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

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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 equilibrium effects of vendor allowances when retailers' product selections are endogenous and vertical contracts are unobserved. I introduce an estimation strategy that uses rich information from observed product selections to inform us about lump-sum payments. Vendor allowances are estimated as the payments needed to rationalize observed assortments. For the empirical analysis, estimates imply that these transfers are important for retailers' profitability, corresponding to about 20% of retailers' variable profits. A counterfactual that restricts firms to only contract on wholesale prices predicts that lump-sum payments incentivize retailers to adjust their product selections. In the absence of vendor payments, total surplus increases because previously excluded low-cost products enter the market.

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1 Introduction

Firms often reach consumers through intermediaries. These 'downstream' firms typically choose to supply only a subset of all possible products, and their product selections may substantially impact total welfare in a market. Typical determinants of retail assortments include consumer preferences and the nature of downstream competition, but vertical contracts with producers may also influence assortment choices. This paper analyzes how the structure of the vertical contract may influence terms of trade, product availability, and the welfare implications of these outcomes. I consider a two-part-tariff contract in which retailers pay a wholesale price and may receive lump-sum payments from manufacturers. I refer to these lump-sum transfers as vendor allowances: vendor allowances do not directly depend on volume; instead, 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 firms to secure product distribution: a survey of retailers and manufacturers confirms that vendor fees influence assortments (Bloom et al. (2000)). When choosing assortments, downstream firms face an opportunity cost to supply a product, which is governed by the profitability of its excluded options. A manufacturer may compensate its retailers for these opportunity costs with decreases in wholesale prices and/or lump-sum transfers. The two-part-tariff contract provides manufacturers with two levers (wholesale prices and lump-sum payments) to align two choices by downstream firms (product assortment and retail pricing). Theory suggests that the vendor-allowance contract may support product selections that exclude low-cost products, with the potential to decrease welfare. However, such product exclusions may also lead to lower equilibrium wholesale prices (along with positive vendor payments). The lump-sum transfers redistribute profits between producers and retailers; whereas, the lower wholesale prices may increase total surplus. Given these theoretically ambiguous and potentially offsetting effects, it is important to study these contracts empirically.

The proprietary nature of vertical contracts and firm costs has been an impediment to most empirical analyses. As a result, I introduce an estimation strategy to identify lump-sum transfers when only limited data are available: downstream prices, sales, and assortments. Specifically, I exploit the rich information from firms' product selections and estimate vendor allowances as the payments needed to rationalize observed assortments. To my knowledge, this is the first paper to use the identities of both observed and non-offered products to infer

[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 vertical arrangements in which producers make lump-sum payments to retailers (Federal Trade Commission (2014)).

information about vertical contracts. As researchers often observe detailed information on product selections, the approach is widely applicable.

The model and estimation strategy are described in the context of the retailer sector. The interactions between producers, retailers, and consumers follow a five-stage game. First, retailers initiate negotiations over the products they would like to supply. Second, negotiations proceed as simultaneous producers' take-it-or-leave-it offers of product-specific wholesale prices and vendor allowances. 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.

Estimation proceeds in two steps. First, researchers may apply standard techniques, as in Berry (1994), to estimate consumer demand; and recover retailers' markups from the optimality conditions imposed by the Bertrand-Nash game. Next, I develop a strategy to infer vendor allowances 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 retailers' shadow price of shelf space. The empirical application models retailers' opportunity costs as the additional profits generated by substituting a product with its most profitable replacement option.[2]

Retailers may extract rents from suppliers if they have a sufficiently profitable deviation; if not, then replacement threats do not affect the contracting process and the model reverts back to the standard producers' take-it-or-leave-it offers. Therefore, no feature of the estimation strategy imposes that vendor allowances will be inferred, while failing to account for firms' replacement threats may result in erroneous estimates of vertical contracts and firms' costs. The approach allows researchers to empirically analyze the importance of replacement threats and evaluate whether vendor transfers are employed by firms.

The empirical strategy is applied to the U.S. grocery yogurt market for the 2001-2010 period using the IRI academic dataset. Vendor transfers are known to play an important role for most 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 test whether retailers' strategic product selections are

[2]A simple example illustrates how vendor allowances may be inferred from observed product selections. Suppose a retailer carries *product 1*, and it could switch *product 1* with *product 2*, leaving the rest of its assortment unchanged. Retailer variable profit for the observed product offering is \$20,500 and variable profit for the alternative assortment would have been \$20,600. This suggests that *product 1* compensated the retailer with a lump-sum transfer of at least \$100. Modeling contracting as producers' take-it-or-leave-it offers implies that producers' offers place retailers on their participation constraints. Combining retailers' outside options with producers' optimality conditions, I back out producers' markups.

influenced by the type of vertical contract used in the market. I find a median consumer price elasticity of -4.05 and average retailer variable profit margins of 28.7%. These estimates align with the 27% mean variable profit margins reported by public grocery chains during the analyzed period. I find that vendor payments constitute, on average, 19.9% of retailers' variable profits.

Retailers' profitable replacement threats create contracting leverage, allowing them to capture both vendor transfers and lower wholesale prices. I compare the estimated outcomes to a simulation of producers' offers, which do not account for retailers' replacement threats. When outside options are ignored, average wholesale prices are 7.7% higher, leading to 6.4% lower vertical profits. This comparison highlights that retailers' outside options not only influence the distribution of profits between upstream and downstream firms, but may also impact equilibrium prices and total surplus.[3]

With these estimates at hand, I investigate the potentially offsetting effects of vendor-allowance contracts. A counterfactual restricts firms to only contract on linear wholesale prices. Simulations find new equilibrium assortments, contracts, and downstream prices, keeping fixed the number of products offered. Results suggest that the type of vertical contract introduces economically meaningful incentives to retailers to adjust product availability. In the counterfactual, retailers adjust assortments to include products that served as the most profitable replacement threats; dropped products have inferred positive vendor allowances. This implies 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.[4]

Theory does not provide clear guidance on how retailers' incentives to distort assortments may impact welfare. On the one hand, such exclusions may decrease total surplus because 'superior' products (due to, for example, low cost) are not supplied in the market; I refer to this as 'distortion effects.' On the other hand, profitable outside options allow retailers to obtain both vendor transfers and wholesale-price discounts. In the counterfactual, wholesale prices for the products supplied in both the observed and counterfactual assortments increase by 2.8%; I refer to wholesale price decreases as 'price effects.' For the studied markets, the distortion effect is larger than the price effect: absent vendor allowances, vertical profits increase by, on average, 1.8%, and consumer surplus is 1.3% higher.

[3]Theory analyses typically focus on setups with perfectly competitive downstream markets where such results do not emerge (e.g. Shaffer (2005), Asker and Bar-Isaac (2014)).

[4]Asker and Bar-Isaac (2014) discuss these results with respect to resale price maintenance and vendor transfers (loyalty rebates) as examples of vertical arrangements that allow an upstream incumbent to transfer rents to competing distributors.

The brick-and-mortar retail sector, analyzed in the empirical setting, present a natural context for studying the role of such vertical arrangements. Given its size and importance for consumers, it is not surprising that the use of lump-sum transfers in the retail sector has 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 these allowances.[5] Generally, the intuition behind the empirical framework matches institutional realities in settings where intermediaries may select from different suppliers. For example, the online environment is easily incorporated by recognizing that access to the first page of search results is often analogous to accessing the retailer's shelf space. Considering these effects, the European Commission fined Google for preferential positioning of its own product services. The European Commission also started a probe into Amazon's placement of own products relative to third-party sellers (Schechner and Pop (2018)).

This paper presents a rigorous framework documenting that vertical practices may impact product availability and welfare. First, I present a blueprint for informing vertical contracts using the rich information provided by the identities of both supplied and non-offered products. The approach allows that retailers' control over product selections increases their leverage in contracting. Next, the counterfactual discusses novel insights that vendor allowances may have not only (negative) product distortion effects but also (potentially positive) pricing effects. The combination of these effects has not been previous documented as the literature on vertical contracts has either kept product selections fixed or imposed undifferentiated firms downstream (or upstream).

The rest of the paper proceeds as follows. Section 2 describes the related literature. I outline the model in Section 3. Section 4 describes the data and Section 5 discusses details of the empirical strategy. Section 6 reports estimation results. 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 dif-

[5]In 2005, the California Senate Committee on Business and Professions held a hearing on vendor fees in the grocery industry. In 2011, the Massachusetts Senate reviewed a petition for legislation to ban certain slotting allowances.

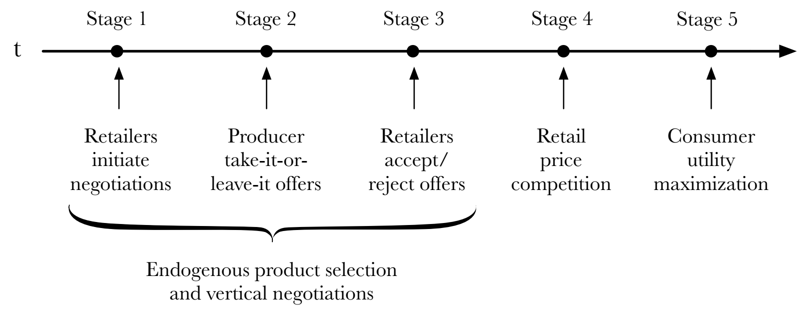
The FTC abstains from providing clear guidelines on the use of slotting fees, citing conflicting theoretical predictions and scarce empirical evidence as a rationale (Sudhir and Rao (2006)).Also see Federal Trade Commission (2001), Federal Trade Commission (2003).

ferentiated product markets. Misra (2008) investigates assortment decisions across grocery stores within a chain. Draganska et al. (2009) 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 use intermediaries; hence, vertical contracts may impact 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. These papers typically treat product availability as exogenous to the model, as in Sudhir (2001), Villas-Boas (2007), Bonnet and Dubois (2010). Bonnet and Dubois (2010) present a framework to identify unobserved two-part tariffs (with or without resale price maintenance), and find that, in the French market for bottled water, manufacturers use two-part tariffs with resale price maintenance. Bonnet and Dubois (2015), developed simultaneously with this paper, extend the model to endogenize retailers' reservation profits: a retailer may refuse a contract and exclude that producer (without replacement). Once these exclusion threats are introduced, the best-fitting supply model is two-part tariffs with exclusion threats, without resale price maintenance. Similarly to my results, the authors find fixed-fee payments from producers to one of the retailers in the market. My approach recognizes that a downstream player may threaten to, not only drop a product, but also substitute that product with a competitor's option. This extension increases the value of such replacement threats in contract negotiations and rationalizes the wide use of vendor transfers from producers to retailers. In terms of estimation, I exploit detailed information contained in both observed and non-offered products to help inform vertical contracts. The counterfactual focuses on understanding how both market prices and product availability may be influenced by the type of contract.

This paper also contributes to the sparser literature that integrates endogenous product selection with vertical relations. Ho and Lee (2017) analyze how insurers' outside options may create incentives to strategically limit their hospital networks. 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.

Figure 1: Timeline of the Game



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.

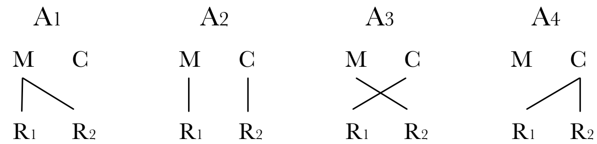
3 Model

This paper analyzes vertical contracts when product availability is endogenous. A stylized version of the model is presented to develop the economic intuition behind the relationship between product selections, retailers' replacement threats, and vertical contracts. Then, I proceed with the general conditions prescribed by the model.

I consider a complete information static setup, taking the identities and characteristics of products, firms, and markets as given. To match notation in the empirical setting, I discuss the model in the context of the retail sector. Figure 1 presents the timeline of the game. First, retailers announce the set of products they would like to supply and initiate negotiations over these products. 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.

Theory motivation: The first example closely follows Shaffer (2005), who analyzes a market with two retailers who may each supply one product. Retailers may choose from two differentiated products: a product from a dominant producer M, and one from a competitive fringe C. The vertical contract consists of a wholesale price (w) and a vendor-allowance

Figure 2: Possible Assortments and Payoffs



payment from the producer (VA). The marginal cost to produce product M is mc_M; product C may be procured at wholesale price of $w_C = mc_C$ (and a zero vendor allowance).[6] The game proceeds following the stages described in figure 1. Retailers may initiate negotiations with producer M, or supply product C.[7,8] Figure 2 shows the potential market assortments.

As in Shaffer (2005), consider the case of homogeneous retailers. This assumption simplifies the exposition because it implies that retailers earn zero variable profits if they supply the same product. I show that retailers may earn positive profits, through vendor transfers, if they have profitable replacement threats. The second example relaxes this assumption in a numerical exercise.

Demand for each retailer i depends on the market assortment A_k and it is described as $q_i(A_k, p)$, with $p = (p_1, p_2)$ tracking retail prices.[9] Firm payoffs and contracts depend on product selections as follows:

A_4: retailers are undifferentiated; thus, if both retailers supply product C, equilibrium prices are $p_1^*(A_4, w_C, w_C) = p_2^*(A_4, w_C, w_C) = w_C$ and vertical profits are zero.

A_3: (or A_2; without loss of generality, I discuss A_3) retailers' profits are
$\Pi_1(A_3) = (p_1 - w_C)q_1(A_3, p)$ and $\Pi_2(A_3) = (p_2 - w_2)q_2(A_3, p) + \text{VA}_2$;
M's profits are $\Pi_M(A_3) = (w_2 - mc_M)q_2(A_3, p) - \text{VA}_2$.
Contract offers are constrained by the value of retailer 2's outside option: which is to *reject M's offer and supply product C at* w_C. The value of the outside option is zero, because if retailer 2 deviates to A_4, then vertical profits are competed away. Vendor transfers will not be used. Producer M's optimality condition simplifies to
$w_2^* = \arg\max_{w_2}(w_2 - mc_M)q_2(A_3, p(A_3, mc_C, w_2))$.
Let $\Pi_M^*(A_3)$ equal M's profits at optimal contract offer $(w_2^*(A_3, mc_C, mc_M), 0)$.

[6]Without loss of generality, the example imposes that retailers' marginal costs equal wholesale costs.

[7]In the stylized example, the first stage of the game is redundant because the competitive fringe offers product C at $w_C = mc_C$. The first stage is important for the generalized version where retailers may supply a subset of products produced by multi-product manufacturers. It imposes that retailers' cost to supply the replacement threat is not strategic. Relaxing this assumption is left for future research, because it raises unsolved theory concerns about the existence and characterization of equilibria.

[8]If only one of the retailers has access to an outside option, then the two retailers will receive different contract offers. Thus, price discrimination may be driven by differences in retailers' outside options. I analyze the effects of these price discriminatory incentives in Hristakeva (2018).

[9]For all positive values, let $q_i(A_k)$ be differentiable, downward sloping in own price, and products M and C be substitutes.

A_1: as in assortment A_4, downstream competition implies that retail prices are $p_1^*(A_4, w) = p_2^*(A_4, w) = w$. Thus, retailers' profits reduce to $\Pi_i(A_1) = \text{VA}_i$. Now, retailers may capture positive profits due to positive outside options. Consider retailer 1's outside option: *reject M's offer and supply product C at w_C* (described by A_3). Given contract offers (w, VA), retailer 1's profit under such a deviation is

$\Pi_1^{dev}(A_3) = (p_1^*(A_3, mc_C, w_2) - mc_C)q_1(A_3, p^*(A_3, mc_C, w_2))$.

A necessary and sufficient condition for both retailers to accept M's contract offer is that $\Pi_1(A_1) = \text{VA}_1 \geq \Pi_1^{dev}(A_3)$ and $\Pi_2(A_1) = \text{VA}_2 \geq \Pi_2^{dev}(A_2)$.

Optimal contract offers place retailers at their participation constraints; substituting these constraints into M's profits gives

$$\begin{aligned}\Pi_M(A_1) &= \sum_{i=1,2}(w_i - mc_M)q_i(A_1) - \sum_{i=1,2}\text{VA}_i \\ &= \sum_{i=1,2}(w_i - mc_M)q_i(A_1) - ((p_1(A_3) - mc_C)q_1(A_3) + (p_2(A_2) - mc_C)q_2(A_2)).\end{aligned}$$

Note that optimal wholesale-price offers, $w^*(A_1, mc_C, mc_M)$, depend on the cost to supply the competitive fringe even if that product is not offered in the market. Furthermore, producer's offers take into account how participation constraints change with w (for example $\frac{\partial \Pi_1^{dev}(A_3)}{\partial w_2} \neq 0$).

Lump-sum transfers equal $(\text{VA}_1^*, \text{VA}_2^*) = (\Pi_1^{dev}(A_3, mc_C, w^*(A_1)), \Pi_2^{dev}(A_2, mc_C, w^*(A_1)))$.

Even though two homogeneous retailers supply the same product, their profits are positive as long as their outside options are positive. The producer will transfer surplus to retailers through vendor allowances because any decreases in wholesale prices are passed to consumers.

Let $\Pi_M^*(A_1)$ capture the value of M's profits at $(w^*(A_1, mc_C, mc_M), \text{VA}^*(A_1, mc_C, mc_M))$.

To characterize the product selection in the market, one compares producer's profits under each assortment: $\Pi_M^*(A_4) = 0$, $\Pi_M^*(A_3)$, and $\Pi_M^*(A_1)$. Both products (M and C) will be supplied if $\Pi_M^*(A_3) > \Pi_M^*(A_1)$ (there are two equilibria governed by the assortments A_2 and A_3). If $\Pi_M^*(A_3) \leq \Pi_M^*(A_1)$, only product M will be offered and retailers will capture vendor transfers from producers.

This example highlights three important features of the model. First, credible replacement threats allow downstream firms to capture a larger fraction of the vertical surplus. Above, this occurs if the equilibrium assortment is A_1 and $\Pi_1^{dev}(A_3) > 0$ ($\Pi_2^{dev}(A_2) > 0$).

Second, upstream firms may choose to coordinate retailers' assortment and pricing choices using both wholesale-price decreases and vendor transfers. When retailers compete, the effectiveness of wholesale-price decreases are mitigated by downstream competition; whereas, lump-sum payments directly increase retailers' profitability. Vendor allowances serve as a tool to support higher retail prices in the spirit of resale price maintenance. Therefore, vendor transfers may be optimal when competing retailers have valuable outside options. These transfers will not be used if the downstream sector is a monopoly.

Third, lump-sum transfers may facilitate a dominant producer to exclude a competitor and mitigate competition. In the setup above, if firms are restricted to contract only on linear wholesale prices, then the producer will not have the tools to share rents with retailers. This result is also highlighted by Asker and Bar-Isaac (2014). One may assume that, if shelf space is allocated according to willingness to pay, then the dominant producer is able to exclude the competitive fringe only when its product is superior (for example due to lower marginal cost). This intuition does not take into account that the incentives to match retailers' participation constraints depend on the degree of substitution with competitors' products. Shaffer (2005) shows that, due to such competitive considerations, there are model parameters for which exclusion is inefficient.

Differentiated retailers: When retailers are differentiated, a producer will use both wholesale prices and lump-sum payments to meet retailers' replacement threats. If the contract is restricted to include only wholesale prices, one may expect that wholesale prices decrease; and this intuition holds if product selections remain unchanged. However, if product selections change in response to the new contract structure, then wholesale prices may increase. This occurs because firms' outside options typically decrease once entry is accommodated. I use a numerical example to illustrate the mechanism. Let demand for retailer i be $q_i = (a - ba) - p_i + bp_{-i}$ if both retailers supply the same product (either A_1 or A_4); and $q_i = (a - b_2a) - p_i + b_2p_{-i}$ if they supply different products (either A_2 or A_3), where $b > b_2$.[10] Set $a = 1$, $b = 0.7$, $b_2 = 0.65$, and $mc_M = 0.2$.

As above, producer M internalizes downstream competition when making contract offers, which may render vendor transfers optimal. With differentiated retailers, wholesale prices may also decrease to match participation constraints. For example, if $mc_C = w_C$=0.325, then both retailers supply product M (described by A_1); and the symmetric producer's offer is $(w_i^*, \mathrm{VA}_i^*) = (0.305, 0.004)$. For comparison, unconstrained offers would be $(w_i, \mathrm{VA}_i) = (0.480, 0)$. Thus, retailers' outside options decrease double marginalization. The supplier prefers to use both vendor transfers and wholesale-price concessions, because further decreases in wholesale prices reduce total industry profit through intra-brand competition.

If firms may only contract on wholesale prices, then, for the parameter values above, it is no longer optimal for producer M to satisfy the participation constraints; and product

[10]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 re-scaled by $1 - b^2$.

C enters the market (suppose retailer 1 supplies C (A_3)). Importantly, once product C is supplied by retailer 1, the value of retailer 2's outside option decreases. This alleviates the constraints on producer M's offer to retailer 2. The new contracts in the market are $w_1 = mc_C = 0.325$ and $w_2^* = 0.369$, which are higher than the wholesale prices under the vendor-allowance contract ($w_1^* = w_2^* = 0.305$). The higher wholesale costs lead to higher retail prices and a decrease in consumer (and total) surplus. These previously undocumented effects are present in the counterfactual simulations discussed in Section 7.

Relationship to theory literature: My setup relates to the theory works that assume complete information in the market. Under that assumption, both efficiency and anti-competitive rationales assume that vendor transfers arise in response to retailers' opportunity cost to supply a product (Sullivan (1997), Marx and Shaffer (2010), Shaffer (1991)) or in response to direct cost to supply an additional product (Kuksov and Pazgal (2007)).[11,12] Asker and Bar-Isaac (2014) exploit similar incentives to understand firms' assortment and contracting choices, using a dynamic game. My setup is closest to Shaffer (2005) and the theory motivation follows closely the model presented in that paper. Importantly, once we allow for differentiated retailers, the use of vendor-allowance contracts may improve consumer welfare if equilibrium wholesale prices decrease, making welfare implications an empirical question.

These theory papers typically assume that producers make take-it-or-leave-it offers. The literature uses this setup to align with oft-cited explanations by retailers that lump-sum payments are only used to compensate them for the opportunity cost of shelf space.[13] The assumption is also common in the other closely related theory literature studying the role of intermediaries' outside options. For example, Katz (1987), O'Brien (2014), and Inderst and Valletti (2009) conclude that modeling negotiations as producers' take-it-or-leave-it offers is not as restrictive if the setup accounts for retailers' replacement threats.[14]

[11] Shaffer (1991) and Piccolo and Miklós-Thal (2012) show that vendor allowances increase market prices. 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 to efficiently allocate scarce shelf space (Sullivan (1997)) or to increase product variety in the market (Kuksov and Pazgal (2007)).

[12] Additional explanations for the use of vendor allowances, which do not fit in my framework, include the use of vendor payments to signal product quality (Lariviere and Padmanabhan (1997)), to ensure that the assortment which maximizes vertical profits is supplied (Aydin and Hausman (2009)), and to coordinate non-contractible manufacturer sales effort (Foros et al. (2009)).

[13] One exception is Marx and Shaffer (2007) where retailers make offers. The model uses 3-part tariffs where vendor transfers are paid at the time contracts are signed, even if the retailer does not supply the product. The authors use this setup to study retailers' ability to exclude competitors downstream.

[14] In a bargaining framework, O'Brien (2014) shows that when retailers have valuable outside options, then the outcome from a bilateral Nash-Bargaining problem is solely determined by the binding constraints. 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. Appendix

General conditions: The stylized example illustrates the role of the vertical contract for product availability in a simple case with two upstream products and single-product retailers. The empirical analysis generalizes the setup where firms manufacture and supply multiple products. 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 and time period ($\{mt\}$) consumers observe the full set of products offered (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 a product from any of the observed retailers. 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.

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

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

D describes the role of vendor transfers in other models of negotiations: (1) a simultaneous Nash-Bargaining solution, and (2) retailers' take-it-or-leave-it offers.

where the summation is over the products supplied by r (A_r) and M stands for market size.[15] Note that retailer r's sales of product j ($Ms_{jr}(A,p)$) 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: The model considers industries where intermediaries control the product assortments they offer to consumers. The determination of product offerings and vertical contracts is modeled sequentially: (i) retailers solicit offers for 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.

Let A be the set of products with initiated negotiations, and $(w_{jr}, \mathrm{VA}_{jr})$ 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

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

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. For example, vendor distribution support, which decreases fixed costs borne by a retailer, will be captured by the vendor-allowance transfer. Notice that vendor allowances affect retailers' total profits; however, given assortments, they do not affect variable profits.

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

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

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' par-

[15] Market and time subscripts are again omitted for readability.

ticipation constraints. These participation constraints reflect retailers' outside options of rejecting a product offer and supplying an alternative assortment. 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'. The credible threat of rejecting an offer and supplying alternative products allows retailers to extract rents from producers. As a result, producers' contract offers are constrained by these outside options

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

The setup allows that each producer's contracts take into account its full set of products supplied by all retailers in the market.

4 Industry and Data

Public grocery chains report vendor allowances, which correspond to 9.5% of retailer's revenues, on average.[16] The extensive use of vendor allowances in the grocery sector makes it a good context to analyze how the use of these payments affect product selection, contracts, and welfare. In addition, brick-and-mortar stores are faced with constrained shelf space, which highlights the importance of assortment decisions for firms' profits and consumer surplus. For the analyzed yogurt category, a retailer offers, on average, 29 product lines selected from 85 branded options. The yogurt category offers at least two additional advantages for the empirical analysis. Yogurts' perishability alleviates consumer-stockpiling considerations, which allows me to employ static demand techniques for the estimation of consumer demand. On the supply side, two producers, Groupe Danone and General Mills, control the majority of market sales. These producers capture, on average, 70% of yogurt sales during the sample period. At the same time, the industry is populated with a number of small and regional producers who compete to place their products on grocers' shelves.

[16] I collected 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 retailers (in a market)	4.2	4	1.7	1	11
retailer market sales ($ millions)	187	155	161	5	1,147

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

The model is applied to the academic Information Resources Inc. (IRI) dataset, which includes store-level data on grocery chains' quarterly sales and units sold in 44 geographical markets in the U.S. for the 2001-2010 sample period, for a total of 1,760 market-quarter pairs.[17] Table 1 summarizes information about the markets and retailers covered in the data. The observed markets vary in size, with an average population of 3.9 million. On average, I observe 4.2 retailers in a market, and each retailer appears in the data in an average of 3 markets. Most of the retailers 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*). Product lines are defined by producers and the aggregation to a product line aims to approximate the level of contracting in the grocery sector. For example, Groupe Danone produces, on average 20 different product lines; some examples include *Dannon Activia Fiber*, *Dannon Danimals*, *Dannon La Creme*, *Stonyfield Farm Yobaby*, etc. Throughout the paper I refer to 'product line' and 'product' interchangeably.

Product lines are described with five 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 $0.940, while non-natural products are, on average, priced at $0.792. Similarly, children's and soy products are more expensive than non-children's and non-soy options, respectively. Columns (3) and (4) describe inside-good market shares; and columns (5) and (6) report the fraction of products supplied in the market with each product characteristic. For example, average market share for natural products is 11.8%, and these products represent 22.9% of all products supplied in the market. Interestingly, only 0.5% of retailers' revenues are attributed to soy products, while these products capture, on average, 3.6% of shelf space.

Some products are supplied by all retailers within a census region. Draganska et al. (2009)

[17] Geographical markets are defined by the IRI. 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

	price		market share		fraction of products	
	mean	st. dev	mean	st. dev	mean	st. dev
by characteristic						
natural	0.940	0.419	0.118	0.065	0.229	0.056
non-natural	0.792	0.264	0.882	0.065	0.771	0.056
child	0.946	0.275	0.114	0.031	0.210	0.031
non-child	0.795	0.315	0.886	0.031	0.790	0.031
light	0.799	0.270	0.336	0.065	0.292	0.046
non-light	0.838	0.329	0.664	0.065	0.708	0.046
creamy	0.846	0.248	0.434	0.098	0.382	0.051
non-creamy	0.815	0.346	0.566	0.098	0.618	0.051
soy	1.085	0.268	0.005	0.003	0.036	0.018
non-soy	0.817	0.310	0.995	0.003	0.964	0.018
by 'staple'						
staple	0.814	0.226	0.556	0.114	0.372	0.061
non-staple	0.833	0.353	0.444	0.114	0.628	0.061

Product characteristics are neither comprehensive nor exclusive. Inside-good market shares reflect fraction of sales attributed to a product with a given characteristic. Fraction of products tracks the number of products in the market with that characteristic out of all products supplied in the market. Prices are converted to constant 2010 dollars using the Consumer Price Index by census region.

refer to these as staple products. The last panel in table 2 summaries prices and inside-good market shares separately for such staple and non-staple product. I define a product to be 'staple' if it is supplied by all retailers in a census region for the respective quarter. Based on this definition, on average, 37.2% of the product lines supplied by a retailer are defined as staple. These products account for 55.6% of retailer revenues.

The sample covers 23 national and regional producers; private labels (non-branded product lines) are offered by 44 of the 80 retailers. Table 3 summarizes prices, 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. Private label products account for 14.6% of market sales. The sample includes 6 branded producers that distribute products in all 44 markets. Only Groupe Danone and General Mills have full coverage across retailers. Some producers have limited market coverage: 8 firms 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 production plant is located in Tillamook, OR. Additional information on producers' distribution is available in the data appendix.

Table 3: Producer market shares and distribution

	price		market share		distribution	
	mean	st. dev	mean	st. dev	#mkts	#ret
Agro Farma	1.442	0.279	0.033	0.044	42	53
Anderson-Erickson	0.591	0.045	0.124	0.127	4	4
Auburn Dairy	0.581	0.104	0.012	0.006	2	3
Belfonte	0.567	0.029	0.127	0.013	1	3
Breyers	0.741	0.135	0.058	0.065	44	77
Cabot Creamery	0.658	0.171	0.003	0.003	16	16
Cascade Fresh	0.814	0.220	0.004	0.009	25	25
Dean Foods	1.032	0.241	0.017	0.024	44	70
Fage USA Corp.	2.076	0.373	0.014	0.015	44	61
General Mills	0.831	0.135	0.394	0.097	44	80
Groupe Danone	0.856	0.136	0.314	0.097	44	80
Johanna Foods	0.585	0.174	0.018	0.021	20	29
Kalona Organics	1.236	0.188	0.003	0.003	4	4
LALA Foods	0.766	0.138	0.032	0.045	44	73
Northwest Dairy	0.528	0.085	0.011	0.010	4	8
Old Home Foods	0.574	0.081	0.075	0.065	2	4
Prairie Farms	0.529	0.060	0.022	0.027	13	17
Purist Foods	0.988	0.038	0.004	0.002	1	3
Springfield Creamery	0.694	0.166	0.008	0.016	24	29
Sun Valley Dairy	1.472	0.336	0.002	0.002	28	14
Tillamook County Creamery	0.636	0.037	0.076	0.020	3	8
Wallaby Yogurt Company	1.140	0.219	0.001	0.001	30	29
Whole Soy	1.252	0.240	0.002	0.002	41	40
Private Label	0.515	0.077	0.146	0.070	44	44

markets column shows the number of markets in which the producer is available in any year; analogously for # retailers. Market shares correspond to inside-good market shares.

Next, I describe the how product assortments vary within and across markets. I use a cosine similarity measure (as in Hwang et al. (2010)), which captures the fraction of overlapping products between pairs of retailers (and pairs of market). Let retailer i's assortment be described by a $N \times 1$ vector A_i; N equals the number of all product lines; $A_i(n)$ takes a value of 1 when product n 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 similarity$_{i,j}$ =1, and if there is no overlap between the assortments, then similarity$_{i,j} = 0$.

The first panel of table 4 summarizes similarities across markets. For these summary

Table 4: 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
retailer assortments					
across retailers (same market)	0.77	0.09	0.70	0.77	0.79
across markets (same retailer)	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. The comparison of market assortments (row 1), asks whether the same set of products is available in pairs of markets within the same census region. In row 2 I construct the statistic for all possible market pairs (both within and across census regions). The comparisons are done separately for each time period.

statistics, the i and j indices track markets instead of retailers; and $A_i(n) = 1$ if I observe that product n is supplied in market i by any retailer. There is relatively small variation in product availability across markets within the same census region (with mean similarity of 0.90). When I construct the measure for all possible pairs of markets, the market similarity decreases to 0.68 (row 2). This decrease is due to the presence of local producers supplying to a few markets (such as Tillamook Creamery).

The second panel summarizes similarities across retailers within the same market, and across markets for the same retailer. The patterns reveal that retailers within the same market carry different assortments (0.77). In comparison, tracking the same retailer across markets implies higher average similarity (0.92). These results suggest that retailers within the same market select different product assortments, therefore, variation in product assortments may not be fully attributed to differences in consumer preferences across markets.

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.

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. This assumption is reasonable in most empirical applications because final consumer prices may be adjusted more flexibly than product assortments (choice of production inputs or networks of suppliers).[18]

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

[18] A violation of this assumption will be the use of resale price maintenance (RPM), where assortment and prices are decided at the same time. RPM serves a similar role as vendor transfers to coordinate the assortment and pricing choices of competing retailers. In the model exposition and empirical application, I focus on presenting a blueprint to identify a new part of the vertical contract: lump-sum vendor transfers. If the application suggests that producers rely on resale price maintenance instead, then the model may be adjusted accordingly using the insights from Rey and Vergé (2004) and Bonnet and Dubois (2015).

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 4 reveal that there is little variation in product availability across markets.[19] 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 typically 'sticky.'[20]

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 instruments vary at the retailer-producer-quarter level. The intuition is that prices depend on costs of operation, but these costs are not correlated with demand-side unobservables.[21]

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. Demand parameters are estimated using the MPEC algorithm 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: An advantage of the estimation

[19] Average market-level assortment similarity is 0.90 for markets within the same census region. 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.

[20] I evaluate assortment changes using weekly-level data, and I find that a retailer changes assortments, on average, once a quarter.

[21] 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.

approach is that it does not require data on vertical contracts or firm costs, which are typically unobserved. Instead, researchers may infer vendor allowances using commonly observed product selections. The estimated payments reflect retailers' opportunity costs. The strategy assumes that observed assortments yield weakly higher expected profits to each retailer than switching each of its products with any feasible alternative.[22] If retailer r may switch 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

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

For the observed market assortment (A), wholesale prices and vendor allowances are $w = [w_{-jr}, w_{jr}]$ and $\text{VA} = [\text{VA}_{-jr}, \text{VA}_{jr}]$, respectively. In the deviation 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 $\text{VA}'_{-jlr} = [\text{VA}_{-jr}, \text{VA}_l]$. Constructing the contracts for replacement products presents a challenge for all analyses that allow for replacement threats and should be based on the specific industry studied. 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 ($\text{VA}_l = 0$). I set w_l to the highest inferred total marginal cost to supply product l by any retailer in that market: $w_l = \max_{r'}\{mc^r_{lr'} + w_{lr'}\}$.[23,24]

Substituting retailer profits from equation 4 in equation 8 yields the following condition for all products j offered by r and all potential replacement products l

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

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 $\text{VA}_l = 0$, these conditions simply to

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

In the retail sector, lump-sum payments flow from producers to retailers, providing a

[22] 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.

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

[24] Additionally, Appendix B presents a robustness check, where I construct retailers' replacement threats using wholesale costs reported in Promodata Price Trak. Promodata Price Trak collects wholesale-price and promotion information from one major wholesaler in each market for the 2005-2010 period.

natural lower bound on vendor allowances: $\mathrm{VA}_{jr} \geq 0$.[25] 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. 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,

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

These deviations can be used by themselves to back-out a vendor allowance for each product-retailer pair. To infer producers' markups, I combine these deviations with producers' optimality conditions. Section 3 described producers' profits as

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

and substituting equation 10 into 5, implies that

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

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^{bind}_p track the constraints that bind for producer p. Then producer p optimality conditions are given by[26]

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

[25] Changes in vendor-allowance estimates from this and other implementation assumptions are discussed in Appendix B.

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

Note that product $\{kr\}$ is not supplied in A'_{-kr}, by definition. The expression above highlights 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 products 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 within the same census region for the analyzed quarter. These restrictions impose 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. I also avoid deviations in which local producers are counterfactually supplied in new census regions: e.g. adding Tillamook Creamery to Boston even though the producer is observed to supply retailers only in the West census region. The set of potential products includes, on average, 14 replacement options per retailer.

The deviations are constructed by ***dropping*** *each product from the observed assortment with* ***replacement***. These deviations keep fixed the shelf space allocated for the product category, both in terms of the number of products and the number of flavors offered. For example, consider the Boston market for the 2010q1 period; suppose that retailer 1 ($r1$) supplies *Yoplait Trix* (t), and that there are three products that $r1$ may offer instead: *Breyers Light* (b), *Stonyfield Farm Yobaby* (s), and *Weight Watchers* (w).

First, I construct retailer 1's expected variable profits for the observed assortment, $E_\xi[\pi_r(A)] = 20,500$. Then I construct the unilateral deviations: replace *Yoplait Trix* with a product from its set of potential offerings. Expected variable profits 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* in retailer 1 is *Breyers Light* with profits of $20,600$. 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 from demand estimation. 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.

Discussion of implementation and estimation assumptions: The empirical implementation makes assumptions to accommodate the specific setup and data availability.

The estimation strategy is broadly implementable and below I discuss the role of estimation assumptions and how those may be adapted in alternative applications.

It is worth highlighting that no feature of the model and estimation strategy imply that the researcher will estimate positive vendor allowances. The framework allows that credible threats to substitute a product enable retailers to extract surplus from suppliers, imposing downward pressure on wholesale prices and increasing vendor transfers. Intermediaries may exploit these threats as long as they have a profitable deviation. That is, if there are no replacement options that generate sufficient profits for the retailer, then these replacement threats will not affect the contracting process. In such cases, the model reverts back to the standard producers' take-it-or-leave-it offers. Therefore, a useful feature of the approach is that it allows us to empirically test whether such transfers are employed by firms.

I model contracts as two-part tariffs with linear wholesale prices and lump-sum payments from producers to retailers. In practice, contracts may include other incentives such as quantity discounts and producer-sponsored promotions. These are paid per-unit sold, so the estimation captures such concessions in retailers' marginal costs.

Quantity discounts may have an additional effect similar to the exclusionary incentives of all-unit discounts discussed by Conlon and Mortimer (2017). Such payments may effectively tie-in the producer's offerings and encourage retailers to carry "enough" of its products (or exclude a close substitute) to take advantage of these discounts. Unfortunately, most researchers do not have access to the detailed contract information available to Conlon and Mortimer (2017). My approach aims to guide empirical studies when vertical contracts are unobserved. In such applications, the implicit assumption is that the incentive requirements, for example for all-unit discounts, do not strictly bind. Concern about such an assumption may be analyzed by looking at the decrease in quantity sold from retailers' profitable deviations.

Consider the empirical application, where interviews with producers suggested that manufacturers offer a quantity discount on a per-truck basis. That is, retailers receive a discount if they purchase inventory to fill a truck. To take advantage of these discounts a retailer may choose to supply more products from a producer. One may evaluate this concern by looking into the types of products with profitable deviations. I find large profitable deviations primarily for low-selling products, which are unlikely to affect the choice to order a truck of inventory. The assumption is that retailers have some flexibility about the timing of their order, so that product selections are not driven by this type of quantity discounts.

Generally, these types of incentives approximate bundling. The specific application requires a no-bundling assumption; however, the framework is more general. An intuitive example is if we analyze a market with single-product producers or if all producers impose full-line forcing (require that all of their products are offered by a retailer). In these case, the framework may allow us to capture information about vertical contracts if data suggest variation in intermediaries' choice of suppliers. If so, then the replacement threats may be intuitively characterized as *drop producer A and replace it with producer B*. In general, if the nature of the market suggests bundling, then the deviations should be constructed at the producer level. An empirical complication in such cases is the choice of the outside option. In some cases, that will be intuitive: substitute the full line of one supplier with another. In other applications, the researcher may need to be more careful in designing the set of substitutes.

Next, I discuss the deviations used in the empirical analysis and how these may be adjusted if additional data were available. By design, deviations keep fixed the number of products offered. The set of outside options is thus restricted to identify vendor transfers separately from retailers' fixed costs to supply an additional product. When information about fixed costs is available or if the application implies no fixed costs, then deviations that change the number of products supplied may be added to better inform firm strategies. In such cases the researcher may also study how limiting product selections can increase negotiation leverage discussed by Marx and Shaffer (2010).

The empirical application exploits one-product deviations in which a retailer replaces a supplied product with a competitor's option. If the researcher observes a planogram (information about the location of product placement on the shelf and the number of product facings), then that information may be incorporated in demand and contract analyses. One may construct retailers' deviations that 'move' products across shelves or increase the number of product facings, in addition to product replacements. Such an analysis would likely be especially useful in online environments where researchers typically observe the order in which products are presented to consumers.

Another deviation may be characterized by adding a product from a separate category (e.g. cream cheese). These replacement threats imply that the outside-option values are the sum of an exogenous component (profits from the second category does not depend on the set of yogurts offered) and an endogenous component (additional profits by unchanged yogurts, as in drop without replacement). Such a deviation is primarily applicable to retail-sector studies. The presented framework is more general as it allows researchers to study strategic implications for input-sourcing choices (substitute one microprocessor supplier with another) or network formation (substitute between hospitals). It is worth highlighting that employing replacement threats within the same category also increases producers' willingness to pay for shelf space. This occurs because the counterfactually added product may be a close substitute to the remaining products offered by that producer.

Now, consider the level of contracting. I construct unilateral deviations at the market level, while one may be concerned that firms negotiate at the census-region or national level. If results imply profitable deviations for a product across all markets, then market-level deviations will derive the same allowance estimates as a setup where product deviations are done at the region level. However, if a product is very successful in Los Angeles and not popular in San Diego, then vendor transfers will be overestimated. This intuition suggests that the more granular the deviation is (at the store level versus all stores in a market versus all stores in a region), the more likely the researcher is to find profitable deviations. The results section considers estimates' sensitivity to this modeling choice.

The estimation assumes that a retailer may exercise its outside option at no additional cost. That is, during contract negotiations, retailers do not incur additional costs to make assortment changes. If such costs are present, then the estimates will capture vendor transfers plus switching costs.

By construction, allowances capture economic transfers from producers to retailers. These transfers reflect both cash payments and incentives in the form of cost savings for the retailers, such as distribution support. Thus, the cost 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 yogurts 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.

6 Results

Demand results are summarized in table 5. The reported estimates of product characteristics are constructed as projections on estimates of product-year intercepts. The estimation uses cost shifters to instrument for price: I collect the geographic distances for each manufacturer's plant and interact these distances with gas prices and retailer fixed effects. The first-stage partial F-stat on excluded instruments is 42.39. The role of the instruments is illustrated by comparing an OLS and an IV logit regressions. Results confirm that the price coefficient moves in the expected direction when instruments are used: from -2.038 to -4.253. With this change, the number of products on the inelastic part of demand falls to less than 1% with IV compared to 7.597% in the OLS setup.

The preferred demand parametrization allows for heterogeneity in consumers' price sensitivity and preferences for product characteristics. The individual-specific price parameter is drawn from market-level empirical income distributions obtained from census data; the

Table 5: Demand Estimates

	logit models OLS	IV	full model mean value	st. deviation
constant	-10.853***	-9.430***	-8.486***	0.249
	(0.250)	(0.234)	(0.291)	(0.567)
price	-2.038***	-4.253***	-6.947***	1.960***
	(0.017)	(0.110)	(0.425)	(0.227)
flavors	1.172***	1.136***	0.773***	0.662***
	(0.004)	(0.004)	(0.084)	(0.074)
child	0.214***	0.207***	8.757***	0.119
	(0.019)	(0.022)	(0.182)	(1.227)
natural	0.018	0.057**	-0.012	1.897*
	(0.024)	(0.026)	(0.041)	(1.043)
soy	-0.861***	-0.845***	-2.047**	0.682
	(0.011)	(0.012)	(0.849)	(4.038)
light	-0.131***	-0.103***	-0.197***	
	(0.020)	(0.021)	(0.021)	
creamy	-0.046***	-0.028***	-0.017***	
	(0.004)	(0.004)	(0.004)	
median own-price elasticity	-1.683	-3.512	-4.048	
	(0.014)	(0.092)	(0.028)	
% own-price elasticity > -1	7.597	0.001	0.170	
controls				
year fe	yes	yes	yes	
producer fe	yes	yes	yes	
retailer×market fe	yes	yes	yes	
retailer×characteristics	yes	yes	yes	
quarter fe	yes	yes	yes	
first stage				
F-stat		42.39	42.39	
p-value		0.00	0.00	

Product characteristics are projected on product-year dummies. The set of product characteristics also includes year and producer FE (not reported above). Additional variables included in the demand estimation are retailer-market intercepts, characteristics interacted with retailer fixed effects, and quarter dummies. Sample size is 230,679. Standard errors are reported in parentheses.

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. The estimates align with expectations: demand is downward sloping and consumer price sensitivity decreases with income. Consumers prefer children's products, while they value less soy, light, and creamy products. Estimates imply a median consumer own-price elasticity of -4.048. 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 average retail markup of 21.6 cents (st. error of 0.007) and a mean variable profit margin of 28.7% (0.009). To analyze how well the model matches reported margins in the grocery industry, I collect information on variable profit margins disclosed by public grocery retailers in their accounting statements. I find that the mean reported variable profit margin is 27% for the sample period.[27]

The inferred retailers' marginal costs are described using product and retailer characteristics in table 6. Retailers are described in terms of their regional presence (a dummy tracking if a retailer is observed in more than one market), and their number of stores in the market. Product lines are described with product characteristics and producer identity. In column (2) I add producer fixed effects, and column (3) includes market×time period controls. Wholesale prices may not be separated from total retailers' marginal costs without additional assumptions, so the descriptions use estimates of total retailers' marginal costs ($mc^{r,total} = mc^r + w$). Results suggest heterogeneity in the costs to supply products with different characteristics. For example, supplying products with each characteristic (natural, child, soy, light, and creamy) is costlier to retailers than their counterparts. The excluded producer is the *Private Label*, and these products have the lowest total marginal cost.[28]

The average backed-out vendor transfer is $465 (st. error 60.88) per market-quarter-retailer-product line. For comparison, the average retailers' revenue per product line is $8,484. Similarly to above, table 7 describes inferred vendor transfers in terms of retailer and product characteristics. Column (2) controls for producers (the excluded firm is *Agro Farma*); column (3) includes market×time period fixed effects. To make these values comparable across products and retailers, the dependent variable is scaled as vendor allowances per flavor and store. For example, the average retailer supplies 5 flavors per product line in 8 stores in the market; using the average vendor transfers of $465 implies a scaled per

[27] I also compare inferred retailers' marginal costs to the wholesale costs reported in Promodata Price Trak. 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. The correlation between inferred retailer marginal costs and reported Promodata wholesale costs is 0.51.

[28] Product, chain, and market×time period fixed effects explain 86.4% of the variation in retailer marginal cost estimates.

Table 6: Describing Retailers' Marginal Costs: $mc^r + w$

	(1)	(2)	(3)
constant	0.546***	0.379***	0.238***
	(0.001)	(0.001)	(0.004)
more than 1 market	-0.088***	-0.080***	-0.055***
	(0.001)	(0.001)	(0.000)
num of stores	0.002***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)
staple	-0.010***	-0.052***	-0.044***
	(0.001)	(0.001)	(0.001)
natural	0.157***	0.152***	0.151***
	(0.000)	(0.000)	(0.000)
child	0.164***	0.014***	0.013***
	(0.001)	(0.001)	(0.001)
soy	0.244***	0.144***	0.149***
	(0.002)	(0.001)	(0.001)
light	0.061***	0.045***	0.041***
	(0.001)	(0.000)	(0.000)
creamy	0.088***	0.111***	0.104***
	(0.001)	(0.000)	(0.000)
Agro Farma		0.712***	0.690***
		(0.007)	(0.006)
Anderson-Erickson		0.018***	0.038***
		(0.001)	(0.001)
Auburn Dairy		-0.018***	0.016***
		(0.004)	(0.003)
Belfonte		-0.026***	-0.014***
		(0.001)	(0.001)
Breyers		0.135***	0.120***
		(0.001)	(0.001)
Cabot Creamery		0.114***	0.179***
		(0.005)	(0.004)
Cascade Fresh		0.228***	0.251***
		(0.003)	(0.003)
Dean Foods		0.356***	0.364***
		(0.001)	(0.001)
Fage USA Corp		1.394***	1.381***
		(0.005)	(0.005)
General Mills		0.151***	0.157***
		(0.001)	(0.001)
Groupe Danone		0.276***	0.279***
		(0.001)	(0.001)
Johanna Foods		0.037***	0.066***
		(0.001)	(0.001)
Kalona Organics		0.007***	-0.006***
		(0.001)	(0.001)
LALA Foods		0.604***	0.574***
		(0.008)	(0.007)
Northwest Dairy		0.172***	0.182***
		(0.001)	(0.001)
Old Home Foods		0.008**	0.051***
		(0.003)	(0.002)
Prairie Farms		0.034***	0.097***
		(0.001)	(0.002)
Springfield Creamery		0.105***	0.134***
		(0.002)	(0.002)
Sun Valley Dairy		0.829***	0.823***
		(0.006)	(0.005)
Tillamook County		0.061***	0.104***
		(0.001)	(0.002)
Wallaby Yogurt		0.546***	0.552***
		(0.003)	(0.003)
Whole Soy		0.543***	0.546***
		(0.002)	(0.002)

Backed out retailers' marginal costs are projected on retailer and product characteristics. The excluded producer is the *Private Label*. In column (2), I add producer fixed effects. Column (3) controls for market-quarter fixed effects. Standard errors are constructed via bootstrap of 100 simulations over demand unobservables.

Table 7: Describing Vendor Allowance Estimates ($ per store-flavor)

	(1)	(2)	(3)
constant	19.376***	14.468**	-2.146
	(1.768)	(5.898)	(15.321)
retailer in > 1 market	-1.706	-1.767	2.958
	(1.923)	(1.947)	(3.412)
retailer num of stores	-0.331*	-0.373**	-0.346*
	(0.181)	(0.180)	(0.201)
staple product	-8.058***	-6.754***	-6.831***
	(0.966)	(1.292)	(1.318)
natural	3.851***	5.368***	5.364***
	(1.307)	(1.220)	(1.124)
child	6.030***	3.820***	3.494***
	(1.163)	(1.159)	(0.970)
soy	26.476***	22.121***	21.678***
	(2.107)	(2.968)	(2.298)
light	1.785***	2.164***	1.907***
	(0.553)	(0.588)	(0.402)
creamy	-1.393**	2.905***	3.475***
	(0.543)	(0.758)	(0.682)
Anderson-Erickson		-6.378	0.025
		(5.590)	(9.115)
Auburn Dairy		14.345	10.897
		(9.444)	(11.196)
Belfonte		-10.810**	-3.832
		(5.475)	(8.803)
Breyers		0.561	1.028
		(5.523)	(6.968)
Cabot Creamery		7.212	14.296
		(19.313)	(17.356)
Cascade Fresh		23.780***	23.900***
		(7.756)	(8.350)
Dean Foods		15.202**	16.380**
		(5.935)	(6.924)
Fage USA Corp		19.774***	19.495***
		(7.110)	(6.994)
General Mills		-1.687	-2.282
		(5.948)	(7.257)
Groupe Danone		3.965	4.212
		(6.028)	(7.440)
Johanna Foods		10.419*	7.596
		(5.693)	(7.553)
Kalona Organics		4.181	-1.847
		(6.410)	(7.742)
LALA Foods		-3.699	2.616
		(17.094)	(10.110)
Northwest Dairy		12.951**	12.696*
		(6.164)	(7.631)
Old Home Foods		9.590	8.636
		(5.863)	(7.833)
Prairie Farms		-9.477	-9.938
		(9.305)	(11.503)
Purist Foods		0.398	5.372
		(5.561)	(7.733)
Springfield Creamery		16.891**	17.402**
		(7.427)	(8.145)
Sun Valley Dairy		39.317***	35.614***
		(9.648)	(10.301)
Tillamook County		-9.095	-8.710
		(5.573)	(7.635)
Wallaby Yogurt		36.561***	34.068***
		(7.683)	(7.443)
Whole Soy		12.096**	13.323*
		(6.156)	(7.057)

The table summarizes vendor transfers with respect to product and retailer characteristics. The dependent variable is the vendor transfers backed out for each market-quarter-retailer-product line. These values are then scaled by the number of stores and flavors supplied for each observation. The excluded producer is *Agro Farma*. Column (3) also includes market×time period fixed effects. Standard errors are constructed via bootstrap, and reported in parentheses.

Table 8: Vendor Allowance Estimates (% of retailer revenues)

	mean	st. error
VA, market deviation	5.855***	0.220
VA, region deviation	5.181***	0.224
VA$\geq$ 0 at producer level	4.686***	0.215

The table reports average vendor transfers as a percent of retailer revenues. Standard errors reflect estimation error from demand analysis; the reported values are constructed via bootstrap of 100 simulations over demand unobservables. The first row presents the result from the main specification: deviations are constructed at the market level, and non-negativity assumption is imposed at the product line. Row (2) constructs the deviations at the census region level (instead of at the market level). In row (3), I compare result sensitivity to imposing the non-negativity assumption of the vendor transfer at the producer level.

flavor-store vendor transfer of \$11.6.

The parameters describing retailers are not statistically significant. I find that producers pay lower vendor transfers for staple products. 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. Conditional on producers' identities, I find that products with each of the defined characteristics pay higher vendor allowances. These suggest that niche products, such as soy and natural-children's yogurts, provide larger incentives than other products. Vendor estimates for soy products are, on average, \$21.678 higher than transfers for non-soy options; and natural-children's products pay \$8.858 more. Estimates suggest meaningful differences in average vendor transfers across producers.[29]

Estimated transfers translate to 5.86% (0.22) of retailers' revenues, on average, and 19.93% (0.66) of variable profits. Vendor payments are likely important for retailers' profitability as 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

[29]Product, chain, and market$\times$time period fixed effects explain 33.1% of the variation in vendor-allowance estimates. Table A5 in appendix B reports results for a regression of vendor transfers on product fixed effects.

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.

Vendor allowances are inferred from retailers' unilateral deviations at the market level, while one may be concerned that product assortment decisions, and respectively contracting, are done at the retailer-region level. The choice for market-level analysis is driven by lack of data on the way firms define regions. For example, it is not clear whether a retailer would consider Southern and Northern California as the same region. If the empirical strategy implies a profitable deviation for a product across all markets, then my estimation approach will derive the same results as a setup where product deviations are done at the region level. However, if a product is very successful in Los Angeles and not popular in San Diego, then my strategy will estimate higher transfers than the approach at the region level.

To evaluate this concern, I test how results change if deviations are constructed at the retailer-census region level. That is, the drop a product deviation implies that the product is eliminated from the chain's assortments in all markets of the same census region. The second row in table 8 shows that when deviations are constructed at the census region level, the average transfers represent 5.181% of retailer revenues.

Another concern is that a multi-product producer may exploit the profitability of staple products to incentivize retailers to supply its other products. I test the sensitivity of my results to that assumption by imposing that vendor transfers are non-negative at the producer level, rather than at the product level. In this case, the mean transfers are estimated to be 4.686% of retailer revenues. Appendix B providers further discussion on how vendor-allowance estimates change under different implementation assumptions.

The assumption that producers' make take-it-or-leave-it offers allows me to back out producers' markups. It is worth highlighting that producers' willingness to pay for shelf space is higher if retailers use replacement threats (substitute a product with a competitor's option). If deviations are constructed as drop a product without replacement, or if the replacement is from a different category, we expect that the change in producer's profit under the deviation is lower than the profit generated by the dropped product. Using replacement deviations within the same category, I often find the opposite result: for 41% of the constructed deviations the benefit to producers from supplying a product exceeds the profit attributed to the product. This number increases to 87% for products with inferred positive vendor transfers. The result occurs because the counterfactually added product steals profits from the remaining products offered by that producer.[30]

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.[31]

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.[32] 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 impose that the producer provides these lump-sum benefits to its retailers at zero cost.

Inferred producers' markups for 2006 are summarized in table 9. To highlight the role

[30] For example, consider the benefits to General Mills from supplying *Yoplait Light Thick and Creamy* in retailer 1 in Toledo, OH. If deviations are constructed as drop a product without replacement, then General Mills' marginal revenue from supplying the product is $495. If deviations allow from product replacement, then the most profitable replacement is LALA Foods' *Blue Bunny Carb Freedom*. General Mills' benefit from supplying *supplying Yoplait Light Thick and Creamy and keeping Blue Bunny Carb Freedom from retailer 1's shelf* equals $837. This example illustrates that for multi-product producers the benefits of supplying a product may exceed the marginal profits generated by that product.

[31] 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. 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. Hence, the milk category may have affected the profitability of distributing yogurt products.

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

Table 9: Producers' Markups

	producer markup	st.error	producer markup, no outside options
Anderson-Erickson	0.181	0.006	0.198
Belfonte	0.202	0.017	0.202
Breyers	0.137	0.002	0.184
Cabot Creamery	0.117	0.028	0.184
Cascade Fresh	0.169	0.004	0.191
Dean Foods	0.203	0.000	0.203
Fage USA Corp	0.196	0.001	0.248
General Mills	0.170	0.001	0.217
Groupe Danone	0.156	0.001	0.205
Johanna Foods	0.124	0.011	0.176
LALA Foods	0.133	0.002	0.188
Northwest Dairy	0.111	0.005	0.179
Old Home Foods	0.179	0.009	0.197
Prairie Farms	0.145	0.003	0.179
Springfield Creamery	0.149	0.004	0.190
Sun Valley Dairy	0.202	0.020	0.220
Tillamook County	0.166	0.011	0.184
Wallaby Yogurt	0.183	0.009	0.211
Whole Soy	0.186	0.001	0.212
Private Label	-	-	-

Columns (1) and (2) report average producers' markups and their respective standard errors. Column (3) shows markups that would be backed out if retailers' outside options are ignored.

of retailers' replacement threats, I also report the markups that researchers would back-out if the estimation ignores retailers' outside options (producer markups, no outside option). Similarly to results from the stylized example in Section 3, these comparisons reveal that retailers' credible threats of replacement pose downward pressure on wholesale prices.

I quantify the effect of retailers' outside options, by 'reversing' the exercise: given estimates of marginal costs (implied by markups reported in column (1) of table 9), I construct producers' contract offers, retail prices, and market outcomes if outside options are ignored, referred to as 'unconstrained' offers and outcomes. The simulation holds fixed the set of products. Conditional on product selection, one expects that wholesale prices are likely to increase if retailers may not threaten to replace a product; vendor transfers will not be offered. Table 10 reports the difference between my estimates and unconstrained outcomes. Unconstrained wholesale prices are, on average, 7.676% higher, which translate into 5.772% higher prices. These contract changes imply 6.434% lower vertical profits and a 3.191% decrease in calculated consumer surplus. The credible replacement threat allows retailers to capture 17.361% higher profits through vendor allowances and wholesale-price discounts.

Table 10: Role of Retailers' Participation Constraints: Results (in % changes)

	role of outside options	relative to max vertical prof.
wholesale prices (all)	7.676***	
	(0.086)	
wholesale prices (VA> 0)	15.344***	
	(0.108)	
wholesale prices (VA= 0)	0.203***	
	(0.012)	
prices (all)	5.772***	-18.905***
	(0.066)	(0.064)
prices (VA> 0)	12.234***	-11.318***
	(0.081)	(0.053)
prices (VA= 0)	0.035*	-25.640***
	(0.019)	(0.038)
vertical surplus	-6.434***	1.160**
	(0.559)	(0.556)
retailer profits	-17.361***	
	(0.529)	
producer profits	3.365***	
	(0.703)	
consumer surplus	-3.191***	28.037***
	(0.082)	(0.356)

The first column shows percent changes in key variables comparing the estimated market outcomes with a simulation that calculates producers' offers, prices, and quantity sold when retailers' participation constraints are ignored. The second set of results compare estimated market outcomes with those that maximize vertical profits.

This comparison highlights that retailers' replacement threats impose downward pressure on wholesale prices and, consequently, mitigate double marginalization. To evaluate these price decreases, the second column of table 10 compares estimated market outcomes to retail prices that maximize vertical surplus. Simulations show that vertical profits with contracts accounting for retailers' replacement threats are, on average, 1.160% lower than maximum vertical profits. Consider the difference between maximum vertical surplus and that under producers' unconstrained offers. The increase in vertical profits under constrained offers captures 85% of the that difference. By ignoring such outside options, researchers may not only mis-allocate the division of vertical profits between retailers and producers, but also over-emphasize double marginalization concerns in the market.

7 Counterfactual Analysis

Theory does not provide clear guidance on the effect of vendor-allowance contracts on product availability and on wholesale prices (if product selections change). Therefore, I use a counterfactual simulation to investigate how the type of vertical contract may influence welfare in a setup with differentiated multi-product producers and retailers. The simulations impose that firms may only contract on wholesale prices, allowing retailers to change product selections. I find that the change in the contract structure introduces meaningful incentives to retailers to adjust product availability. In the counterfactual, retailers supply previously excluded 'superior' products (for example, due to lower marginal costs), which increases welfare in the market. The changes in product selections are in line with the results discussed by Shaffer (2005) and Asker and Bar-Isaac (2014).

The simulations account for assortment changes, wholesale prices, and retail markups, holding shelf space and product characteristics fixed.[33] 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. Demand structural shocks are set to zero.

Another challenge is presented by the combinatorial problem of finding new equilibrium assortments in a market. The analysis is conducted for 4 markets in 2006q1 where I observe two grocery chains: Atalnta, GA, Toledo, OH, Minneapolis/St. Paul (MN), and Mississippi. On average, grocery chains in these markets supply 34 products from 40 options, which

[33] 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.

yields about four million possible assortments.[34] 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 over the remaining, on average, six thousand assortments for each retailer in the market.[35] The function iterates over retailers 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 assortment is not guaranteed, the brute-force search identifies one equilibrium in assortments and prices.

Table 11 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 1.766%, and consumer surplus would be 1.295% higher. Even though total vertical profits are predicted to increase, retailers are worse off. Retailers' profits decrease by -1.488%, while total producers' profits increase by 5.659%. These results are largely driven by the changes in retailers' assortments.

The restricted vertical contract implies a change in product availability. Counterfactual assortments are constructed by changing, on average, 6.250 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. Then, I examine how wholesale prices adjust for the counterfactual product selections.

The model prescribes that replacement products may influence vertical contracts and firm payoffs if used as credible threats in contract negotiations. Counterfactual 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 may only lower wholesale prices to match retailers' outside options. For the observed assortment, these adjustments require that wholesale prices decrease by, on average, 5.43%. Such decreases

[34] 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.

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

Table 11: Counterfactual Analysis: Results (in % changes)

	restricted contract	role of outside options in count. A
vertical profits	1.766***	-0.236*
	(0.109)	(0.138)
retailer profits	-1.488**	-3.109***
	(0.614)	(0.570)
producer profits	5.659***	4.224***
	(1.447)	(0.730)
consumer surplus	1.295***	-1.682***
	(0.292)	(0.350)
# products	67.250	67.250
	-	-
# switched prods	6.250***	0
	(0.150)	-
wholesale prices (all)	-2.750***	4.123***
	(0.850)	(0.858)
wholesale prices (unchanged)	2.811***	3.724***
	(0.940)	(0.893)
wholesale prices (switched)	-35.278***	7.752***
	(1.328)	(1.456)
retailer prices (all)	-1.941***	2.989***
	(0.626)	(0.649)
retailer prices (unchanged)	2.120***	2.693***
	(0.686)	(0.676)
retailer prices (switched)	-28.508***	5.722***
	(1.095)	(1.111)

The first column shows percent changes in key variables comparing the observed and counterfactual market outcomes. Column 2 compares estimated counterfactual outcomes to those from producers' take-it-or-leave-it offers that ignore retailers' participation constraints. The analysis imposes the counterfactual product selection.

violate at least one producer's individual rationality conditions.

Instead, in the counterfactual retailers add the products that governed their most profitable replacement deviations and exclude products with large positive vendor allowances. Specifically, 40% of the newly supplied products served as profitable replacement threats for the observed assortments; and 87.5% of the counterfactually excluded products have estimated positive vendor transfers. These adjustments lead to lower values of retailers' replacement threats, which affect equilibrium wholesale prices. Conditional on product changes, table 11 reports counterfactual adjustments in wholesale prices. Average wholesale prices fall by 2.750%, 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 2.811%. 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 75% of the products. These increases reflect the lower values of retailers' outside options in the counterfactual.

To illustrate this, the second column in table 11 shows how retailers' outside options influence contracts and firm payoffs for the counterfactual assortments. The exercise is analogous to the comparison presented in table 10; that is, given the new product assortments, I simulate contracts and outcomes as producers' take-it-or-leave-it offers that ignore retailers' participation constraints. The counterfactual assortments imply low values of retailers' outside options: average unconstrained wholesale prices are 4.123% higher, which is almost half the 7.676% difference under the observed assortment from table 10.

Theory does not provide clear guidance on how restricting the vertical contract may affect total surplus; thereby welfare effects remain an empirical question. First, I find the distortion effects highlighted by Shaffer (2005): vendor allowances support product selections that exclude 'superior' products. At the same time, these adjustments decrease retailers' outside options, alleviating the downward pressure on wholesale prices. This 'price effect' is not well documented in the theory literature because most setups assume a homogeneous upstream and/or downstream sector. I find that wholesale prices increase for three quarters of the products, however, average wholesale prices decrease. For the studied markets, the adjustments in product selections have a larger effect than the increases in wholesale prices, implying a higher total surplus.

Table 12 reports the change in producers' total profits, variable profits, and the number of products supplied. I find that only LALA Foods is negatively affected in the counterfactual. In terms of products supplied, Dean Foods offers, on average, 2.5 less products per quarter; and Breyers expands its distribution of products. To gain insight into the assortment changes, table 13 lists the products supplied in Atlanta, GA. The table displays the number of chains that carry the product in the observed and counterfactual assortments. In this market, Breyers gains distribution for 2 additional products (*Breyers Light* and *Breyers Creme Savers*), and expands presence for *Breyers* and *Breyers Smooth and Creamy.* These adjustments are compensated by drops in Dean Foods' *Horizon* products, one less product offered by Groupe Danone, and *Whole Soy.* Overall, the product variety in the market decreases. For the observed market assortment, there are 38 unique branded products supplied in the market, while in the simulated assortment, consumers may choose from 36 products.

Vendor-allowance estimates likely capture both cash payments from producers and in-

Table 12: Changes in Producers' Profitability and Distribution

	Δ total Π_p ($)	Δ variable Π_p ($)	Δ # products
Breyers	4798.374***	4290.662***	2.333***
	(332.741)	(313.644)	(0.025)
Dean Foods	2700.017***	-237.647	-2.000***
	(214.489)	(144.995)	(0.050)
General Mills	1697.251*	-641.350	0.000
	(1025.341)	(822.864)	(0.000)
Groupe Danone	4465.740***	31.204	0.000
	(877.451)	(639.945)	(0.025)
LALA Foods	-1429.134**	-1828.004***	0.500***
	(676.565)	(629.237)	(0.000)
Old Home Foods	572.861**	-364.196*	0.000
	(275.134)	(188.535)	(0.000)
Whole Soy	377.018	-221.753	-0.333***
	(243.805)	(207.441)	(0.000)

This table shows changes in producers' total profits, variable profits, and number of products supplied, under the counterfactual scenario of no vendor allowances for yogurt products.

centives in the form of retailers' cost savings. The counterfactual analysis eliminates all positive economic transfers from producers to retailers. 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. These questions are addressed in the context of the retail sector. Contracts between producers and retailers commonly consist of wholesale prices and vendor transfers. Despite the widespread use of this contract, the Federal Trade Commission does not have a conclusive position on the effects of vendor allowances. Due to rarely available contract data, I develop a framework that exploits the identities of observed products supplied in a market to infer information about vertical contracts. 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.

I quantify vendor allowances and assess their importance for retailers' profitability in the grocery industry using data on yogurt products. Constructed vendor allowances suggest

Table 13: Changes Product Availability for the Atlanta, GA Market

producer	product line	observed A # retailers	count. A # retailers
Breyers	Breyers	1	2
	Breyers Creme Savers	0	1
	Breyers Light	0	1
	Breyers Smooth and Creamy	1	2
	Yofarm Yocrunch	2	2
Dean Foods	Horizon Natural Little Blends	1	0
	Horizon Organic	1	2
	Horizon Organic Tuberz	1	0
	Horizon Organic Yo-Yos	1	0
	Silk	1	1
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 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	2	2
	Dannon Danimals	2	2
	Dannon Fat Free	2	2
	Dannon Fruit on the Bottom	2	2
	Dannon La Crem with Chocolat	2	1
	Dannon La Creme	2	2
	Dannon La Creme Mouse	1	1
	Dannon Light N Fit	2	2
	Dannon Light N Fit Carb Control	2	2
	Dannon Light N Fit Creamy	0	1
	Dannon Light N Fit with Fiber	2	2
	Dannon Natural	2	2
	Dannon Natural Flavors	2	2
	Dannon Premium	1	1
	Dannon Sprinklins	2	2
	Stonyfield Farm	2	2
	Stonyfield Farm Kids	1	0
	Stonyfield Farm OSoy	2	2
	Stonyfield Farm Yobaby	2	2
LALA	Weight Watchers	1	1
Whole Soy	Whole Soy	1	0

The table reports the number of retailers that supply a product in Atlanta, GA under the observed and counterfactual assortment. For example, in the observed assortment *Breyers Smooth and Creamy* is supplied by only one retailer, and in the counterfactual the product is supplied by both retailers.

that these transfers correspond to 5.855% 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 empirical setting allows me to uncover how product availability and wholesale prices may change if contracts were restricted to include only wholesale prices. Results suggest that the vendor-allowance contract may support assortments that exclude popular (or low cost) products. 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.

References

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

Aydin, G. and W. H. Hausman (2009): "The role of slotting fees in the coordination of assortment decisions," *Production and Operations Management*, 18, 635–652.

Berry, S. (1994): "Estimating discrete-choice models of product differentiation," *RAND Journal of Economics*, 25, 242–262.

Berry, S., A. Eizenberg, and J. Waldfogel (2016): "Optimal product variety in radio markets," *The RAND Journal of Economics*, 47, 463–497.

Berry, S., J. Levinsohn, and A. Pakes (1995): "Automobile prices in market equilibrium," *Econometrica*, 63, 841–890.

Berry, S. and J. Waldfogel (1999): "Free entry and social inefficiency in radio broadcasting," *RAND Journal of Economics*, 30, 397–420.

Bloom, P. N., G. T. Gundlach, and J. P. Cannon (2000): "Slotting allowances and fees: schools of thought and the views of practicing managers," *Journal of Marketing*, 64, 92–108.

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

——— (2015): "Identifying two part tariff contracts with buyer power: empirical estimation on food retailing," Working paper.

Bronnenberg, B. J., M. W. Kruger, and C. F. Mela (2008): "Database paper: the IRI Marketing data set," *Marketing Science*, 27, 745–748.

Conlon, C. and J. H. Mortimer (2017): "Efficiency and foreclosure effects of vertical rebates: empirical evidence," Working paper.

Draganska, M., M. Mazzeo, and K. Seim (2009): "Beyond plain vanilla: modeling joint product assortment and pricing decisions," *Quantitative Marketing and Economics*, 7, 105–146.

Dubé, J.-P., J. Fox, and C. Su (2012): "Improving the numerical performance of static and dynamic aggregate discrete choice random coefficients demand estimation," *Econometrica*, 80, 2231–2267.

Eizenberg, A. (2014): "Upstream innovation and product variety in the U.S. home PC market," *The Review of Economic Studies*, 81, 1003–1045.

Fan, Y. and C. Yang (2017): "Competition, product proliferation and welfare: a study of the U.S. smartphone market," working paper.

Federal Trade Commission (2001): "Report on the Federal Trade Commission workshop on slotting allowances and other marketing practices in the grocery industry," `http://www.ftc.gov/reports/report-federal-trade-commission-workshop-slotting-allowances-other-marketing-practices`, accessed Nov 2014.

——— (2003): "Slotting allowances in the retail grocery industry: selected case studies in five product categories," `http://www.ftc.gov/reports/use-slotting-allowances-retail-grocery-industry`, accessed Nov 2014.

——— (2014): "Guides for advertising allowances and other merchandising payments and services," `https://federalregister.gov/a/2014-23137`.

Foros, O., H. J. Kind, and J. Y. Sand (2009): "Slotting allowances and manufacturers' retail sales effort," *Southern Economic Journal*, 76, 266–282.

Ho, K. and R. Lee (2017): "Equilibrium provider networks: bargaining and exclusion in health care markets," Working paper.

Hristakeva, S. (2018): "Wholesale price discrimination with endogenous product selections," Working paper.

Hwang, M., B. J. Bronnenberg, and R. Thomadsen (2010): "An Empirical Analysis of Assortment Similarities Across U.S. Supermarkets," *Marketing Science*, 29, 858–879.

Inderst, R. and T. Valletti (2009): "Price Discrimination in Input Markets," *RAND Journal of Economics*, 40, 1–19.

Israilevich, G. (2004): "Assessing supermarket product-line decisions: the impact of slotting fees," *Quantitative Marketing and Economics*, 2, 141–167.

Katz, M. (1987): "The Welfare Effects of Third-Degree Price Discrimination in Intermediate Good Markets," *American Economic Review*, 77, 154–67.

Kuksov, D. and A. Pazgal (2007): "Research note - the effects of costs and competition on slotting allowances," *Marketing Science*, 26, 259–267.

Lariviere, M. A. and V. Padmanabhan (1997): "Slotting allowances and new product introductions," *Marketing Science*, 16, 112–128.

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

——— (2010): "Slotting allowances and scarce shelf space," *Journal of Economics & Management Strategy*, 19, 575–603.

Misra, K. (2008): "Understanding retail assortments," Working paper.

Nevo, A. (2001): "Measuring market power in the ready-to-eat cereal industry," *Econometrica*, 69, 307–342.

O'Brien, D. P. (2014): "The Welfare Effects of Third-Degree Price Discrimination in Intermediate Good Markets: the Case of Bargaining," *RAND Journal of Economics*, 45, 92–115.

Piccolo, S. and J. Miklós-Thal (2012): "Colluding through suppliers," *The RAND Journal of Economics*, 43, 492–513.

Rey, P. and T. Vergé (2004): "Resale price maintenance and horizontal cartel," Working paper.

Schechner, S. and V. Pop (2018): "EU Starts Preliminary Probe into Amazon's Treatment of Merchants," Https://www.wsj.com/articles/european-union-probing-amazon-s-treatment-of-merchants-using-its-platform-1537367673, accessed October 2018.

Shaffer, G. (1991): "Slotting allowances and resale price maintenance: a comparison of facilitating practices," *RAND Journal of Economics*, 22, 120–135.

——— (2005): "Slotting allowances and optimal product variety," *The B.E. Journal of Economic Analysis & Policy*, 5, 1–28.

Sudhir, K. (2001): "Structural analysis of manufacturer pricing in the presence of a strategic retailer," *Marketing Science*, 20, 244–264.

Sudhir, K. and V. R. Rao (2006): "Do slotting allowances enhance efficiency or hinder competition?" *Journal of Marketing Research*, 43, 137–155.

Sullivan, M. W. (1997): "Slotting allowances and the market for new products," *Journal of Law and Economics*, 40, 461–493.

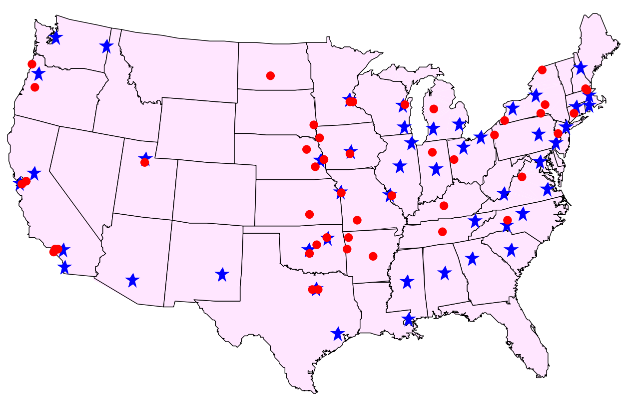
Villas-Boas, S. B. (2007): "Vertical relationships between manufacturers and retailers: inference with limited data," *Review of Economic Studies*, 74, 625–652.

Viswanathan, M. (2012): "Economic impact of category captaincy: an examination of assortments and prices," Working paper.

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.[36] 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.

[36]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), *cy'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.[37] The soy products in the dataset

[37] Due to the aggregation at the product line, I sometimes aggregate over products with different fat content. The 'light' characteristic tracks product lines that explicitly highlight that these products are low fat/diet related: e.g. Blue Bunny Lite 85 (vs Blue Bunny). I check the importance of different fat-content options in the raw data for each product line. I can identify 3 fat content options: low fat, non fat, and whole. On average, I observe 85 unique branded product lines in a given year; and 48 of these products offer only one fat content option. For the remaining products I check whether one of the fat options captures most of the sales. I find that for three quarters of these products more than 76% of sales are attributed to one of the fat options. I acknowledge that due to aggregation at the product line, a concern may arise that I do not flexibly capture differences in product characteristics for the remaining 10 product lines. The decision to aggregate the data to the product line aims to approximate the negotiations between retailers and producers, while the decision of which flavors and fat content options are offered to consumers may be

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.

The sample consists of 23 national and regional producers and 44 private label brands. Variation in the number of products supplied by producer is shown in table A1. The average retailer in the sample offers 31 products selected from about 85 non-private label options produced in a year. Retailers may select from, on average, 20 different product lines offered by Groupe Danone, 12 by General Mills, 4.7 by Breyers, etc. 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 retailers. Groupe Danone produces the *Dannon*, *Stonyfield Farm*, and *Brown Cow* brands, while General Mills distributes the *Yoplait* and *Colombo* brands.

Variation in producer distribution differs across single-product and multi-product producers. For producers offering few options (1 or 2 products), the assortment variation stems from retailers' choices whether to supply that producer or not. This is shown in column (3) that tracks the fraction of retailers in a market that supply a producer (conditional on at least one retailer in that market offering the producer). For example, conditional on being present in the market, Cascade Fresh is supplied in 1 out of 3 retailers, on average. Alternatively, multi-product producers are present in most retailers: 71% of the retailers for Dean Foods up to 100% for General Mills and Groupe Danone. For those firms, I look at the variation in retailers' selection within producer. The last column in table A1 tracks producer-specific assortment similarities across retailers in the same market. The measure is constructed for pairs of retailers that both supply the analyzed producer. Results show that retailers choose different subsets of products from their producers, with similarities ranging from 0.6 to 0.9.

Figure A2 visualizes the assortment variation across retailers for the top 6 producers 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

influenced by store managers.

Table A1: Producer Supply across Retailers

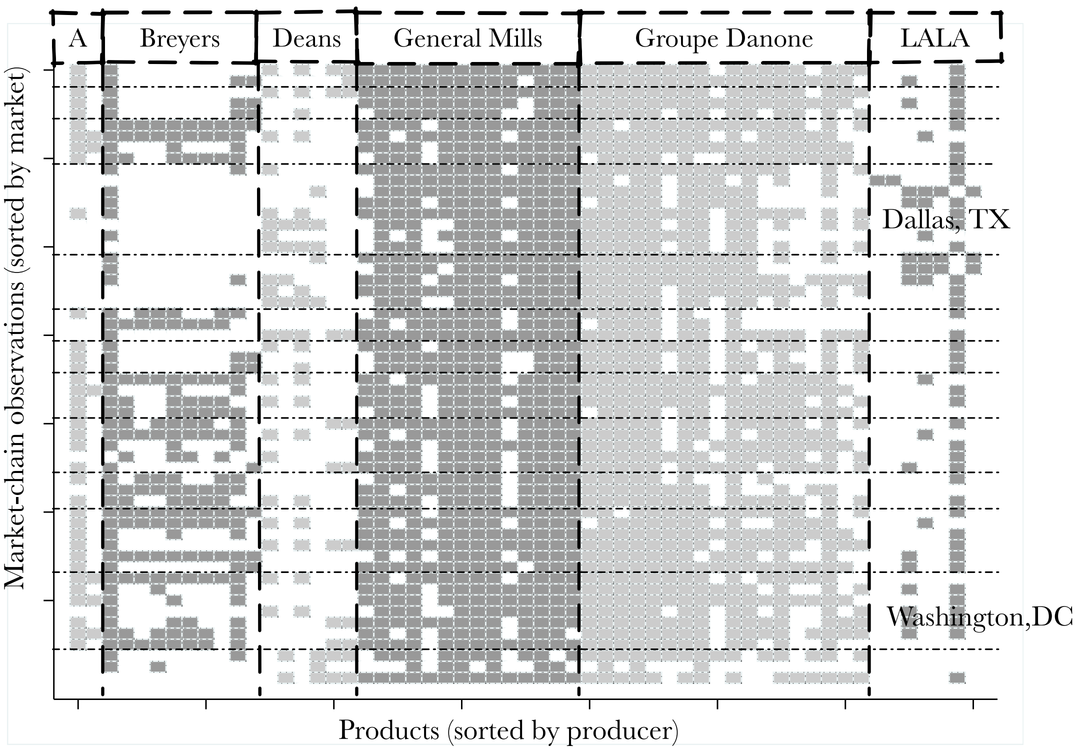
producer	# product options	# products supplied	fraction of retailers in a market	assort. similarity x-retailers
Agro Farma	1.15	1.11	0.63	0.95
Anderson-Erickson	2.00	1.98	0.69	1.00
Auburn Dairy	1.40	1.30	0.36	0.89
Belfonte	1.00	1.00	0.78	1.00
Breyers	4.66	3.28	0.81	0.78
Cabot Creamery	1.00	1.00	0.38	1.00
Cascade Fresh	1.00	1.00	0.34	1.00
Dean Foods	5.69	2.25	0.71	0.60
Fage USA Corp	1.00	1.00	0.62	1.00
General Mills	11.96	9.18	1.00	0.90
Groupe Danone	20.05	13.08	1.00	0.82
Johanna Foods	3.20	2.29	0.46	0.76
Kalona Organics	1.00	1.00	0.51	1.00
LALA Foods	4.18	1.88	0.78	0.76
Northwest Dairy	1.00	1.00	0.57	1.00
Old Home Foods	3.40	2.70	0.78	0.99
Prairie Farms	1.28	1.03	0.69	0.99
Purist Foods	1.00	1.00	0.37	1.00
Springfield Creamery	1.00	1.00	0.50	1.00
Sun Valley Dairy	1.00	1.00	0.30	1.00
Tillamook County	1.00	1.00	1.00	1.00
Wallaby Yogurt	1.00	1.00	0.32	1.00
Whole Soy	1.00	1.00	0.40	1.00

The variable '# product options' tracks the average number of product options available in a year by each producer.

pair is observed in the data, while white blocks correspond to instances in which the product is not offered by the retailer. Figure A2 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. (2009) refer to these as staple products), while the availability of other products varies markedly across retailers.

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 A2 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

Figure A2: 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.'

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.

Table A2: 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.

First, I consider the assumption that vendor allowances flow from producers to retailers. Table A3 shows the size of vendor allowances as a percent of retailers' revenues imposing different assumptions. The first row reports the estimates if 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.

The second panel in table A3 shows that without the non-negativity restriction, average vendor allowances are negative. To evaluate the role of staple products for these results, I separate the vendor estimates for staple and non-staple product. Staple products are defined as product lines that are supplied by all retailers in a census region during the

Table A3: Vendor Allowance Estimates

	mean	st. error
VA≥ 0		
VA (all)	5.855	0.220
VA (non-staple)	15.182	0.348
VA (staple)	4.024	0.170
VA$\lesseqgtr 0$		
VA (all)	-3.550	0.358
VA (non-staple)	6.518	1.895
VA (staple)	-7.579	0.718
VA (staple$^{\text{top 5 products}}$)	-6.867	0.328
VA (staple$^{\text{excluding top 5 products}}$)	-0.711	0.422

The last row restricts the vendor allowances of five staple products to equal zero. The excluded products are *Yoplait Light*, *Yoplait Original*, *Dannon Light N Fit*, *Yoplait Go Gurt*, and *Yoplait Trix.* VA (staple$^{\text{excluding top 5 products}}$) calculates the transfers for these five products.

quarter. Results suggest positive vendor transfers for non-staple products.

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, profitable products are supplied by most retailers. As a result, if we allow for negative vendor allowances, the profitability of a few products may imply negative transfers. Thus, I further separate the estimates for the 'top 5 products' from the remaining staple products. In this exercise, 'top 5 products' are defined as the products supplied in the largest number of retailers, markets, and time periods.[38] The last two rows of table A3 show that the negative vendor transfers are driven by these five products. This exercise highlights the role of staple products. Industry practitioners have confirmed that highly profitable products, such as *Yoplait Light*, need not offer incentives to be supplied in the market. At the same time, a producer is not able to extract lump sum payments for these highly profitable products.

Nevertheless, a multi-product producer may exploit the profitability of such products to motivate retailers to supply its other products. Table 8 showed that if the non-negativity assumption is imposed at the producer level, rather than at the product level, mean transfers are estimated to be 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

[38] These product lines are *Yoplait Light*, *Yoplait Original*, *Dannon Light N Fit*, *Yoplait Go Gurt*, and *Yoplait Trix*.

allowances, as well as products with high consumer demand, for which I do not find a profitable deviation.

Table A5 reports a regression of backed out vendor transfers on product fixed effects. Figure A3 visualizes these estimates across producers for the setup imposing that vendor transfers are non-negative. 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 product lines within a producer. For example, the two extreme projections for Groupe Danone indicate that the producer pays, on average, \$52 more per store-quarter-'product-line' for *Stonyfield Farm YoMommy* than for *Dannon Light N Fit*.

For completeness, I replicate column (3) of table 7 without the assumption that vendor transfers are non-negative. The specifications imposing and relaxing the non-negativity conditions are reported in columns (1) and (2) of table Results are shown in table A4; both parameterizations include market×time period fixed effects. When the non-negativity assumption is relaxed, then the estimate for staple products becomes more negative, and the soy parameter increases. The estimates at the producer level become noisy.

The second concern about the estimation implementation is that the constructed retailers' outside options may be lower than 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.

To evaluate the first concern I reestimate vendor transfers using wholesale costs reported by Promodata. Promodata Price Trak collects wholesale-price and promotion information from one major wholesaler in each market for the 2005-2010 period. For the main specification, the cost to supply a replacement product l reflects the maximum retailer marginal cost to supply product l ($mc_l^{r,total}$) by any retailer in that market. For this exercise, marginal costs of replacement products are taken from Promodata and these are typically lower; so unsurprisingly, I find more profitable retailers' deviations, and higher vendor allowances. The inferred average vendor allowances amount to 8.50% of retailers' revenues.

Table A5: Vendor Allowance Estimates by Product

	VA≥ 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

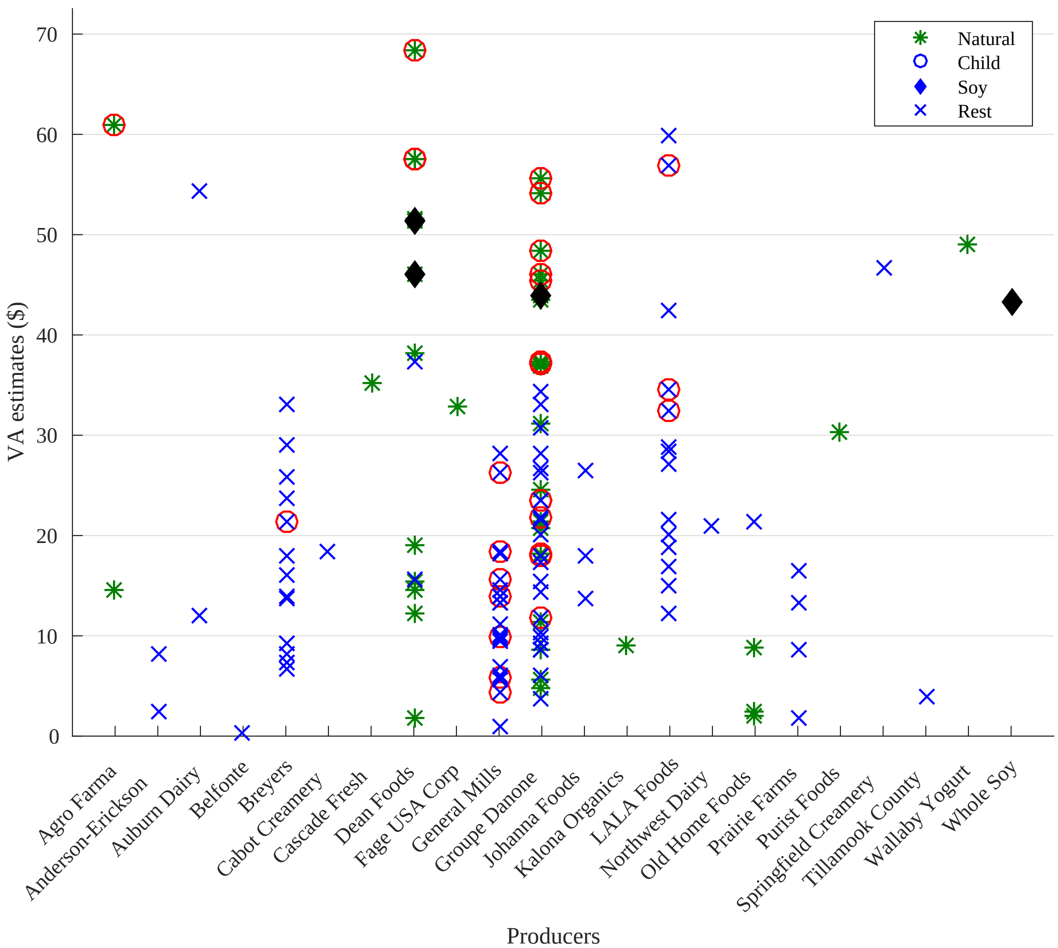
Cultural Revolution	9.00	12.86	6.61	17.57
Blue Bunny	18.73	8.90	13.42	22.41
Blue Bunny Carb Freedom	16.98	3.69	6.98	8.80
Blue Disney Yo-Pa	34.57	13.40	34.15	19.31
Blue Bunny Disney Swirl	32.35	11.28	32.03	15.65
Blue Bunny Light	20.12	8.67	14.02	22.17
Blue Bunny Lite 85	15.02	1.18	1.90	2.67
Blue Bunny 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
cys	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

These assumptions suggest that the vendor-allowance estimates may be construed as a lower bound on the importance of these payments for retailers. An earlier version of the paper used bounds to inform the size of lump-sum transfers. However, in order to study how contract types affect market outcomes, I use the assumption that producers make take-it-or-leave-it offers. that is, the assumption that vendor-allowance estimates hold with an equality is needed for the counterfactual analysis.

Next, I evaluate counterfactual results' sensitivity as the value of retailer replacement threat changes. I implement the change in outside-option values by scaling the cost to supply replacement products (w_l). First, I re-estimate vertical contracts and infer producers' markups for each set of w_l. Then, I simulate the counterfactual allowing for different values of retailer deviations and using the newly inferred firm costs.

I test result sensitivity using the first market from the counterfactual (Atlanta, GA). Table A6 compares results as I move the dial between w_l*0.95 and w_l*1.05; column (3) reports the values under the main specification. The first panel summarizes the changes in inferred contracts. For the Atlanta market, I estimate vendor allowances of 2.08% of retailer revenues under the main specification. As I scale w_l, these transfers move up to 2.67% and

Figure A3: Comparison of Vendor Allowances across Products



The *x-axis* sorts the products by producer, the *y-axis* measures the dollar value of vendor-allowance estimates. Transfers are reported per store-quarter-flavor to ease comparisons across product lines. I use different symbols to plot the vendor transfer of product lines with different characteristics described as: natural, marketed for children, soy, and rest. The figure does not report standard errors. All estimates and standard errors are reported in table A5.

Table A4: Vendor Allowance Estimates

	VA≥ 0	VA $\lesseqgtr 0$
constant	-2.146	-34.162
	(15.321)	(65.226)
retailer in > 1 market	2.958	-5.078
	(3.412)	(15.049)
retailer num of stores	-0.346*	0.307
	(0.201)	(0.735)
staple	-6.831***	-22.233***
	(1.318)	(4.033)
natural	5.364***	9.740**
	(1.124)	(3.792)
child	3.494***	-1.246
	(0.970)	(3.620)
soy	21.678***	40.924***
	(2.298)	(6.741)
light	1.907***	5.383**
	(0.402)	(2.325)
creamy	3.475***	9.641***
	(0.682)	(2.528)
Anderson-Erickson	0.025	-8.183
	(9.115)	(37.485)
Auburn Dairy	10.897	15.095
	(11.196)	(47.202)
Belfonte	-3.832	-17.726
	(8.803)	(38.405)
Breyers	1.028	6.035
	(6.968)	(37.082)
Cabot Creamery	14.296	38.836
	(17.356)	(70.104)
Cascade Fresh	23.900***	49.084
	(8.350)	(37.505)
Dean Foods	16.380**	26.373
	(6.924)	(37.290)
Fage USA Corp	19.495***	41.654
	(6.994)	(37.532)
General Mills	-2.282	-4.347
	(7.257)	(36.007)
Groupe Danone	4.212	11.557
	(7.440)	(36.452)
Johanna Foods	7.596	14.350
	(7.553)	(35.614)
Kalona Organics	-1.847	0.997
	(7.742)	(35.537)
LALA Foods	2.616	22.350
	(10.110)	(37.831)
Northwest Dairy	12.696*	24.064
	(7.631)	(36.727)
Old Home Foods	8.636	20.854
	(7.833)	(38.192)
Prairie Farms	-9.938	-18.233
	(11.503)	(40.378)
Purist Foods	5.372	5.290
	(7.733)	(37.523)
Springfield Creamery	17.402**	38.351
	(8.145)	(37.006)
Sun Valley Dairy	35.614***	53.536
	(10.301)	(45.764)
Tillamook County	-8.710	-34.210
	(7.635)	(36.710)
Wallaby Yogurt	34.068***	59.539
	(7.443)	(41.562)
Whole Soy	13.323*	16.722
	(7.057)	(37.939)

Results are obtained by projecting product-chain-market-time period deviations on product, retailer, and market characteristics. All regressions include market×time period fixed effects. Each deviation is scaled to reflect the vendor transfer per store and flavor. Standard errors are obtained via bootstrap.

down to 1.62%, which imply a 27.98% increase in vendor transfers (respectively a -22.38% decrease). Changes in inferred average producers' markups range from -7.19% (down to $0.14) to 5.37% (up to $0.16).

The second panel compares results for the counterfactual analysis. Product selections change in the same manner; the only exception is the simulation under w_l*0.95 where a retailer changes one more offered product with its most profitable replacement. The assortment changes imply lower values of replacement threats; hence, wholesale prices (for unchanged products) increase in the counterfactual. Differences across the five tests can be largely explained by different degrees of "loosening" contract constraints.

For example, in the observed assortment retailers have the lowest value of substitution threats under w_l*1.05, and contracts are closest to unconstrained offers. For the counterfactual, these differences imply smaller increases in average wholesale prices for unchanged products (1.87%), resulting in larger decreases in average prices (-3.44%) and higher increase in consumer (and total) surplus.

In contrast, we expect that the adjustments will have larger a price effect (increase in prices as constraints decrease) under w_l*0.95. In this simulation, one of the retailers replaces an additional product with its most profitable substitute. This change drastically decreases the constraints for that retailer; and wholesale prices increase by 9.51%. In this simulation, the wholesale-price adjustments lead to higher average prices and a decrease in consumer surplus.

Table A6: Counterfactual Analysis: Sensitivity

	w_l*0.95	w_l*0.98	w_l	w_l*1.02	w_l*1.05
VA (% of ret. rev)	2.67	2.30	2.08	1.88	1.62
producer markups (ave $s)	0.14	0.15	0.15	0.15	0.16
vertical profits	1.18	3.72	3.90	3.93	5.50
retailer profits	-7.47	-2.27	-2.24	-2.22	-1.72
producer profits	18.66	15.84	16.32	16.36	20.09
consumer surplus	-0.67	1.83	1.84	1.85	2.11
wholesale prices (all)	2.29	-3.79	-3.80	-3.81	-4.81
wholesale prices (unchanged)	9.51	3.07	3.06	3.05	1.87
wholesale prices (switched)	-44.06	-42.14	-42.14	-42.14	-42.14
retailer prices (all)	1.83	-2.67	-2.68	-2.68	-3.44
retailer prices (unchanged)	7.02	2.33	2.32	2.31	1.44
retailer prices (switched)	-35.67	-33.90	-33.90	-33.90	-33.89

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.

D Role of vendor transfers in other models of negotiations

The presence of vendor allowances does not depend on the assumption that producers' make take-it-or-leave-it offers. I discuss below the cases of simultaneous Nash-Bargaining solutions as in O'Brien (2014) and that of retailers' take-it-or-leave-it offers using the setup in Shaffer (1991).

Nash Bargaining: Consider a market with two retailers, who may choose from two differentiated product options: a product from a dominant producer M, and one from a competitive fringe C. To simplify the exposition assume that contracts are two-part tariffs with lump-sum payments either positive or negative. In parallel to the example used in the paper, the case of interest is when both retailers supply product M, and they have an outside option of terminating negotiations with M and supplying product C instead.

First, consider the case without outside options, which ignores product C (the standard NB solution). Separate firms' profits into variable and fixed components: $\Pi_M(w, \text{VA}) = \Pi_M^v(w) - \text{VA}_1 - \text{VA}_2$ (for producer M), and $\Pi_i(w, \text{VA}) = \Pi_i^v(w) + \text{VA}_i$ (for each retailer i). The NB solution between the dominant supplier and each retailer solves

$$\max_{w_i, \text{VA}_i} \phi_i(w, \text{VA}) = (\Pi_M^v - \text{VA}_1 - \text{VA}_2 - d_i^p)^{1-\gamma}(\Pi_i^v + \text{VA}_i - d_i)^\gamma$$

where the bargaining weight γ is set to be the same for both retailers. Let d_i track the disagreement payoffs for each retailer, and d_i^p for the producer. These may be interpreted as the payoffs each firm will earn during negotiations. Solving for (w_i, VA_i) gives

$$w_i^{NB} : \frac{\partial \Pi_M^v}{\partial w_i} + \frac{\partial \Pi_i^v}{\partial w_i} = 0$$

and

$$\text{VA}_i^{NB} = \gamma(\Pi_M^v(w^{NB}) - d_i^p(w^{NB})) - (1-\gamma)(\Pi_i^v(w^{NB}) - d_i(w^{NB})).$$

That is, wholesale prices are set to maximize the bilateral surplus generated by each retailer-producer pair, and lump-sum payments are used to redistribute that surplus. If $w^{NB} > mc_M$, then lump sum transfers may be either positive or negative.

For comparison, the textbook case of producers' take-it-or-leave-it offers implies that wholesale prices maximize total surplus ($w^* : \frac{\partial \Pi_M^v}{\partial w} + \frac{\partial \Pi_1^v}{\partial w} + \frac{\partial \Pi_2^v}{\partial w} = 0$) and lump sum transfers flow from retailers to producers.

Introduce outside options in Nash Bargaining: Each retailer has an outside option of terminating negotiations with M and supplying product C instead. Note that these outside options are different from disagreement payoffs. They create constraints on the NB solution as follows

$$\max_{w_i, \mathrm{VA}_i} \phi_i(w, \mathrm{VA}) = (\Pi_M^v - \mathrm{VA}_1 - \mathrm{VA}_2 - d_i^p)^{1-\gamma}(\Pi_i^v + \mathrm{VA}_i - d_i)^\gamma$$

$$\text{subject to: } \Pi_i^v + \mathrm{VA}_i \geq \Pi_i^{\text{deviate}}$$

where Π_i^{deviate} is described as a unilateral deviation by retailer i to supply product C. The constraint plays a role only when it binds, with $\Pi_i^v(w^{NB}) + \mathrm{VA}_i^{NB} < \Pi_i^{\text{deviate}}(w^{NB})$ at the unconstrained contracts $(w^{NB}, \mathrm{VA}^{NB})$. Note that $\frac{\partial \Pi_i^{\text{deviate}}}{\partial w_i} = 0$, thereby w^{NB} describes the solution to the constrained problem as well. The transfers equal

$$\mathrm{VA}^{NBconstr} = \max\{\Pi_i^{\text{deviate}}(w^{NB}) - \Pi_i^v(w^{NB}), \mathrm{VA}_i^{NB}\}.$$

As a result, a retailer may exploit its outside option to capture a larger fraction of the vertical surplus. If the outside option is 'large,' then lump-sum transfers do not depend on bargaining power or positions.

For comparison, if producers make take-it-or-leave-it offers, then wholesale-price offers maximize total surplus less the values of the outside options

$$w^{*constr} : \frac{\partial \Pi_M^v}{\partial w} + \sum_{i=1,2} \frac{\partial \Pi_i^v}{\partial w} - \sum_{i=1,2} \frac{\partial \Pi_i^{\text{deviate}}}{\partial w} = 0$$

as $\frac{\partial \Pi_i^{\text{deviate}}}{\partial w_{-i}} \neq 0$. Lump-sum payments may flow from producers to retailers if $\Pi_i^{\text{deviate}}(w^{*constr}) - \Pi_i^v(w^{*constr}) > 0$.

The example shows that positive vendor transfers emerge only if retailers compete downstream ($w^{NB} > mc_M$,$w^* > mc_M$). Transfers increase with the value of retailers' outside options, retailer bargaining power, and retailer disagreement payoffs. In my model I rely on the outside options alone. If the outside options is 'large,' then it determines the lump-sum transfers in the bargaining game.

Without an assumption on the negotiation protocol, my approach allows me to infer a lower bound on vendor transfers. Then, we can consider if the application resembles a 'world with large outside options.' I find that, on average, vendor transfers represent (at least) 19.93% (0.66) of retailer variable profits. I interpret these results as suggestive evidence that outside options are 'large' and they govern contracts in the market. In empirical settings where outside options are not 'large' and the negotiations resemble a Nash-Bargaining solution, my approach will provide a lower bound on vendor transfers.

Naturally, the full non-cooperative game will have a different solution from the bargaining solution as $\gamma \to 0$. The modeling choice is driven by identification issues - empirically, one cannot separately identify bargaining power parameters from lump-sum transfers unless the researcher has additional variation in the data. As a result, I defer to theory works on vendor allowances and those on firms' outside options, where authors typically assume that producers make take-it-or-leave-it offers.

Retailers take-it-or-leave-it offers: If the industry suggests that downstream firms make take-it-or-leave-it offers, then the model may be adjusted respectively. In these cases, producers' participation constraints may be considered to impose constraints on the offers made. Vendor allowances may emerge in equilibrium to soften retail price competition. These transfers will decrease with the value of producers' outside options. To show this, I adjust the model used in Shaffer (1991).

Consider a market with two differentiated retailers and a competitive upstream sector. For simplicity, let producers' outside options be exogenous and equal to $T \geq 0$. That is, producer m will accept an offer if $\Pi_m(w, \text{VA}) \geq T$.

Retailer i's profit is $\Pi_i(w, \text{VA}) = \Pi_i^v(w) + \text{VA}_i$. Retailer i offers a contract to maximize its profit, subject to m's participation constraint: $\Pi_m(w, \text{VA}) = \Pi_m^v(w) - \text{VA}_i \geq T$. Retailers will place producers on their participation constraints; substituting the constraint implies that retailer i will choose wholesale prices to maximize vertical surplus created with manufacturer m: $\max_{w_i} \Pi_i^v(w) + \Pi_m^v(w)$.

The well-studied case of local monopoly downstream implies that $w_i^* = c$ (and $\text{VA}_i = -T$ flowing from retailers to producers). However, if retailers compete downstream, they have incentives to soften downstream competition by committing to higher wholesale prices. When $w_i > c$, retailer j finds it optimal to increase its final price; which in turn increases retailer i's profits. Retailer i extracts the rest of the profits from its supplier with a vendor transfer. Retailer j has similar incentives. When $w_i^* > c$, positive vendor transfers emerge. The transfers to retailers decrease as the value of producers' outside option increases (and may turn negative).