in the industry.

Figure 4: Equilibrium Contracts and Payoffs

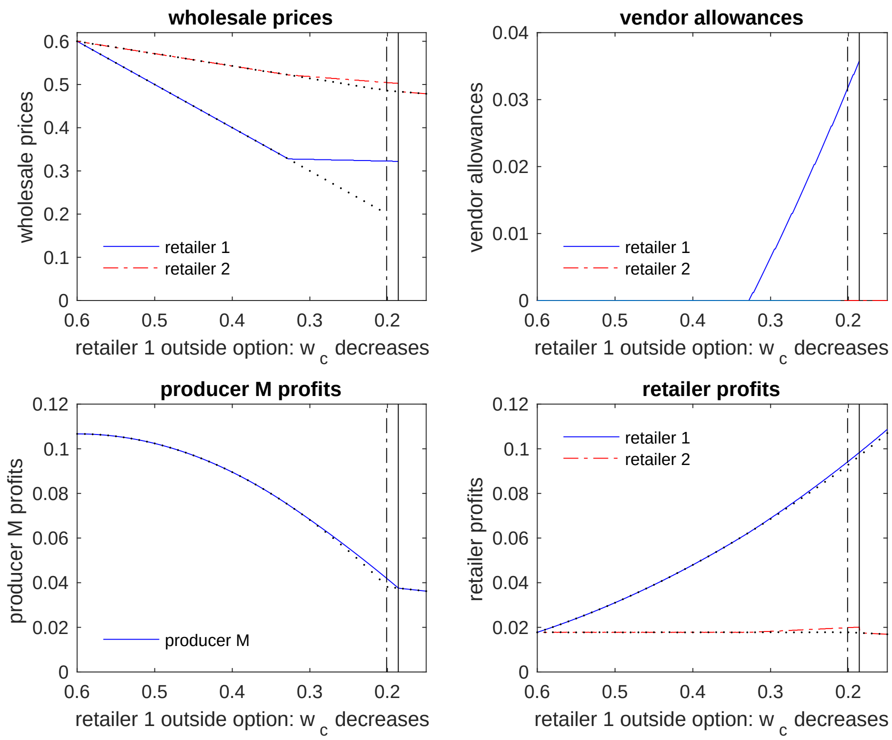


if product C is not offered. To see this, let M's marginal cost equal $mc_M = 0.2$, retailers' marginal costs consist of only wholesale costs, and demand for retailer i be $q_i = \alpha - p_i + \gamma p_{-i}$, setting $\alpha = 0.5$ and $\gamma = 0.5$.[8] Suppose that products C and M are perfect substitutes, that is, if product C is supplied by retailer 1, its demand is given by $q_1 = \alpha - p_1 + \gamma p_2$. Figure 4 shows the changes in equilibrium contracts, market assortments, and firm payoffs as the value of retailer 1's outside option increases; that is, as w_C decreases from 0.6 to 0.17. Solid lines track the contract and payoff for retailer 1 and dashed lines for retailer 2.

Producer M internalizes downstream competition when making contract offers, and, as a result, vendor allowances emerge as w_C decreases. For example, if w_C=0.3, then, in equilibrium both retailers supply product M (A_1 in figure 3). The value of retailer 1's outside option affects the wholesale prices and vendor allowances for both retailers. The contract for retailer 1 is $(w_1, \text{VA}_1) = (0.327, 0.006)$; and $(w_2, \text{VA}_2) = (0.518, 0)$ for retailer 2. Due to downstream competition, producer M finds it optimal to maintain higher wholesale prices

[8] The linear demand is derived from a quadratic utility function: $U = aq_1 + aq_2 - \frac{1}{2}(q_1^2 + q_2^2 + 2bq_1q_2)$, with $a > 0$ and $0 \geq b < 1$. Without loss of generality, the demand expressions are rescaled by $1 - b^2$, and the parameters are defined as $\alpha := a - ba$ and $\gamma := b$.

Figure 5: Equilibrium Assortments and Payoffs (w-only contract comparison)



and match retailer 1's participation constraint with a lump-sum transfer. Vendor allowances serve as a tool to support higher retail prices (in the spirit of resale price maintenance). In general, vendor allowance contracts may emerge in markets where competing retailers have credible outside options.

Next, figure 4 shows that, as w_C decreases, the equilibrium assortment changes from A_1 to A_5 (in A_5 retailer 1 supplies product C and retailer 2 offers product M). The plots mark this change in assortments with a solid vertical line: the assortment is A_1 if $w_C \geq 0.186$; and A_5 if $w_C < 0.186$. The benefits to producer M from excluding product C increase with product and retailer substitutability. Notice that if $w_C \in (0.2, 0.186]$, then the competitive fringe is excluded even though product C is cheaper to produce than M. Thus, downstream competition may render it optimal for M to match retailer 1's outside option even if its marginal cost is higher than the cost of C.

This result disappears if the contract is restricted to consist of only wholesale prices. The additional dotted lines in figure 5 show the outcomes if the contract is restricted to include only wholesale prices. Absent vendor allowances, producer M matches retailer 1's participation constraint by offering a lower wholesale price. Again, as w_C decreases, the equilibrium assortment changes from A_1 to A_5. The dashed vertical lines in all plots mark the new value of w_C at which the assortment changes: A_1 if $w_C \geq 0.20$, and A_5 if $w_C < 0.20$. This implies that, if $w_C \in [0.186, 0.2)$, then the elimination of vendor allowances affects product availability, along with terms of trade and firm payoffs.

The example also shows that price discrimination may be driven by differences in retailers' outside options. The Robinson-Patman Act prohibits producers from selling the same product at different prices to different retailers where such discrimination lessens competition. However, the price discrimination above would satisfy the "meeting-competition defense" described in Section 2(b) of the Robinson-Patman Act. The essential principle is that firms may price discriminate to match the prices and incentives of a potential competitor (Calvani and Breidenbach (1991)). I analyze the effects of these price discriminatory incentives in Hristakeva (2018).

Next, I describe the general conditions prescribed by the game in reverse order.

Consumer demand: Consumer choice is modeled using a random utility framework that describes products as bundles of characteristics. In each market-quarter ($\{mt\}$) consumers observe the full set of product offerings (A_{mt}) and select the product-retailer pair that maximizes their utility. I define consumer i's indirect utility from choosing product j at retailer r as

$$u_{ijr} = X_{jr}\beta_i - \alpha_i p_{jr} + \xi_{jr} + \epsilon_{ijr} \tag{1}$$

where market and time subscripts are omitted for ease of readability. The utility function depends on prices (p_{jr}), observed product, retailer, and market characteristics (X_{jr}), and a component not observed by the researcher but considered by consumers when making their purchase decisions (ξ_{jr}). The model allows for two types of consumer heterogeneity: $\theta_D = (\alpha_i, \beta_i)$ are individual-specific taste parameters, while ϵ_{ijr} are idiosyncratic shocks modeled as i.i.d. extreme value type I error terms.

To complete the demand model, an outside option is defined as the choice not to purchase yogurt from any of 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 a market are given by

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

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

The indirect utility function 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 select one yogurt in a quarter, while consumers may buy multiple yogurts. I do not observe individual consumer purchases and, therefore, I cannot allow for multi-unit shopping behavior as modeled by Hendel (1999) and Kim et al. (2002). The implicit assumption is that multi-unit purchases are either for different members of a household or for independent consumption occasions.

Retail price competition: Vendor allowances consist of lump-sum transfers that do not affect retailers' sales. Conditional on assortments, these payments do not affect retailers' variable profits; thus, vendor allowances are irrelevant for retail pricing analysis. Given market assortments (A) and retailers' marginal costs and wholesale prices (mc^r, w), retailer r's variable profits ($\pi_r(A, mc^r, w)$) equal

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

where the summation is over the products supplied by r (A_r) and M stands for market size.[9] Note that retailer r's sales of product j ($M s_{jr}(A, p)$) depend on its own assortment and its competitors' offerings. Bertrand-Nash competition requires that equilibrium prices satisfy the following first-order conditions

$$s_{jr}(A, p) + \sum_{k \in A_r} (p_{kr} - mc^r_{kr} - w_{kr}) \frac{\partial s_{kr}(A, p)}{\partial p_{jr}} = 0.$$

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

Vertical negotiations and retailers' 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 sequentially: (i) retailers initiate negotiations over the products they would like to supply; (ii) producers make simultaneous take-it-or-leave-it offers; (iii) retailers decide whether to accept a product offer. If a retailer rejects a product offer, it may supply an alternative product in its place. Contracts consist of product-specific wholesale price and vendor allowance. The contract does not allow for bundling because the practice is not

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

common for the yogurt category.[10] In line with industry practices, I assume that the parties may not contract over retail prices.

Let A be the set of products with initiated negotiations, and (w_{jr}, VA_{jr}) be the contract offer that retailer r receives for supplying product j ($\{jr\} \in A$). Retailer r's expected profit from supplying assortment A_r is

$$\begin{aligned} E_\xi[\Pi_r(A, mc^r, w, \text{VA})] &= E_\xi[\pi_r(A, mc^r, w) + \sum_{j \in A_r} \text{VA}_{jr} - C_r] \\ &= E_\xi[\pi_r(A, mc^r, w)] + \sum_{j \in A_r} \text{VA}_{jr} - C_r \end{aligned} \tag{4}$$

I assume that product selections and contract negotiations are completed prior to the realization of structural shocks (ξ); yet, firms may form expectations over these shocks, as reflected by the expectations operator. The C_r term captures the cost of supplying A_r if the retailer incurs all expenses. I assume that C_r may vary with assortment size but it 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 transfer. Notice that vendor allowances affect retailers' total profits; however, given assortments, they do not affect variable profits.[11]

Similarly, producer p's expected profit from supplying A_p is described as

$$E_\xi[\Pi_p(A, mc^p, w, \text{VA})] = E_\xi[\pi_p(A, mc^p, w)] - \sum_{\{jr\} \in A_p} \text{VA}_{jr} \tag{5}$$

where mc^p capture producers' marginal costs.

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

[10] The empirical results depend on the industry practice that producers do not bundle in the yogurt category: that is, contracts are not contingent on the number (or identities) of product lines supplied by the retailer. Nevertheless, interviews with producers suggested that large producers (e.g. Groupe Danone) offer a quantity discount on a per-truck basis. That is, retailers receive a discount if they purchase inventory to fill a truck. Such incentives may effectively tie the producer's offerings and incentivize retailers to carry "enough" of its products to take advantage of these discounts. I do not observe vertical contracts so I cannot account for such incentives. The empirical analysis suggests that quantity discounts may not be important enough to undermine the general strategic implications from the model. I find large profitable retailer deviations primarily for low-selling products, which are unlikely to affect the choice to order a truck of inventory. The implicit assumption is that quantity discount requirements do not strictly bind. For example, retailers may have some flexibility about the timing of their order, so that product selections are not driven by these incentives.

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

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. That is,

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

where A' is any counterfactual assortment in which retailer r unilaterally deviates from the set of products with initiated negotiations; and (w', VA') reflect retailer r's costs and transfers when supplying the counterfactually added products in A'. These deviations assume that retailers may procure such replacement products from a wholesaler or another intermediary at a non-negotiated cost of w' and a zero vendor allowance. The credible threat of rejecting an offer and supplying alternative product allows retailers to extract rents from producers. As a result, producers' contract offers are constrained by these outside options

$$\begin{aligned} &\max_{w,\mathrm{VA}} E_\xi[\Pi_p(A, mc^p, w, \mathrm{VA})] \\ &\text{s.t: } E_\xi[\Pi_r(A, mc^r, w, \mathrm{VA})] \geq E_\xi[\Pi_r(A', mc^{r\prime}, w', \mathrm{VA}')]. \end{aligned} \tag{7}$$

Vendor allowances capture economic transfers from producers to retailers. These transfers reflect both cash payments from producers and incentives in the form of cost savings for the retailers, such as distribution support. Thus, the cost of vendor allowances to producers might be lower than the benefits captured by retailers. This would occur if producers may provide operations support at lower costs than 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 retailers' opportunity costs of shelf space; therefore, they reflect the value of these transfers to the retailer.

Papers studying vertical relations have also modeled the interactions between firms using a Nash-in-Nash bargaining problem. Nash-bargaining requires that only observed product-retailer pairs affect negotiation outcomes. The disagreement payoffs for each negotiating pair are derived by dropping the pair and keeping the rest of the assortment fixed. As a result, these payoffs do not account for retailer r's outside option to terminate the negotiations with a producer and supply a different assortment A'. Binmore et al. (1989) relax these conditions and show that, in a Nash-bargaining framework, the strategic use of an outside option acts as a constraint on the minimum payoffs obtained by the agent. These constraints are similar to the retailers' incentive compatibility conditions defined in equation (6), and they prescribe a lower bound on vendor allowances. Moreover, if retailers' outside options are large, then these retailers' participation constraints determine the equilibrium contracts and payoffs of the bargaining game.

In addition, my goal is to present a framework for identifying unobserved vendor transfers from product assortment variation. A bargaining model is not well-suited for the analysis of vendor transfers because lump-sum transfers may not be separately identified from bargaining power parameters. I focus on studying vendor transfers because they are wide-spread in the retail industry, whereas their equilibrium consequences are unclear. Importantly, the analysis allows me to analyze how the use of the vendor allowance contract may affect product selection strategies and, in turn, welfare. As a result, I model contract negotiations as producers' take-it-or-leave-it offers, and the discussion above highlights that the modeling choice may not be as restrictive because the setup accounts for retailers' replacement threats.

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

Step 1. Demand and retailer markups: The analysis of retailers' assortment decisions requires a rich demand model to allow for flexible variation in consumer preferences. To that end, a flexible fixed-effects parameterization is used to characterize consumers' indirect utility. I include product-year intercepts to capture changes in mean product valuations 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, respectively. 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, soy, creamy, or light. These interactions capture the possibility that a product characteristic may be perceived differently across retailers; for example, consumers may regard natural products to be of higher quality when bought at 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. Instead, 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. As a result, the observed sample may not be a random sample from the underlying distribution of product characteristics. I assume that retailers choose assortments before the realization of unobservable structural shocks to demand. The flexible demand parametrization allows me to capture systematic components that are likely known prior to the assortment choices and contract negotiations. The demand shock may be decomposed as

$$\xi_{jrmt} = \xi_{j,year} + \xi_{rm} + \xi_{r,characteristic} + \Delta\xi_{jrmt}.$$

The fixed effects included in my estimation take into account $\xi_{j,year}$ (the product-year vertical component) and ξ_{rm} (the retailer-market unobservable). The econometric error that remains in $\Delta\xi_{jrmt}$ includes product-market and product-retailer specific unobservables. The descriptive statistics in table 3 revealed that there is little variation in product availability across markets.[12] To capture product-retailer unobservables that may affect retailers' assortments, I rely on interactions between product characteristics and retailer fixed effects ($\xi_{r,characteristic}$). Given the parametrization, the identifying assumption is that $\Delta\xi_{jrmt}$ is not observed at the assortment stage. The assumption is credible because assortment decisions are "sticky." Changing an assortment requires coordination across stores. In consequence, grocery chains typically adjust assortments at only a few predetermined occasions during the year.

Unlike assortment decisions, prices adjust as market conditions change. In the model, retailers select optimal prices after observing demand shocks. If retailers observe these shocks and condition on them when setting prices, then retail prices are endogenous. I employ cost-based instruments to address price endogeneity. The instruments capture direct components of retailers' market costs: transportation costs, interacted with retailer fixed effects. The intuition is that prices depend on costs of operation, but these costs are not correlated with demand-side unobservables.[13] Demand parameters are estimated using the MPEC algorithm

[12] The additional variation in product availability across census regions is driven by the locations of small producers' production facilities. For example, during the sample period, Tillamook Creamery's products are only available in Portland, Spokane, and Seattle, and its plant is located in Tillamook, OR. As a result, I attribute the additional variation across census regions to supply conditions, rather than demand unobservables. The vendor allowance estimation and counterfactual analysis preserve these patterns and do not allow local producers to enter new census regions.

[13] 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.

described in Dubé et al. (2012). MPEC is preferred to nested fixed-point methods as it avoids the numerical issues associated with nested inner loops.

Step 2. Vendor allowances and producer markups: The analysis does not require data on vertical contracts or firm costs, which are typically unobserved. Instead, vendor allowances are inferred as retailers' opportunity costs of shelf space. The strategy assumes that observed assortments yield weakly higher expected profits to each retailer than switching each of its products with any feasible alternative.[14] If retailer r switches a product it supplies ($j \in A_r$) with a product it does not supply ($l \notin A_r$), then its incentive compatibility requires that

$$E_\xi[\Pi_r(A, mc^r, w, \mathrm{VA})] \geq E_\xi[\Pi_r(A'_{-jlr}, {mc^r}'_{-jlr}, w'_{-jlr}, \mathrm{VA}'_{-jlr})] \quad \text{for } \forall j \in A_r,\ \forall l \notin A_r. \quad (8)$$

For the observed market assortment (A), wholesale prices and vendor allowances are $w = [w_{-jr}, w_{jr}]$ and $\mathrm{VA} = [\mathrm{VA}_{-jr}, \mathrm{VA}_{jr}]$, respectively. In the counterfactual assortment (A'_{-jlr}), retailer r supplies product l instead of j and the change in its contract is reflected in $w'_{-jlr} = [w_{-jr}, w_l]$ and $\mathrm{VA}'_{-jlr} = [\mathrm{VA}_{-jr}, \mathrm{VA}_l]$. Constructing the contracts for replacement products presents a challenge for all analyses that allow for replacement threats. For example, Ho and Lee (2017) set the contract to the reservation price of the hospital that serves as a replacement threat (hospital l). That is, they use the minimum price that hospital l would be willing to accept to be included in the insurer's network. In my setup, this would be analogous to constructing a minimum w_l that the producer would be willing to offer to be supplied by the retailer. Instead, I use the industry practice that retailers may also procure products from wholesalers or other intermediaries at non-negotiated wholesale prices (w_l) and no vendor transfers ($\mathrm{VA}_l = 0$). I take a conservative approach and set w_l to the highest inferred total marginal cost to supply product l by any retailer in that market: $w_l = \max_{r'}\{mc^r_{lr'} + w_{lr'}\}$.[15] Thus, the vendor allowance estimates may be construed as a lower bound on these transfers. Additionally, Section 6 presents a robustness check, where I construct retailers' replacement threats using wholesale costs reported in Promodata Price Trak.[16]

Substituting retailer profits from equation (4) in equation (8) yields that the following

[14] Naturally, retailers have multiple unilateral deviations. A retailer may switch multiple products at a time or it may add a new product by decreasing the shelf space of another 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 and fixed costs constant.

[15] As described in Villas-Boas (2007), the separate identification of retailers' and producers' marginal costs (and wholesale prices), requires additional assumptions.

[16] Promodata Price Trak collects wholesale-price and promotion information from one major wholesaler in each market for the 2005-2010 period.

condition holds for all products j offered by r and all potential replacement products l

$$E_\xi[\pi_r(A, mc^r, w)] + \sum_{k\in A_r} \mathrm{VA}_{kr} - C_r \geq E_\xi[\pi_r(A'_{-jlr}, mc^{r\prime}_{-jlr}, w'_{-jlr})] + \sum_{k\in A'_{-jlr}} \mathrm{VA}_{kr} - C_r.$$

The counterfactual product assortment holds fixed the number of products supplied by the retailer; hence, retailer fixed costs (C_r) are the same across the two considered assortments. As $\mathrm{VA}_l = 0$, these conditions further simply to

$$\mathrm{VA}_{jr} \geq E_\xi[\pi_r(A'_{-jlr}, mc^{r\prime}_{-jlr}, w'_{-jlr})] - E_\xi[\pi_r(A, mc^r, w)] \qquad \text{for } \forall j \in A_r \text{ and } \forall l \notin A_r. \quad (9)$$

In the grocery industry, lump-sum payments flow from producers to retailers, so industry practices provide a natural lower bound on vendor allowances, that is, $\mathrm{VA}_{jr} \geq 0$.[17] Additionally, producers' profit maximization requires that, if $\mathrm{VA}_{jr} > 0$, then contract offers place retailers at their participation constraints. Vendor allowances reflect the shadow price of shelf space, which is approximated as the additional retailers' profits generated by switching each product with its most profitable replacement.[18] In particular, given a profitable retailer deviation, equation (9) holds with equality for the most profitable replacement option for product j at retailer r. That is,

$$\mathrm{VA}_{jr} = \max\{0, \max_{l\notin A_r}\{E_\xi[\pi_r(A'_{-jlr}, mc^{r\prime}_{-jlr}, w'_{-jlr})] - E_\xi[\pi_r(A, mc^r, w)]\}\} \qquad \text{for } \forall j \in A_r. \quad (10)$$

These deviations can be used by themselves to infer vendor allowances for all products observed in the market. To infer producers' markups, I combine these deviations with producers' optimality conditions. Section 4 described producers' profits as

$$E_\xi[\Pi_p(A, mc^p, w, \mathrm{VA})] = E_\xi[\pi_p(A, mc^p, w)] - \sum_{\{jr\}\in A_p} \mathrm{VA}_{jr} \quad (5)$$

[17] Changes in vendor allowance estimates from this and other implementation assumptions are discussed in the appendix.

[18] This condition assumes that during negotiation periods, retailers incur no costs to make such assortment changes. If such costs are present, then the estimates might be overestimating vendor transfers.

and substituting equation 10 into 5, implies that

$$
\begin{aligned}
E_\xi[\Pi_p(A, mc^p, w, \mathrm{VA})] =& E_\xi\Bigg[\sum_{\{j,r\}\in A_p}(w_{jr} - mc^p_{jr})s_{jr}\Bigg] \\
& - \sum_{\{jr\}\in A_p} \max\Bigg\{0, E_\xi\Bigg[\sum_{k\in A'_{-jr}}(p_{kr}(A'_{-jr}) - mc^r_{kr} - w_{kr})s_{kr}(A'_{-jr}) \\
& \qquad - \sum_{k\in A_r}(p_{kr}(A) - mc^r_{kr} - w_k)s_{kr}(A)\Bigg]\Bigg\}
\end{aligned}
\tag{11}
$$

where A'_{-jr} identifies retailer r's most profitable assortment deviation when product j is excluded. Note that retailers' participation constraints enter producers' first order conditions only if these constraints bind. Let A_p^{bind} track the constraints that bind for producer p. Then producer p optimality conditions are given by[19]

$$
\begin{aligned}
\frac{\partial \Pi_p}{\partial w_{lr}} =& s_{lr} + \sum_{\{kr\}\in A_p}(w_{kr} - mc^p_{kr})\frac{\partial s_{kr}}{\partial w_{lr}} \\
& - \sum_{\{jr\}\in A_p^{bind}}\Bigg[-s_{lr}(A'_{-jr}) + \sum_{\{kr\}\in A'_{-jr}}\left(\frac{\partial p_{kr}(A')}{\partial w_{lr}}s_{kr}(A') + (p_{kr}(A') - mc^r_{kr} - w_{kr})\frac{\partial s_{kr}(A')}{\partial w_{lr}}\right)\Bigg] \\
& + \sum_{\{jr\}\in A_p^{bind}}\Bigg[-s_{lr} + \sum_{\{kr\}\in A_r}\left(\frac{\partial p_{kr}}{\partial w_{lr}}s_{kr} + (p_{kr} - mc^r_{kr} - w_{kr})\frac{\partial s_{kr}}{\partial w_{lr}}\right)\Bigg].
\end{aligned}
\tag{12}
$$

Note that product $\{kr\}$ is not supplied in A'_{-kr}, by definition. The expressions above highlight that a multi-product producer will internalize that the wholesale price of one product, will affect retailers' outside options for its other products.

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 during the time period and that the retailer may supply the counterfactual product without incurring disproportionately large fixed costs. In addition, I avoid deviations in which regional brands are counterfactually supplied in other census regions. The set of potential products includes, on average, 14 replacement options per retailer.

[19] I have omitted the expectations operators for ease of readability.

The deviations are constructed by ***dropping*** *each product from the observed assortment with* ***replacement****.* These deviations keep yogurt shelf space fixed, both in terms of the number of products and the number of flavors offered. I substitute the dropped product with the replacement option that renders the highest variable retailer profits based on my estimates of demand parameters. For example, consider the Boston market for the 2010q1 period and suppose that retailer 1 in Boston ($r1$) supplies *Yoplait Trix* (t). First, I construct retailer 1's expected variable profits for 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 set of potential product deviations. For simplicity, suppose that there are three products in retailer 1's set of potential offerings: *Breyers Light* (b), *Stonyfield Farm Yobaby* (s), and *Weight Watchers* (w). The expected variable profits per store for each deviation are

$$E_\xi[\pi_r(A'_{-t,b,r1})] = 20,600,\ E_\xi[\pi_r(A'_{-t,s,r1})] = 20,540,\ E_\xi[\pi_r(A'_{-t,w,r1})] = 20,300.$$

The most profitable replacement for *Yoplait Trix* for retailer 1 is *Breyers Light* with profits of $20,600$. I use the ***drop*** *Yoplait Trix,* ***replace*** *with Breyers Light* deviation. Given that producers make take-it-or-leave-it offers, the deviation yields that

$$E_\xi[\pi_r(A)] + \mathrm{VA}_{t,r1} \geq E_\xi[\pi_r(A'_{-t,b,r1})] \implies \mathrm{VA}_{t,r1} = \max\{0, 100\} = 100.$$

Expected retailers' variable profits are simulated using the empirical distribution of structural shocks. For all simulations and counterfactual assortment changes, retail prices are re-optimized according to the Bertrand-Nash competition assumption. The deviations are constructed for non-private-label products only.

6 Results

The demand estimation allows for heterogeneity in consumers' price sensitivity and preferences for product characteristics. The individual-specific price parameter is drawn from the empirical income distribution, while the random coefficients for product characteristics (marketed for children, natural, soy, number of flavors) and the constant term are estimated using draws from the standard normal distribution. Results from the demand parameterization are reported in table 4. The reported estimates of product characteristics are constructed as projections on the estimated product-year intercepts. The estimates align with expectations: demand is downward sloping and consumer price sensitivity decreases with income. In addition, consumers prefer children's and creamy products, while they value soy and light

Table 4: Demand Estimates

	mean value	st. deviation
constant	-7.366	0.249
	(0.200)	(0.567)
price	-6.947	1.960
	(0.425)	(0.227)
flavors	0.773	0.662
	(0.084)	(0.074)
natural	0.048	0.119
	(0.041)	(1.227)
child	7.087	1.897
	(0.179)	(1.043)
soy	-15.363	0.823
	(0.682)	(4.038)
creamy	0.146	
	(0.003)	
light	-0.279	
	(0.021)	
median own-price elasticity	-4.317	
	(0.028)	
% own-price elasticity > 0	0.000	
% own-price elasticity > -1	0.006	
median markup (in $)	0.211	
	(0.000)	
median margin	0.275	
	(0.000)	

Standard errors are reported in parentheses. 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: producers' transportation costs interacted with retailer fixed effects, with an F-stat of 93.1. Sample size is 230,679. Results are obtained using the MPEC algorithm. Markups are derived under the assumption of retail price competition. Variable profit margins are calculated as variable profits divided by total sales.

products less.

Demand estimates imply a median consumer own-price elasticity of -4.3. The second panel in table 4 also reports that none of the calculated own-price elasticities are positive and only 0.006% of the estimates suggest individuals on the inelastic part of their yogurt demands. The assumption of retail price competition leads to an estimated median retail markup of 21 cents and a median variable profit margin 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 the median reported variable profit margin is 27% for the sample period.

Table 5 summarizes inferred retailers' marginal costs and compares these estimates to the wholesale costs reported in Promodata Price Trak. Wholesale prices may not be separated from total retailers' marginal costs without additional assumptions, so the first column

Table 5: Retailers' Marginal Costs

	retailer mc $mc^r + w$	st.error	w Promodata	w' outside option
Agro Farma	1.10	0.00	0.92	1.25
Anderson-Erickson	0.37	0.00	-	0.38
Auburn Dairy	0.38	0.00	-	0.46
Belfonte	0.33	0.00	-	0.36
Breyers	0.51	0.00	0.56	0.59
Cabot Creamery	0.42	0.00	0.40	0.46
Cascade Fresh	0.57	0.00	0.71	0.65
Dean Foods	0.77	0.00	0.55	0.97
Fage USA Corp	1.73	0.00	1.37	1.97
General Mills	0.61	0.00	0.39	0.61
Groupe Danone	0.65	0.00	0.77	0.85
Johanna Foods	0.37	0.00	0.37	0.44
Kalona Organics	0.95	0.00	-	1.03
LALA Foods	0.55	0.00	0.49	0.58
Northwest Dairy	0.34	0.00	-	0.38
Old Home Foods	0.39	0.00	0.40	0.40
Prairie Farms	0.32	0.00	-	0.36
Springfield Creamery	0.44	0.00	0.37	0.55
Sun Valley Dairy	1.15	0.00	-	1.25
Tillamook County	0.43	0.00	-	-
Wallaby Yogurt	0.88	0.00	-	0.92
Whole Soy	1.00	0.00	-	1.10
Private Label	0.31	0.00	-	-

reports estimates of total retailers' marginal costs ($mc^{r,total} = mc^r + w$). Results suggest heterogeneity in the costs to supply products from different producers. For example, supplying organic products (e.g. Fage, Whole Soy) is costlier to retailers; whereas, private labels have the lowest total marginal cost.

Reported prices from Promodata show similar patterns. Promodata Price Trak collects wholesale-price and promotion information from one major wholesaler in each market for the 2005-2010 period. I match 60 (out of 148) products from Promodata to the IRI dataset, and column 3 summarizes the wholesale costs for the matched products. Inferred retailers' costs ($mc^{r,total}$) include both wholesale costs and additional retailers' marginal costs, so they are typically larger than collected contracts.[20] The last column summarizes the constructed costs to supply replacement-threat products, which are used to calculate retailers' outside options. These costs reflect the maximum retailer marginal cost to supply product l ($mc_l^{r,total}$) by any

[20] In some cases, inferred wholesale costs are lower. This may arise if the grocery chains covered in the IRI data sample obtain lower wholesale prices or better promotional discounts than the specific wholesaler that reports contracts to Promodata.

retailer in that market. Using the maximum retailer marginal costs is conservative; thus, the vendor allowance estimates may be construed as a lower bound on these transfers. Below, I compare my inferred vendor payments to the estimates constructed using wholesale costs from Promodata.

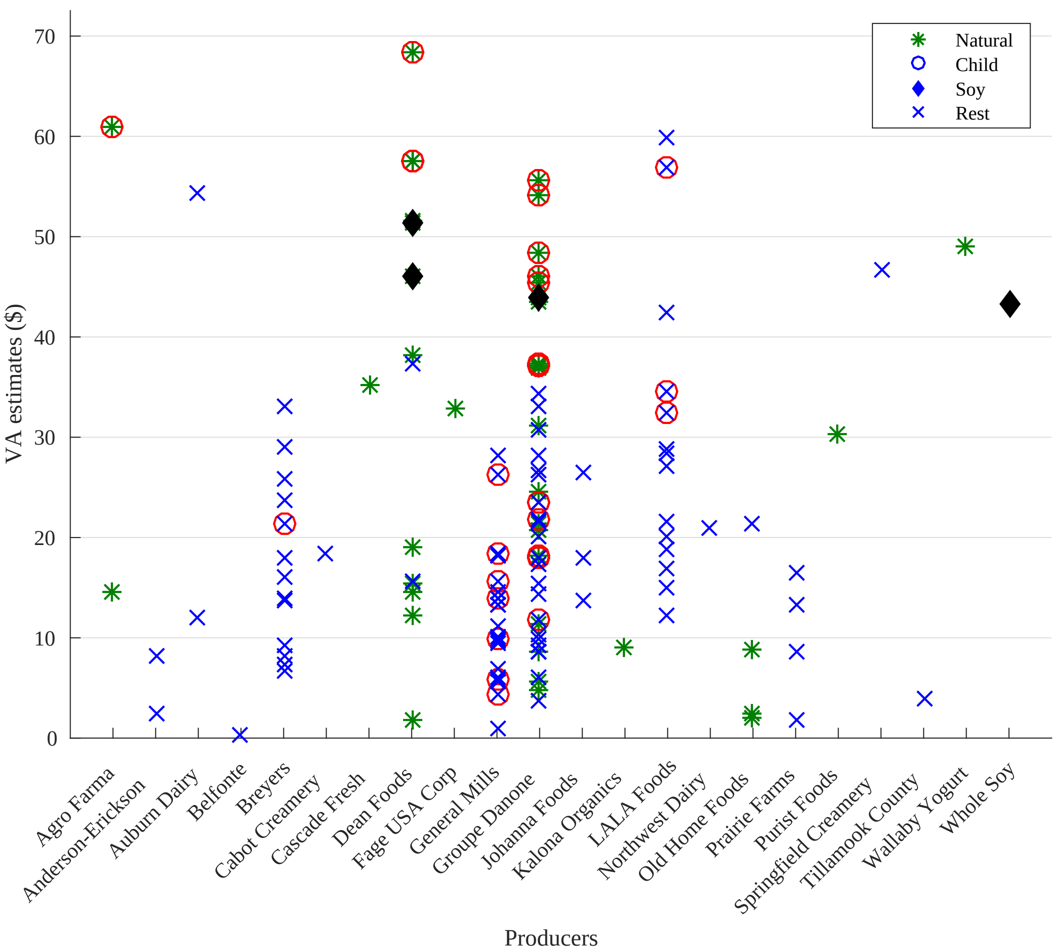
I find that, on average, vendor transfers represent 5.86% (st. error of 0.22) of retailers' revenues and 19.93% (0.66) of variable profits.[21] These payments are likely important for retailers' profitability, given that public grocery chains in the U.S. report profit margins on the order of 2-4% of revenues. Vendor allowance payments reported in retailers' 10-K filings are the closest accounting statement metric to the estimated transfers. I collect data on vendor allowances reported by public grocery chains that are observed in my data. During the sample period, mean reported vendor payments correspond to 9.5% of their revenues. The closeness between estimated and reported vendor allowances is reassuring, but should be interpreted with caution, recognizing the differences between the two measures. The estimated vendor allowances are designed to reflect retailers' opportunity costs. As a result, the estimates capture vendor support in the form of savings in distribution costs, a transfer that is not recorded in accounting statements. Additionally, 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 my vendor allowance estimates; rather they would be captured in the retail markups analysis.

As a robustness check, I estimate vendor transfers using wholesale costs from Promodata to construct the value of replacement threats. The inferred vendor allowances amount to 8.5% of retailers' revenues, on average. In this specification, marginal costs of replacement products are typically lower, as shown in table 5; so unsurprisingly, I find more profitable retailers' deviations, and higher vendor allowances.

To illustrate the differences in constructed vendor allowances across products, I project the payments prescribed by the model on product fixed effects. Figure 6 shows these estimates across producers for the 130 non-private label products supplied during the analyzed period. To ease comparability, vendor allowances are reported as the lump-sum transfer per store, quarter, and flavor. The *x-axis* sorts the products by producer, while different symbols identify product characteristics: natural products are marked with an asterisk, a circle identifies products marketed for children, and soy yogurts are shown with a diamond shape. The figure shows substantial heterogeneity in vendor allowances across products within a producer. For example, the two extreme projections for Groupe Danone indicate that the

[21] The appendix discusses the changes in vendor allowance estimates under different implementation assumptions.

Figure 6: Comparison of Vendor Allowances across Products



The *x-axis* sorts the products by producer, the *y-axis* measures vendor allowances. Vendor allowances are reported per store-quarter-flavor to ease comparisons across retailers and product lines.

producer pays, on average, \$52 more per store-quarter-'product-line' for *Stonyfield Farm YoMommy* than for *Dannon Light N Fit*. This result aligns with industry narratives that producers may refuse to pay allowances for staple products, but they are likely to pay large transfers for products that may be profitably replaced by retailers.

Inferred vendor allowances are derived from retailers' incentive compatibility conditions, so they capture the value of these economic transfers to retailers. Therefore, it is possible that the estimates overstate the costs to producers. If a producer provides vendor allowances at a lower cost than the benefits captured by the retailer, then the producer may have further incentives to offer vendor allowances instead of wholesale price discounts. Efficiencies in providing vendor allowances might be present, if, for example, these transfers are in the form of distribution support. Dean Foods presents a case where transfers to retailers might be primarily in the form of distribution support.

Dean Foods is a food manufacturer that specializes in dairy products. During the sample period of 2001-2010, the firm produced a wide variety of local and national brands such as *Alta Dena*, *Land O'Lakes*, *Garelick*, *Silk*, etc. Even though the company distributed a number of yogurt products, its most popular dairy products were in the milk category. Over the sample period, milk products represented more than 70% of all offerings supplied by the manufacturer, and it completed the sale of all yogurt operations in 2011 in order to focus on core dairy products. Importantly, Dean Foods distributed its products through a wide direct-store-delivery system, which was developed to accommodate its core milk business.[22] Hence, the milk category may have affected the profitability of distributing yogurt products.

Economies of scope in distribution may allow Dean Foods to provide vendor allowances for its yogurt products at little or no additional costs. Such efficiencies affect producers' individual rationality conditions and optimal contract offers. Producers' individual rationality conditions impose that the cost to supply a product may not exceed the additional benefits generated by the product. The marginal benefit from supplying a product is lower than the constructed vendor allowances for 60% of Dean Foods' products, even if I use producer revenues.[23] Dean Foods' operations convey that its efficiencies in providing transfers may rationalize the inferred vendor allowances in these cases.

The counterfactual analysis requires estimates of producers' marginal costs, and these estimates depend on the cost of vendor allowances to producers. If Dean Foods' vendor allowances are assumed to be cash transfers, then optimality conditions imply negative markups for its products. Instead, I use the insights about Dean Foods' operations and

[22]Direct-store-delivery is common practice in the milk category. In contrast, I could not find support that such systems are used by other yogurt producers.

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

Table 6: Producers' Markups

	producer μ^p with o.o.	st.error	producer μ^p, no o.o.
Anderson-Erickson	0.17	0.01	0.20
Belfonte	0.20	0.02	0.20
Breyers	0.15	0.00	0.18
Cabot Creamery	0.07	0.03	0.18
Cascade Fresh	0.17	0.01	0.19
Dean Foods	0.20	0.00	0.20
Fage USA Corp	0.21	0.00	0.25
General Mills	0.16	0.00	0.22
Groupe Danone	0.15	0.00	0.20
Johanna Foods	0.12	0.01	0.17
LALA Foods	0.13	0.00	0.19
Northwest Dairy	0.12	0.01	0.18
Old Home Foods	0.18	0.01	0.20
Prairie Farms	0.15	0.00	0.18
Springfield Creamery	0.14	0.00	0.19
Sun Valley Dairy	0.21	0.02	0.22
Tillamook County	0.17	0.01	0.18
Wallaby Yogurt	0.18	0.02	0.21
Whole Soy	0.19	0.00	0.21
Private Label	-	-	-

impose that the producer provides these lump-sum benefits to its retailers at zero cost. Inferred producers' markups (μ^p) for 2006 are summarized in table 6. To highlight the role of retailers' replacement threats, I also report the markups that would be inferred if the estimation ignores retailers' outside options (producer μ^p no o.o.). Similarly to results from the stylized example in Section 4, these comparisons reveal that retailers' credible threats of replacement mitigate double marginalization. I further explore the effects of these wholesale price discounts in the counterfactual analysis.

7 Counterfactual Analysis

The empirical analysis suggests that credible replacement threats allow retailers to extract lower wholesale prices and vendor allowances. The counterfactual studies whether the vendor allowance contract affects retailers' strategic product selections and, in turn, terms of trade. To do so, I restrict the contract to consist of only wholesale prices.

This restriction of the vertical contract may, in practice, affect equilibrium product assortments, retail and wholesale prices, the number of products offered, and the types of products developed by producers. The counterfactual accounts for adjustments in retailers' assortments, retail prices, and wholesale prices, and holds retail 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 retailers' fixed costs unchanged. If vendor allowances were eliminated for yogurts, retailers could reallocate space across other product categories. However, to allow for such adjustments, I would need data on retailers' category-specific fixed costs, along with estimates of consumer preferences, wholesale prices, and vendor allowances for other refrigerated categories.

The model imposes that, conditional on the set of products with initiated negotiations (A), wholesale price offers maximize producers' profits subject to retailers' participation constraints. For each producer p these conditions are

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

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

Note that wholesale prices have three effects. First, they directly affect producers' profits ($E_{\xi}[\Pi_p(A, mc^p, w)]$). Second, conditional on retailers' option values, wholesale prices are the only tool available to producers to match these participation constraints through retailers' variable profits ($E_{\xi}[\Pi_r(A, mc^r, w)]$). Finally, wholesale prices influence the value of retailers' outside options ($E_{\xi}[\Pi_r(A', mc^r, w')]$) and the replacement products that determine these outside options (A'). To take these forces into account, I re-calculate retailers' outside options at each wholesale price iteration. These outside options reflect the one-product deviations described in the estimation section. Retailers' marginal costs of private labels are not adjusted. Structural shocks are set to zero due to computational complexity.

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 supply 34 products from 40 options, which yields about four million possible assortments.[24] Simulating the wholesale price offers for an assortment is computationally taxing because the algorithm re-calculates retailers' 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 assortments. In particular, I fix staple products and simulate, on average, six thousand assortments for each retailer in the market.[25] The function iterates over retailers

[24]Similarly to the empirical analysis, 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. The availability of private labels is kept fixed.

[25]In addition, I take one thousand assortments at random and simulate their contract offers. These checks

Table 7: Counterfactual Analysis: Results (in % changes)

	counterf. results	st. error	role of retailers' outside options: count. A	st. error	obs. A	st. error
vertical profits	0.84	0.16	0.14	0.67	0.31	0.73
retailer profits	-2.38	1.74	1.00	1.06	4.42	2.44
producer profits	5.77	2.70	-1.11	0.28	-5.46	1.72
consumer surplus	0.22	0.35	0.54	0.34	0.90	0.64
# products	65.25	0.00	65.25	0.00	65.25	0.00
# switched prods	4.75	0.46	0.00	0.00	0.00	0.00
wholesale prices (all)	-3.03	1.23	-1.96	1.01	-3.89	0.63
wholesale prices (unchanged)	1.69	1.08	-2.22	1.01	-3.85	0.78
wholesale prices (switched)	-35.59	5.74	0.97	1.19	-4.30	0.77
retailer prices (all)	-2.16	0.84	-1.43	0.86	-2.89	0.62
retailer prices (unchanged)	1.25	0.79	-1.61	0.87	-2.82	0.74
retailer prices (switched)	-29.23	4.85	0.76	0.87	-3.60	0.91

The first column shows percent changes in key variables comparing the observed and counterfactual market outcomes. Columns 2 and 3 show the difference between the equilibrium contracts and producers' take-it-or-leave-it offers that ignore retailers' participation constraints. Column 2 uses the counterfactual assortments; column 3 report these differences for the observed assortment.

in the market until no retailer would find it profitable to alter its assortment. The algorithm is described in appendix C. Even though a unique equilibrium is not guaranteed, the brute-force search over assortments identifies one equilibrium in assortments and prices.

Table 7 reports counterfactual changes for key variables. The simulations suggest that if contracts were restricted to include only wholesale prices, then, on average, vertical surplus would increase by 0.84%, and consumer surplus would be 0.22% higher. These increases are driven by the change in retailers' assortments discussed below. Even though total vertical profits are predicted to increase, retailers are worse off. Retailers' profits decrease by 2.38%, while total producers' profits increase by 5.77%.

Moreover, the change in the vertical contract affects product availability. Counterfactual assortments are constructed by changing, on average, 4.75 products in a quarter. This suggests that retailers' product selections cannot be understood in isolation from contract negotiations. Expected contract offers govern retailers' profitability from supplying a product. Similarly, equilibrium contracts depend on the set of products with initiated negotiations. First, I discuss the counterfactual changes in product selections and the implications for retailers' strategies. Next, I examine how wholesale prices adjust for the counterfactual

reveal that assortments excluding staple products require wholesale price decreases that violate at least one producer's individual rationality. As a result, assortments that imply large retailers' outside options could not be supported with the restricted contract.

product selections. Last, I analyze the changes in individual producers' profits and product distributions.

The counterfactual changes in assortments are primarily driven by adjustments from one of the retailers. Retailer 1 changes, on average, 4.25 products, while retailer 2 switches 0.5 products. This difference in adjustment size is related to differences in inferred vendor allowances. Estimates suggest that retailer 1 receives positive transfers for 39% of its products; whereas, retailer 2 receives payments for 7% of its products. As a result, the contract restriction leads to larger adjustments for retailer 1. The model prescribes that replacement products may influence vertical contracts and firm payoffs because these products may be used as credible threats in contract negotiations. Thus, retailer 1 may be strategically excluding products in order to obtain better terms of trade from its producers. In the counterfactual retailer 1 adds the products that governed its most profitable replacement deviations and excludes products with positive vendor allowances. Consequently, these adjustments imply lower values of retailer 1' replacement threats.

In fact, simulations show that the restricted contract cannot support assortments in which retailers have large outside options. For example, the observed assortments may not be supported by a contract that consists of only wholesale prices. Absent vendor allowances, producers need to lower wholesale prices to match retailers' outside options. For the observed assortment, these adjustments require that retailer 1's wholesale prices decrease by, on average, 8.5%. However, these decreases in wholesale prices violate at least one producer's individual rationality conditions. Additional simulations showed that assortments, which exclude "popular" products and imply large retailers' outside options, could not be supported by the restricted contract. Instead, in the counterfactual, retailer 1 supplies 75% of the products that served as profitable replacement threats for its observed assortment. These findings suggest that retailers' ability to distort assortments in order to command favorable contracts is weakened under the restricted contract.

Conditional on these changes in product selections, table 7 reports the counterfactual changes in wholesale prices. Average wholesale prices fall by 3.03%, 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 the counterfactual assortments ("unchanged" products) increase by 1.69%. If product assortments were kept fixed, then we would expect wholesale prices to decrease when vendor allowances are eliminated. Instead, I find that wholesale prices increase for a third of the products. These increases reflect the lower values of retailers' outside options in the counterfactual.

To illustrate this, the second panel in table 7 shows how retailers' outside options influence contracts and firm payoffs for the observed and the counterfactual assortments separately. For each assortment, I compare the equilibrium contracts with contracts simulated as producers' take-it-or-leave-it wholesale price offers that ignore retailers' participation constraints. Column 3 reports the differences for the counterfactual assortments; column 5 shows the results for the observed market assortments. The counterfactual assortments imply low values of retailers' outside options so counterfactual wholesale prices are closer to unconstrained take-it-or-leave-it offers. In the counterfactual, average wholesale price offers are 1.96% lower than unconstrained offers. These discounts generate a 1.00% increase in retailers' profits and a 0.54% increase in consumer surplus. In comparison, for the observed assortment, the credible threat of replacing a product allows retailers to capture 4.42% higher profits through vendor allowances and wholesale price discounts. Constrained wholesale price offers are, on average, 4.39% lower, which leads to 0.31% higher vertical profits and 0.9% higher consumer surplus. These comparisons highlight that retailers' replacement threats impose downward pressure on wholesale prices and, consequently, mitigate double marginalization.

Last, I compare the impact across producers. Table 8 reports the change in producers' total profits, variable profits, and the number of products supplied. If vendor allowances consist entirely of cash transfers, then all producers are better off in the counterfactual. However, if producers benefit from efficiencies in providing these economic transfers, then the results differ by producer. For example, changes in producers' variable profits show that, if vendor allowances cost zero to producers, then Cascade Fresh, Dean Foods, and Whole Soy are predicted to be worse off. In the counterfactual, Dean Foods supplies, on average, 2.5 less products per quarter. Cascade Fresh and Whole Soy lose distribution of their product in half of the quarters, and a third of the quarters, respectively. The producers that benefit from expanded distribution are LALA Foods and Groupe Danone. The increased distribution leads to both higher total and variable profits for these producers.

To gain insight into the assortment changes, table 9 lists the products supplied in Toledo, OH for the third quarter of 2006. The table displays the number of chains that carry the product in the observed and counterfactual assortments. Retailer 2 drops *Cascade Fresh* (Cascade Fresh) and replaces it with *Dannon La Crem with Chocolate* (Groupe Danone). The other changes are adjustments in retailer 1's assortment. In this quarter, the counterfactual predicts that Cascade Fresh, Dean Foods, and Whole Soy would lose distribution if the vertical contract is restricted to include only wholesale prices. In addition, the product variety in the market decreases. For the observed market assortment, there are 36 unique branded products supplied in the market, while in the simulated assortment, consumers may choose from 32 products.

Table 8: Changes in Producers' Profitability and Distribution

	Δ total Π_p (\$)	Δ variable Π_p (\$)	Δ # products
Cascade Fresh	767.68	-130.54	-0.50
Dean Foods	2206.11	-519.80	-2.50
General Mills	1524.49	1125.81	0.00
Groupe Danone	1627.90	300.83	1.50
LALA Foods	2557.91	1780.27	2.00
Springfield Creamery	290.55	12.80	0.00
Whole Soy	940.89	-252.58	-0.75

Vendor allowance estimates likely capture both cash payments from producers and incentives in the form of retailers' cost savings. The counterfactual analysis eliminates all positive economic transfers from producers to retailers. As a result, the counterfactual results may differ from adjustments after a ban on only cash payments from producers. As cash and non-cash transfers can be substituted, I focus on understanding the effects of all lump-sum economic transfers from producers to retailers when product selections are endogenous.

8 Conclusion

This paper 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 quantify vendor allowances and assess their importance for retailers' profitability in the grocery industry using data on yogurt products. The framework incorporates both retail price competition and endogenous product assortment decisions. By exploiting information from observed retailers' 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 product selections to infer information about vertical contracts. Constructed vendor allowances suggest that these transfers correspond to 5.86% of retailer revenues. These payments are likely important for retailers' profitability, given that public grocery chains in the U.S. report profit margins on the order of 2-4% of revenues.

The counterfactual studies how product availability and wholesale prices would change if contracts were restricted to include only wholesale prices. Results suggest that the vendor

Table 9: Changes Product Availability for the Toledo-2006q3 Market

producer	product line	observed A # chains	count. A # chains
Cascade F.	Cascade Fresh	1	0
Dean Foods	Horizon Organic	1	1
	Horizon Organic Tuberz	1	0
	Horizon Organic Yo-Yos	1	0
General Mills	Yoplait Go Gurt	2	2
	Yoplait Kids	2	2
	Yoplait Light	2	2
	Yoplait Light Thick and Cream	2	2
	Yoplait Original	2	2
	Yoplait Ro Gurt	2	2
	Yoplait Thick and Creamy	2	2
	Yoplait Trix	2	2
	Yoplait Whips	2	2
	Yoplait Yumsters	2	2
Groupe Danone	Dannon Activia	2	2
	Dannon Creamy Fruit Blends	1	2
	Dannon Danimals	1	2
	Dannon Fat Free	2	2
	Dannon Fruit on the Bottom	2	2
	Dannon La Crem with Chocolat	1	1
	Dannon La Creme	2	2
	Dannon Light N Fit C&S Control	2	2
	Dannon Light N Fit	2	2
	Dannon Light N Fit Carb Control	2	2
	Dannon Natural	2	2
	Dannon Natural Flavors	2	2
	Dannon Premium	1	1
	Dannon Sprinklins	1	1
	Stonyfield Farm	2	2
	Stonyfield Farm O'Soy	2	2
	Stonyfield Farm Yobaby	2	2
LALA Foods	Blue Bunny Carb Freedom	1	2
	Blue Bunny Lite 85	1	2
	Weight Watchers	2	2
Springfield	Nancys	1	1
Whole Soy	Whole Soy	1	0

allowance contract facilitates retailers' strategies to distort assortments in order to obtain better terms of trade from producers. Hence, a retailer may find it optimal to exclude a "popular" product from its assortment to use it as a replacement threat in contract negotiations. If wholesale prices were kept fixed, such distortions would decrease total vertical profits and consumer surplus. Alternatively, if we focus only on wholesale prices, then retailers' credible threats of profitably replacing a product allow them to capture wholesale price discounts and vendor allowances from producers. These lower wholesale prices may benefit consumers and generate higher vertical profits. Counterfactual results show that vertical profits and consumer surplus increase when the contract is restricted. This suggests that, for the studied market, the assortment distortion effects are larger than the benefits from lower wholesale prices.

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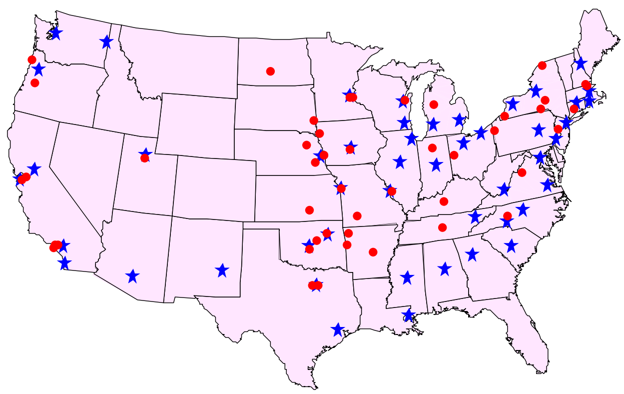
A Data Appendix

The analysis uses the academic Information Resources Inc. (IRI) dataset, which 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. I observe between 4% and 16% of all stores in a geographic market, for a total of 80 grocery chains in the sample.[26] For each chain in the sample, the dataset contains information on an average of 25% of its stores. Chains vary in size; their estimated market annual sales range from \$5 million to \$1,147 million. Most of the chains in the IRI dataset are among the main competitors in their respective markets. For each market, I observe at least 2 and, on average, 3 to 4 of the 5 major grocery chains. The five main competitors in a market account for 50-94% of sales in the grocery sector for the analyzed markets.

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

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

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 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-ounce*), which includes a variety of flavors (e.g. *Stonyfield Smooth & Creamy, 6-ounce, 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-ounce 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.

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. I define five product characteristics: natural, marketed for children, soy creamy, or light. 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 the 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 products as creamy, light, or children's, I inspect product line names and use key words. The soy products in the dataset are *Silk* (Dean Foods), *Silk Live* (Dean Foods), *Stonyfield Farm O'Soy* (Groupe Danone), and *Whole Soy* (Whole Soy).

Consumers are offered a variety of natural, children's, creamy, and light options: typically, more than 25 product-retailer offerings with each of these characteristics are available in a market. The exception is soy products with, on average, 4 product-retailer soy options available in a market. For the sample period, soy yogurts may be characterized as "niche" offerings: they are offered by only three producers, supplied by only some of the retailers, and are low-velocity items generating low sales as compared to other products.

Table A1: Producer market shares and distribution

	mean	median	sd	min	max	#mkts	#ret
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 A2: 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.

The sample consists of 24 national and regional producers and 44 private label brands. Table A1 shows market shares and market presence by producer. During the sample period, the two main competitors are Groupe Danone and General Mills; they collectively control, on average, 70% of yogurt sales. Groupe Danone produces the *Dannon*, *Stonyfield Farm*, and *Brown Cow* brands, while General Mills distributes the *Yoplait* and *Colombo* brands. Private labels are offered by 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 A4. 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.

Table A3: Geographic Distances between Plants and Markets

producer	mean	sd
Agro Farma	828	636
Anderson-Erickson	679	343
Auburn Dairy	1496	563
Belfonte	683	345
Breyers	890	640
Cabot Creamery	953	645
Cascade Fresh	1504	559
Crowley Foods	804	633
Dean Foods	739	424
General Mills: Yoplait	379	200
General Mills: Colombo	965	670
Groupe Danone: Dannon	354	160
Groupe Danone: Stonyfield Farm	960	668
Groupe Danone: Brown Cow	1485	635
Fage USA Corp.	863	643
Johanna Foods	826	652
Kalona Organics	656	369
LALA Foods	1010	452
Northwest Dairy	1443	555
Old Home Foods	738	331
Prairie Farms	725	344
Purist Foods	929	365
Springfield Creamery	1507	596
Sun Valley Dairy.	1416	604
Tillamook County Creamery	1539	591
Wallaby Yogurt Company.	1502	638
Whole Soy	1459	627

Geographic distances are reported in nautical miles. If a brand has its own manufacturing facility, the distance measure is calculated at the brand rather than producer level. This is the case for Colombo (General Mills), Stonyfield Farm (Groupe Danone), and Brown Cow (Groupe Danone). If a producer has multiple plants manufacturing a brand, I assign the closest plant to each market.

The estimation methodology addresses retail price endogeneity by employing cost shifters as instrumental variables. I create a "distance" measure to capture transportation costs from each producer's manufacturing facility to each market. First, I locate yogurt plants in the U.S. that were used during the sample period. Table A3 summarizes the geographic distance information between each brand and the 44 markets used for the analysis. General Mills and Groupe Danone produce multiple brands, however, some of these brands were manufactured in separate facilities. During the sample period Colombo (General Mills), Stonyfield Farm (Groupe Danone), and Brown Cow (Groupe Danone) were produced in their own plants. In such cases, distance measures are constructed at the brand level. If a producer had multiple plants manufacturing a brand, I assign the closest plant to each market.

B Vendor Allowances Additional Results

The vendor allowances reported in the main results impose that these economic transfers flow from producers to retailers, and that the constructed deviations match the value of retailers' outside options. Below, I discuss each of these assumptions. First, I discuss the assumption that vendor allowances flow from producers to retailers. Table A4 shows the size of vendor allowances as a percent of retailers' revenues when we impose different assumptions. The first row reports the vendor allowance estimates if these transfers are restricted to be non-negative. As shown in the main results, my implementation suggests that vendor allowances represent 5.86% of retailers' revenues on average.

Next, I allow that a multi-product producer may exploit the profitability of some of its products to motivate retailers to supply its other products. That is, I impose that vendor transfers are non-negative at the producer level, rather than at the product level. In this case, the mean transfers decrease to 4.69% of retailer revenues. This decrease is primarily driven by the two large producers in the sample: Groupe Danone and General Mills. These producers supply both products with large retailers' profitable deviations, which will imply large vendor allowances, as well as products with high consumer demand, for which I do not find a profitable deviation.

Naturally, the assumption that VA≥ 0 mainly affects products that are highly profitable to retailers. In these cases, the deviations suggest large payments from retailers to producers. In addition, these products are supplied by all retailers. As a result, if we allow for negative vendor allowances, the profitability of a few products would imply negative transfers. The third row in table A4 shows that without the restriction, average vendor allowances are negative. However, these negative estimates are driven by three products: *Yoplait Light* (General Mills), *Yoplait Original* (General Mills), and *Dannon Light N Fit* (Groupe Danone). If the vendor allowances for these products are set to zero, then, on average, retailers receive positive transfers from retailers. In the grocery industry, payments flow from producers to retailers. As a result, the main results presented impose a non-negativity assumption. For completeness, table A5 shows product-specific mean vendor allowances with and without the non-negativity assumption.

Alternatively, it is possible that the constructed retailers' outside options are lower than

Table A4: Vendor Allowance Estimates

	mean	st. error
VA$\geq$ 0	5.86	0.22
VA$\geq$ 0 at brand	4.69	0.21
VA$\lesseqgtr$ 0	-3.55	0.36
VA$\lesseqgtr$ 0*	0.25	0.29

VA$\lesseqgtr$ 0*: restricts the vendor allowances of three products to equal zero. The excluded products are *Yoplait Light*, *Yoplait Original*, and *Dannon Light N Fit*.

the true values used in negotiations. In the estimation, I impose conservative assumptions when I create retailers' unilateral deviations. First, I assume that replacement products may be obtained at a cost equal to the maximum retailer marginal cost for that product in the market. Second, the deviations are restricted to products that are supplied in the market or supplied by the same chain in another market of the same census region. Third, it is possible that retailers also use products from other categories, for example cream cheese, to threaten a producer with replacement. Last, the model imposes producers' take-it-or-leave-it offers, which imply the lowest possible vendor allowances for retailers. These assumptions suggest that the vendor allowance estimates represent a lower bound on the importance of these payments for retailers. The vendor allowance estimates are used to back out producers' marginal costs. Therefore, the assumption that vendor allowance estimates hold with an equality is important for the counterfactual analysis.

Table A5: Vendor Allowance Estimates by Product

	VA$\geq$ 0		VA $\lesseqgtr$ 0	
product line	mean VA	st error	mean VA	st error
Chiobani	14.47	3.45	-11.18	26.91
Chiobani Champions	61.02	173.91	61.02	1165.06
Anderson Erickson	2.48	0.47	-29.85	2.33
Anderson Erickson Yo Lite	8.24	1.35	0.33	2.14
Lil Yami	54.25	17.95	54.25	65.23
Yami	12.01	2.48	8.02	5.07
Belfonte	0.25	0.49	-24.84	2.20
Breyers	7.30	1.25	-11.57	4.23
Breyers Creme Savers	13.68	2.12	3.03	9.95
Breyers Disney	21.32	7.34	17.14	86.62
Breyers Fruit Parfait	18.05	4.92	17.92	10.46
Breyers Inpirations	33.09	7.24	32.13	81.14

Breyers Light	8.13	1.17	-5.88	3.60
Breyers Light N Lively	9.33	6.32	2.64	9.65
Breyers Smart	25.90	8.91	21.29	83.09
Breyers Smooth and Creamy	6.75	2.37	-8.51	7.53
Breyers YoCrunch 100 Calorie	23.66	5.68	21.98	36.64
Breyers YoCrunch Fruit Parfait	14.01	10.35	10.64	84.39
Breyers YoCrunch Light	29.13	12.38	28.38	41.04
YoFarm YoCrunch	16.00	0.69	8.39	4.05
Cabot	18.35	19.33	14.64	79.32
Cascade Fresh	35.30	4.86	33.77	13.09
Alta Dena	37.38	12.40	36.70	30.24
Hillside	15.74	10.20	12.52	24.62
Horizon Natural Little Blends	57.52	8.03	57.52	27.32
Horizon Organic	38.23	2.09	37.74	7.28
Horizon Organic Tuberz	57.53	7.78	57.39	22.66
Horizon Organic Yo-Yos	68.39	9.25	68.39	30.61
Mountain High	1.81	0.93	-45.11	5.25
Mountain High Classic	12.17	2.65	11.98	12.19
Mountain High European Delight	14.59	3.83	12.22	15.92
Mountain High Natural Fat Free	15.33	2.45	14.14	10.12
Mountain High Naturally Nutri	19.13	6.97	18.28	12.81
Rachels	51.48	7.12	50.99	12.85
Silk	45.97	3.00	45.72	7.39
Silk Live	51.40	8.42	49.34	25.27
Fage Total	32.93	4.58	25.77	12.67
Colombo	1.03	12.08	-49.57	49.00
Colombo Classic	13.95	5.50	-16.06	11.75
Colombo Light	13.97	1.89	-6.31	7.47
Yoplait	9.52	4.15	-2.30	45.53
Yoplait Carb Monitor	18.11	1.83	14.44	4.55
Yoplait Delights	11.11	4.63	1.22	17.22
Yoplait Expresse	13.36	2.98	4.31	13.52
Yoplait Fiber One	13.91	4.37	6.41	15.46
Yoplait Go Gurt	5.95	0.81	-29.97	3.74
Yoplait Go Gurt Fizzix	26.29	5.67	24.18	11.50
Yoplait Grande	5.62	3.64	-28.22	88.23
Yoplait Healty Heart	28.27	2.29	26.83	5.70
Yoplait Kids	9.89	3.30	-11.38	14.61
Yoplait Light	6.87	0.29	-29.54	1.82
Yoplait Light Thick and Cream	10.03	1.85	-4.11	5.10
Yoplait Original	6.05	0.26	-37.37	1.66
Yoplait Ro Gurt	15.55	8.79	-0.74	22.84
Yoplait Splitz	18.38	9.20	16.64	31.50

Yoplait Thick and Creamy	9.65	0.88	-6.73	6.80
Yoplait Trix	4.26	1.12	-34.96	5.10
Yoplait Whips	13.38	0.67	1.67	2.71
Yoplait Yo Plus	14.49	1.78	5.91	8.68
Yoplait Yumsters	14.03	6.36	2.67	21.90
Brown Cow	36.98	2.03	32.08	5.53
Dannon	9.79	1.24	-15.62	4.95
Dannon Activia	8.67	0.80	-22.88	4.32
Dannon Activia Dessert	33.01	24.97	32.04	84.70
Dannon Activia Fiber	20.06	5.14	13.17	21.85
Dannon Activia Light	9.35	1.44	-13.48	8.27
Dannon All Natural	8.64	2.28	-25.31	13.56
Dannon Creamy Fruit Blends	10.24	1.87	-6.80	5.55
Dannon Dan O Nino	23.48	4.95	15.89	20.05
Dannon Danimals	11.81	2.26	-3.34	7.30
Dannon Danimals Coolision	23.46	12.07	19.96	41.54
Dannon Danimals Crushcups	21.75	4.59	14.99	23.09
Dannon Fat Free	3.69	2.13	-31.00	6.52
Dannon Fruit on the Bottom	14.35	2.06	0.97	5.81
Dannon La Crem with Chocolat	34.31	3.86	32.21	9.36
Dannon La Creme	8.63	1.11	-10.19	3.95
Dannon La Creme Mousse	21.87	2.34	16.98	8.02
Dannon Light N Fit C&S Control	21.50	6.20	13.08	13.33
Dannon Light N Fit	5.99	0.41	-29.95	2.12
Dannon Light N Fit Carb Control	15.35	3.59	0.85	8.27
Dannon Light N Fit Crave Control	26.20	7.96	25.07	19.05
Dannon Light N Fit Creamy	17.27	1.35	9.30	4.16
Dannon Light N Fit Plus	26.67	3.12	23.30	12.11
Dannon Light N Fit with Fiber	28.14	3.33	25.33	10.53
Dannon Natural	4.68	4.79	-50.27	15.93
Dannon Natural Flavors	5.57	2.10	-25.78	8.83
Dannon Premium	11.37	4.97	-13.03	12.11
Dannon Sprinklins	17.91	3.17	7.69	8.72
Dannon Whipped	30.82	1.34	29.89	3.43
Oikos	31.26	5.11	24.59	17.43
Stonyfield Farm	20.74	0.82	11.90	5.47
Stonyfield Farm Blended Organic	24.55	8.03	24.55	15.55
Stonyfield Farm Kids	45.42	7.54	44.51	16.95
Stonyfield Farm Organic Moo La	43.44	36.09	42.75	61.08
Stonyfield Farm OSoy	43.97	5.09	43.40	13.88
Stonyfield Farm Planet Protect	21.28	20.58	9.93	49.22
Stonyfield Farm Squeezers	48.38	8.83	47.56	20.08
Stonyfield Farm Yobaby	18.13	1.71	10.05	7.17

Stonyfield Farm Yobaby Meals	54.10	47.07	53.65	105.78
Stonyfield Farm Yokids	37.08	16.47	35.66	42.08
Stonyfield Farm Yomommy	55.55	40.03	55.55	57.14
Stonyfield Farm Yoself	46.05	20.77	45.67	37.06
Stonyfield Farm Yotoddler	37.31	56.63	37.25	117.89
LA Yogurt	13.77	1.46	-2.65	4.48
LA Yogurt Custard Classics	17.94	6.06	11.95	15.06
LA Yogurt Sabor Latino	26.55	7.32	25.08	12.80
Cultural Revolution	9.00	12.86	6.61	17.57
Blue Bunny	18.73	8.90	13.42	22.41
Blue Bunny Carb Freedom	16.98	3.69	6.98	8.80
Blue Disney Yo-Pa	34.57	13.40	34.15	19.31
Blue Bunny Disney Swirl	32.35	11.28	32.03	15.65
Blue Bunny Light	20.12	8.67	14.02	22.17
Blue Bunny Lite 85	15.02	1.18	1.90	2.67
Blue Bunny Lite 85 Superfruit	21.49	6.23	18.58	7.80
Blue Bunny Sweet Freedom	12.29	12.20	-2.08	21.97
Blue Bunny Swirl Sensation	28.42	4.68	27.29	17.91
La Creme	28.74	6.87	25.28	21.29
LALA	42.42	2.86	38.23	6.14
LALA Light	59.91	45.09	59.91	95.27
Weight Watchers	27.13	1.53	19.28	4.31
Yomi Light	56.93	25.66	56.20	41.05
Darigold	20.88	1.73	15.83	6.61
Gaymont	21.28	54.52	18.02	81.51
Old Home	2.45	3.73	-59.43	8.31
Old Home 100 Calorie	8.79	4.30	-26.17	12.63
Old Home Gaymont	2.09	5.74	-41.29	13.17
Hiland	1.87	1.15	-26.18	5.50
Hiland Health Wise	13.25	12.89	12.91	42.55
Prairie Farms	8.67	2.06	-41.57	8.48
Robers	16.38	0.89	12.65	1.62
Nancys	30.22	4.25	24.56	9.84
Voskos	46.61	8.22	45.28	24.79
Tillamook	3.85	0.88	-38.16	6.77
Wallaby Organic	49.12	4.45	49.08	17.75
Whole Soy	43.22	2.45	43.07	6.83

C Counterfactual Algorithm

The counterfactual algorithm iterates over retailers' assortment best responses to find an equilibrium. I use the following steps:

1. Consider retailer 1. Fix the assortments for its competitors. Find retailer 1's optimal assortment (along with contracts, prices, and quantities) under the restricted contract. This process involves the following steps:

   1.1 Iterate over potential assortments that retailer 1 may choose to supply.

      i Take a potential assortment for retailer 1 (keeping the assortments of competitors fixed).

      ii Find new contracts, which maximize producers' profits subject to retailers' participation constraints (described below under *Finding constrained wholesale contracts*).

      iii Given new wholesale prices, check that no producer has a profitable deviation. The deviation is constructed as: increase wholesale price of a product (or products for multi-product producers) and allow for the entry of its best replacement product.

   1.2 Keep only the assortments, for which no producer has a profitable deviation.

   1.3 From this subset of options, find the assortment that maximizes retailer 1's profits, given its competitors' product selections.

2 Update the assortment for retailer 1 and repeat the steps for its competitors. Iterate over retailers until optimal assortments do not change.

Finding constrained wholesale contracts: For each tested assortment, I compute new wholesale prices that maximize producers' profits subject to the retailers' participation constraints. The process is described as follows:

1. Compute producer unconstrained optimal wholesale price offers for the tested assortment.

2. Given these wholesale prices, find the products that govern retailers' most profitable deviations. Keep the identities of the best replacements fixed for the iterations. This decreases the computational burden substantially, because identifying the best replacement product for each supplied option typically includes the calculation of (65 products available in the market)*(10 product deviations)=650 retailer deviations, optimal markups, and quantities sold.

3. Construct retailers participation constraints' under these wholesale prices.

4. Find producers' optimal markups given these constraints.

5. Update retailers' participation constraints given new producers' markups.

6. Iterate over [4.] and [5.] until constraints and markups converge.