ASSESSING THE CONSEQUENCES OF A CHANNEL SWITCH

Xinlei (Jack) Chen  
jack.chen@sauder.ubc.ca

George John  
gjohn@csom.umn.edu

Om Narasimhan  
onarasimhan@csom.umn.edu

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Xinlei (Jack) Chen is an Assistant Professor at the Sauder School of Business, University of British Columbia, George John is the Pillsbury-Gerot Chair, and Om Narasimhan is an Assistant Professor, both at the Carlson School of Management, University of Minnesota. This paper is based on the first author’s doctoral dissertation. The authors are listed alphabetically and contributed equally to the paper. We would like to thank Rajesh Chandy, Sam Kortum, Rakesh NIRaj, Jaideep Prabhu, and Myles Shaver for helpful comments on earlier drafts.
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ABSTRACT

Switching marketing channels is an expensive, sticky decision. While a number of theories suggest efficiency and strategic differences between channels, there is virtually no work on combining these ideas into an empirically workable methodology to assess the impact of a channel switch. In this study, we undertake to close this gap with an empirical study of the sports drink market, featuring competing producers and heterogeneous channels.

We estimate demand and cost parameters for a number of alternative models of competitive interaction and use these estimates to study the switching of Gatorade from its extant (independent wholesaler) channel to the direct-store-delivery (DSD) channel belonging to Pepsi.

Our initial results indicate the following: Pepsi should switch Gatorade to the DSD channel only if (i) the switch decreases Gatorade’s manufacturing cost by at least 14%, or (ii) the switch increases the share of profit it can obtain by at least 13%, or (iii) the switch enhances demand by the equivalent of a price cut of 4.96¢ for a 32 oz. package. Absent these increases, Pepsi should not switch. Our methodology and results speak to both managers contemplating a channel switch and anti-trust authorities faced with the task of evaluating the consequences of a change in vertical structure.

Keywords: Channel structure; New Empirical Industrial Organization; Oligopoly competition
1. INTRODUCTION

Decisions to change a product’s marketing channel are both expensive and difficult to undo. To see the scope of the problem consider the recent history of the sports drink market, consisting of Gatorade, owned by Quaker Oats, Powerade owned by Coke, and All Sport owned by Pepsi. Historically, Gatorade was distributed through a grocery wholesaler channel, whereas Powerade and All Sport have each been distributed through their own direct store delivery (DSD) channels. Pepsi acquired Quaker Oats in 2002, making it feasible to switch Gatorade to Pepsi’s DSD channel. As it turned out, apparently in order to assuage antitrust concerns, Pepsi actually offered to desist from distributing Gatorade through Pepsi’s DSD channel for a number of years. In addition, it divested All Sport to a small firm (Monarch), and announced that it would continue distributing All Sport through its DSD channel. Were the antitrust concerns that ostensibly provided the motivation for these actions well founded? What would have been the consequences, in terms of profits, prices, and market shares, had Pepsi elected to distribute Gatorade through the DSD channel post-merger?

The answers to the above questions turn out to be surprisingly involved, because of the large number of effects that work in different directions. These effects divide into two broad categories – efficiency and strategic effects. Efficiency or coordination effects can be further sub-divided into four classes of issues. Pricing effects (e.g., double marginalization; see Moorthy (1987)) are the first class here, followed by moral hazard and specific investment problems (often referred to collectively as transaction costs; e.g., see Mathewson and Winter 1983; Dutta et al. 1999). Physical distribution costs and service output levels complete these efficiency effects. In the extant models, some of these drivers favor switching to the DSD channel (e.g., to eliminate double marginalization), but others go against it (e.g., physical distribution costs).

Strategic effects add competition to the mix above. Some work suggests that firms gain from softening inter-brand price competition through delegation, i.e., the equivalent of using the

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1 We define a channel change as a decision that changes the vertical interactions between channel members. An example is a change by a manufacturer from selling its products through retailers to a direct sales channel. However, we do not consider a switch from one retailer to another retailer as a channel change. In other words, channel changes refer to changes in channel structure, not changes of one channel member for another.

2 Wholesalers are independent firms that take title to the product and deliver to the loading dock of a retail store. Their downstream channel structures are quite varied. Some wholesalers own and operate their own retail stores, while others sell to independent stores, or both. The wholesaler channel is a vertically non-integrated or separated channel in our analysis.
wholesaler channel. The intuition is that channel structures can soften inter-brand competition between oligopolists, and these effects will be traded off against efficiency. For instance, Rey and Stiglitz (1995) show that two vertically integrated competitors can soften price competition by inserting an intermediary, i.e., by vertically separating the actors. The gain from this separation is proportional to the intensity of competition between the two oligopolists, which in turn is succinctly captured by the cross-price elasticities between them. In addition, since channel switches are enabled by horizontal mergers (e.g., in our context, Pepsi’s purchase of Gatorade is what lets it switch Gatorade to the DSD channel) such vertical switches need to account for the effects of the change in the horizontal structure as well. This would let Pepsi price these products such as to maximize joint profits, an outcome that might well be different from pricing them as competitors. Again, the incentive to do this will depend on the cross-price elasticities between All Sport and Gatorade.

Assessing the magnitudes of these efficiency and strategic effects is obviously an empirical task, yet little evidence is available in the extant work. Studies of efficiency differences between channels (Anderson and Schmittlein, 1984; Dutta et al. 1999; John and Weitz, 1988) have typically worked out of a reduced form perspective, which does not yield the policy-invariant parameter estimates required to evaluate a channel switch prospectively. A recent strand of the literature has estimated policy-invariant parameters employing structural models of channels (e.g., Berto Villas-Boas 2004; Besanko et al. 1998; Besanko et al. 2003; Kadiyali et al. 2000; Slade 1998; Sudhir 2001; Villas-Boas and Zhao 2005). However, none of these studies examines interactions between manufacturers who employ different types of channels to reach consumers, as is the case in our context. In addition, none of them examines the consequences of switching from one channel structure to another. Thus, we face the challenge of modeling the strategic interaction between the manufacturers, while simultaneously accommodating heterogeneous channel structures.

Heterogeneous channel structures have not been studied to date, and they are central to answering our research question. We need a workable means to specify a counterfactual, viz. a firm employing a new channel that is different from its current channel, and estimate the resulting

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3 DSD channels feature control and/or integration over downstream activities. The product is delivered to individual retail stores by dedicated trucks, and placed on shelves by employees dedicated to the task. The DSD channel is a vertically integrated channel in our analysis.

4 To sum, the strategic effect will be directly related to the intensity of competition between the upstream oligopolists. This in turn can be captured by the elasticity matrix of the products; any factor that increases cross-price elasticities between competitors’ products is likely to enhance the magnitude of the strategic effect.
differences in shares, profits, etc. Formally, this requires us to model a) *heterogeneous channel structures* (e.g., one competitor using a wholesaler channel while another uses a DSD channel), b) *horizontal and vertical competitive interactions* across multiple tiers, e.g., manufacturers competing with each other (horizontally), selling to wholesalers (vertically), and selling to retailers (vertically), and c) *channel specific costs*, i.e., costs that differ across channel types.

In this paper we specify and estimate a model with the features enumerated above. We start by characterizing the demand side of the market following Berry, Levinsohn, and Pakes (hereafter BLP 1995) and Nevo (2000) in which a set of heterogeneous, utility-maximizing consumers choose among the available alternatives. Using price, volume and marketing data from a chain of grocery stores, we estimate the demand for various brands in this market. Next, we characterize the extant supply side of the market as a set of pricing rules. Following that, we use the demand estimates from the first step, and the pricing rules from the second step to estimate channel costs. This poses an econometric challenge because one almost never observes the prices between manufacturers and wholesalers. We overcome this problem by first estimating the upstream costs of each channel (i.e., the combined costs of all channel members up to but not including the retailer) and then breaking this down into its components (i.e., production and distribution costs) with the help of cost ratios constructed from accounting statements.

Armed with these demand and cost estimates, we specify a series of what-if scenarios. By constructing these scenarios judiciously, we are able to separate out the gains and losses to each channel member (e.g., the net profit change) as well as to separate out the importance of the different causal drivers.

Our analysis suggests that Pepsi should switch Gatorade to the DSD channel only if the switch (i) decreases Gatorade’s manufacturing cost by at least 14%, or (ii) increases Pepsi’s share of upstream channel profit by at least 13%, or (iii) increases preference for Gatorade by the equivalent of a price cut of 4.96¢ for a 32 oz. package. We find that efficiency effects generally outweigh strategic effects in this context. Indeed, the single biggest deterrent to switching Gatorade to DSD turns out to be this channel’s elevated distribution costs. In terms of implications for anti-trust authorities, we show that both producer and consumer welfare (and hence, social welfare) decline with the switch. If, however, enhanced service levels in the DSD channel lead to an increase in the product preference parameter of greater than 0.22 in absolute value, which is equivalent to the demand increase from a 5.39¢ price cut for Gatorade 32 oz., then social welfare increases unambiguously.
We believe this paper improves the ratio of evidence to theory about vertical contracting issues in marketing channels. A large number of theoretical models currently speak to vertical market structure issues, but the scant empirical work makes it difficult to sort out the real-world significance of the posited effects. We provide the first empirical insights into the comparative efficiency of DSD and wholesaler channels – given the prevalence of such channels in many categories (see Table 1), our documentation of these cost and service level differences is important to managers and policymakers. Our results suggest the DSD channel is considerably costlier than the wholesaler channel in this marketplace. While the switch to a more costly channel has the predictable deleterious consequences on profits, market share, and social welfare in general, we are also able to provide bounds on both demand enhancement and manufacturing cost reduction that could offset these costs. Methodologically, we construct empirical moment conditions from a distribution channel game that accommodates qualitatively different channel types used by competing firms.

Our approach and results are relevant to both managers and antitrust authorities. While managers have long known that channels offer different combinations of cost and service levels, they have lacked a workable means of employing observable data to impute these effects. Similarly, advances in the tools required to address vertical structure issues have lagged significantly behind horizontal merger tools. Indeed, current policy towards vertical contracting issues is best described as ambiguous in the vacuum following the Justice Department’s disavowal of its own 1984 Vertical Merger Guidelines. We illustrate the possible utility of our work with a brief discussion of a recent case. Nestle was permitted to acquire Dreyer’s ice cream, but was required by the Federal Trade Commission to divest its DSD system (used to distribute its Hagen-Dazs brand) to a rival ice cream firm, CoolBrands. The logic was that this vertical divestiture would cure the presumed negative impact of the merger. To the best of our knowledge, the public documents show no empirical analysis of the merger’s impact or the effect of the cure. Our model provides a way to evaluate these effects.

The rest of this paper is organized as follows. Section 2 introduces the research context. Section 3 presents the model. Section 4 discusses the estimation approach. Section 5 presents the empirical results. Section 6 presents and discusses the what-if scenarios central to our paper. We end with suggestions for future research in Section 7.
2. RESEARCH CONTEXT

Sports drinks are non-carbonated “isotonic” products that assist electrolyte balance during athletic activity; examples are Gatorade, Powerade and All Sport. It is a large market with domestic sales of $2 billion in 2000 and annual growth exceeding 10%. It is a differentiated oligopoly with products distinguished by brand image, ingredients, size, flavor, and price. Gatorade is the leading brand with Powerade (Coca-Cola) entering in 1994, and All Sport (Pepsi) entering in 1995. Together, these brands constituted 97% of the total U.S. market in 2000 (See Table 2).

Two distinct channels are used to reach end consumers. Gatorade utilizes a three-tier channel, where an independent wholesaler purchases products from the manufacturer, and resells them to retailers. Some large retail chains act as their own wholesaler, but in all cases, these wholesalers are vertically separated from the manufacturer. There are no cross-equity holdings or other forms of contractual integration. As such, the three-tier channel is vertically non-integrated. On the other hand, Powerade and All Sport utilize the two-tier direct-to-store-delivery (DSD) systems of Coca-Cola and Pepsi respectively. In these DSD systems, each manufacturer grants an exclusive territory to a local bottler who is closely tied to the parent company. For instance, in 1998, 77.3% of Coke’s volume (72.5% of Pepsi’s volume) went through bottlers who were either partially or fully vertically integrated with their manufacturer. Indeed, in 1989, Pepsi owned its bottlers in 23 of the 24 most heavily populated markets in the U.S, while Coca-Cola had an equity position in bottlers serving 21 of these 24 markets (Beverage Digest 1989).

DSD bottlers are franchisees who manufacture the products in their bottling plants using certain inputs such as concentrate purchased from the parent. They sell the products to the retailers in their territory through a vertically integrated operation whereby the products are delivered directly to each retail store. As such, this is a more vertically integrated channel than the wholesaler channel described above. Table 2 summarizes the channel structure in the sports drink market.

Further Institutional Details: DSD channels account for almost 25% of supermarket volume, and are prominent in categories such as beverages, breads, greeting cards, and snacks. DSD products

5 The retail channel accounts for 93.6% of total dollar sales, so we ignore the small volumes going through non-retail channels.
6 To be completely precise, the channel is partially vertically integrated, since there is an independent downstream retailer. In that sense, the switch we analyze is equivalent to examining the impact of partial vertical integration.
7 Most of these details are obtained from a study of E-Commerce opportunities in DSD channels, conducted by the Grocery Manufacturers of America (2002a).
categories tend to be high “velocity” categories that require frequent replenishment (some DSD goods are delivered daily), and/or impulse purchase categories that are sensitive to in-store merchandising efforts. The most tangible difference between our two channels is that DSD bottlers employ their own trucks to deliver the parent firm’s product line to each retail store. The bottler’s employees unload and stock the merchandise, and undertake point of sale (POS) merchandising and other promotional activities at the time of the visit. In effect, the upstream firm is responsible for managing shelf space, inventory, as well as planning and executing in-store merchandising.

In contrast to the exclusive territory and exclusive dealing contracts typical of DSD systems, the wholesaler purchases a wide range of products from a very large number of manufacturers who then deliver their own products to the wholesaler’s distribution center. Although multiple wholesalers may exist in the same locality, and specialty items such as ethnic foods may be procured by a retailer from a different wholesaler, any given category is always obtained from a single wholesaler. Following the receipt of orders from its retail accounts, the wholesaler’s distribution center picks and packs items from different manufacturers for delivery to the retail stores’ dock. At the retail store dock, the unloading and stocking tasks are done by the retailer.

In either channel, we can categorize the costs of going to market as consisting of (a) manufacturing costs incurred inside the factory, (b) carrying/transportation costs incurred inside the distribution center and the truck going to the retailer, and (c) handling/stocking costs incurred inside the retail store. However, the activities that drive these costs are undertaken by different entities in the two channels, which implies that the assignment of these costs also varies across the channels.

In the wholesaler channel, the upstream entities (the manufacturer and the wholesaler) incur the costs from the first two categories; viz. manufacturing and carrying costs. As such, the relevant (distribution) cost of the wholesaler channel consists of the carrying cost only. By contrast, the upstream entities in a DSD channel incur costs across all three categories. As such, the distribution cost for the DSD channel consists of both the carrying cost and the handling cost. There are a number of ramifications here.

First, the DSD channel is likely to cost the manufacturer more than a wholesaler channel. This is understandable given the much smaller range of products from a single manufacturer that is

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8 We do not refer to these as ‘distribution’ costs to avoid confusion in terminology with our use of distribution costs later in the discussion, and elsewhere in the paper.
9 We thank an anonymous reviewer for help in clarifying the differences between the DSD and wholesaler channels.
delivered more frequently and directly to a retailer’s shelves – fewer economies of scale and/or scope are realized in this fashion. For the retailer, the opposite is true because of the shifting of costly activities away from him.

Second, DSD channels generally use route drivers with high sales incentives to ensure that products are well stocked and merchandised. This is a crucial difference – industry studies by the Grocery Manufacturers of America (2002b) suggest that stock-outs cost the retailer about 4% of sales, or about $200,000 in annual sales for an average supermarket, quite apart from adversely impacting customer loyalty (to the brand and to the store).

Notice the costs and incentive differences across channels. On the one hand, better-stocked shelves, especially during promotions, are likely to increase sales and customer loyalty, which would favor the use of the DSD channel; on the other, distribution costs are higher in the DSD channel. In sum, each institution is a combination of costs and service levels whose net payoffs are unclear10.

3. MODEL

Figure 1 illustrates our model of the structure of this market. The three manufacturers are \( M_1 \) (Gatorade), \( M_2 \) (All Sport), and \( M_3 \) (Powerade). Notice that \( M_2 \) and \( M_3 \) are composite entities consisting of the brand-owner and its local bottler because of the extensive financial interlocks documented previously. \( M_1 \) sells its products to a wholesaler \( W \), while \( M_2 \) and \( M_3 \) sell their products through their respective DSD bottlers. Consumers purchase products from a monopolistic retailer who purchases products from the wholesaler and DSD bottlers.

3.1 Consumer Demand

Our approach follows BLP (1995) and Chintagunta et al. (2003) closely, and specifies a discrete choice random coefficients model of consumer utility at the store level, while accounting for observed and unobserved differences in consumers across stores. Specifically, we model each consumer as choosing among different products in the store to maximize her utility in each period. The utility of consumer \( i \) choosing product \( j \) in store \( s \) at time \( t \) is:

\[ U_{ijst} = \alpha_j + \beta_j X_{ijst} + \epsilon_{ijst} \]

\[ \alpha_j \] is a fixed effect for product \( j \), \( \beta_j \) is a random coefficient for product \( j \) with a normal distribution, \( X_{ijst} \) is a vector of observed characteristics of the product, consumer, store, and time, and \( \epsilon_{ijst} \) is a random error term.

One could ask why we don’t see cases where the manufacturer contracts with a wholesaler for the same level of services as the DSD system? Such an institution would offer the advantages of the two existing systems while mitigating their drawbacks. We do not delve into this issue, but believe an appeal to theories such as incomplete contracting (e.g. Williamson, 1985) is probably needed to justify the existence of these two institutional forms.
\[ U_{ijts} = \alpha_{ijs} + X_{jts} \beta + \theta_{is} p_{jts} + \xi_{jts} + \epsilon_{ijts}, \quad i = 1, \ldots, I; \quad j = 1, \ldots, J; \quad t = 1, \ldots, T; \quad s = 1, \ldots, S \]

where \( \alpha_{ijs} \) is consumer \( i \)'s time-invariant product preference\(^{11} \), \( p_{jts} \) is the retail price of product \( j \) at time \( t \) in store \( s \), \( X_{jts} \) is a \( T \times K \) matrix of independent variables such as promotion, \( \xi_{jts} \) is the mean of the random part of the consumer's unobserved preference for product \( j \) at time \( t \) in store \( s \), which is observed by both the manufacturer and consumers, but unobserved by the econometrician, and \( \epsilon_{ijts} \) is a random error term that follows an i.i.d. type 1 extreme valued distribution. An outside good is defined to capture the consumer's choice of not buying any product.

It is important to define more precisely the \( \alpha_{ijs} \) term and to distinguish it from the \( \xi_{jts} \) term. The \( \alpha_{ijs} \) term is a staple of brand-choice models in marketing, and represents the time-invariant product preferences of a consumer. As discussed earlier, service levels in DSD channels are higher than in wholesaler channels. These differences are likely to enhance preference for the product — \( \alpha_{ijs} \) also captures this effect, which we label the channel effect. Thus, the \( \alpha_{ijs} \) term captures both time-invariant intrinsic product preference (arising from product attributes, say), and differences in preference that arise from the higher service level of the channel. To ease exposition, in what follows we refer to the overall \( \alpha_{ijs} \) term as the product preference\(^{12} \), understanding that it consists of two components — intrinsic product preference and channel effect.

Consider the \( \xi_{jts} \) term. It captures time-varying factors, such as changes in shelf space allocation, in-store displays, or even a news article highlighting the dehydration fighting properties of sports drinks. These are observable to the consumer, and influence her brand choice, but they are unobservable to us. These factors are likely to be correlated with price, which leads to endogeneity issues that we discuss later. Note that \( \xi_{jts} \) is mean zero. As such, it does not capture the systematic, time-invariant portion of the channel effect, i.e., that portion of product preference that arises explicitly from the higher service levels of the channel (because the service levels are consistently higher, not random shocks).

Finally, we account for heterogeneity in consumer preferences in a manner similar to Chintagunta et al. (2003) by allowing both \( \alpha_{ijs} \) and \( \theta_{is} \) to vary across consumers, as a function of demographic store-specific variables (further details are provided in the Technical Appendix). Given

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\(^{11}\) We refer to this term as ‘product preference’ rather than the more commonly used ‘brand preference’ because in our case \( j \) denotes a product, which is a brand-size combination.

\(^{12}\) If one observed the same product going through two different channels, we could employ a channel dummy, and identify the channel effect separately from the intrinsic product preference effect.
the above, we can obtain the market share of any product \( j \) as a function of the demand side parameters. The demand side parameters are essentially estimated by trying to get these calculated market shares as close to the observed market shares as possible.

### 3.2 Supply Model

We model industry behavior by specifying horizontal competitive interactions among manufacturers\(^{13}\) while accounting for their vertical channel interactions with the wholesaler and retailer. These horizontal and vertical interactions give rise to a very rich space of possible games, including the horizontal games between the three manufacturers, and the vertical games between the three manufacturers and the wholesaler, as well as between the manufacturers/wholesaler and the retailer (e.g., Sudhir 2001). While we estimate all the possible games suggested above (a total of 30 games), we discuss and report only the best fitting game. All the games estimated, as well as the statistical test employed to pick between the games are described in detail in the Technical Appendix.

The game used in the paper is a Stackelberg game with \( M_1 \) (Gatorade) as a leader charging a uniform price to its wholesaler (McGuire and Staelin 1983). In stage 1, \( M_1 \) chooses prices to the wholesaler (\( W \)) for its products, conditional on other firms’ reactions. In stage 2, given \( M_1 \)’s wholesale prices, the wholesaler (\( W \)), and the other two manufacturers, \( M_2 \) and \( M_3 \), choose (uniform) wholesale prices to the retailer for their own products in a Bertrand-Nash game. Note that \( M_1 \) chooses a wholesale price equal to its marginal cost, i.e., the channel is vertically coordinated. Finally, in stage 3, the retailer chooses retail prices according to a brand management strategy.

More formally, let \( N_{it} \) denote the number of products produced by manufacturer \( M_i \) in week \( t \), and \( N_i \) denote the total number of products in the market in week \( t \) (\( N_i = \sum_i N_{it} \)). \( F_{it} \) denotes the set of products produced by manufacturer \( M_i \) in week \( t \). Thus, \( F_i \) is the total set of products in the market in week \( t \). Subscripts \( j \) and \( k \) denote products belonging to the manufacturers. The game is solved backwards, so we start with the retailer’s problem.

\(^{13}\) Although the bottlers actually manufacture the product in the DSD systems, we shall refer to the brand-owners (Pepsi, Coke) as the manufacturers.
**Specifying the Retailer’s Problem**

Given wholesale prices, the retailer chooses retail prices using a *brand management* strategy, which involves maximizing the sum of profits for the products from each of the three manufacturers individually:

\[
\text{Max } \Pi_{R_i} = \sum_{j \in F_i} (p_{jt} - w_{jt} - c^R_{jt})Q_{jt}(p) \quad i = 1, 2, 3
\]

where \( w_{jt} \) is the wholesale price for product \( j \) at time \( t \), \( c^R_{jt} \) is the retailer’s marginal cost for product \( j \) at time \( t \), and \( Q_{jt} \) is the quantity of product \( j \) at time \( t \).

The first order conditions are

\[
Q_{jt} + \sum_{k \in F_i} (p_{kt} - w_{kt} - c^R_{kt}) \frac{\partial Q_{jt}}{\partial p_{jt}} = 0 \quad \forall \ j \in F_i
\]

Written in matrix form, the price-cost margins for the retailer (R) are

\[
\text{PCM}_R = p_i - w_i - c^R_{jt} = -(TR \cdot \Delta_{1t})^{-1} Q_i
\]

where \( \Delta_{1t} \) is an \( N_t \times N_t \) matrix of marketing response to retail price, with

\[
\Delta_{1t}(i, j) = \frac{\partial Q_{jt}}{\partial p_{jt}} \quad \forall i, j \in F_i
\]

\( TR \) is an \( N_t \times N_t \) matrix indicating the retailer’s pricing strategy. In the brand management case this is given by:

\[
TR(k, j) = \begin{cases} 
1 & \text{if } k, j \in F_i, i = 1, 2, 3 \\
0 & \text{otherwise}
\end{cases}
\]

\( Q_i \) is a vector of quantities, and \( TR \cdot \Delta_{1t} \) is the element-by-element product of two matrices. We show how to calculate \( \Delta_{1t} \) in the Technical Appendix.

**Specifying the Manufacturers’ and Wholesaler’s Problem**

Stage 1: Gatorade (\( M_1 \)) chooses a uniform price to the wholesaler (\( W \)) for its products that is equal to its marginal cost, i.e., \( w^M_{jt} = c^w_{jt} \quad \forall \ j \in F_{1t} \).

Stage 2: Given \( M_1 \)'s wholesale prices, the wholesaler (\( W \)) and the other two manufacturers, \( M_2 \) and \( M_3 \), play Bertrand-Nash with each other to choose wholesale prices for their own products. The objective function for \( W \) is

\[
\text{Max } \Pi_{Wt} = \sum_{j \in F_t} (w_{jt} - w^M_{jt} - c^w_{jt})Q_{jt}(p).
\]
The first order conditions are

$$Q_{jt} + \sum_{k \in F_{it}} (w_{kt} - w_{kt}^{M_{i}} - c_{kt}^{w}) \frac{\partial Q_{it}}{\partial w_{jt}} = 0 \quad \forall \ j \in F_{1t}$$

Similarly, the objective functions for $M_2$ and $M_3$ are

$$\text{Max} \ \Pi_{M_{ij}} = \sum_{j \in F_u} (w_{jt} - c_{jt}^{M_{i}})Q_{jt}(p) \quad i = 2,3$$

where $c_{jt}^{M_{i}} (i = 2,3)$ is the joint cost of composite firm $i$, which comprises the manufacturer and the bottler. The first order conditions are

$$Q_{jt} + \sum_{k \in F_{it}} (w_{kt} - c_{kt}^{M_{i}}) \frac{\partial Q_{it}}{\partial w_{jt}} = 0 \quad \forall \ j \in F_{it}, \ i = 2,3$$

Written in matrix form, the price-cost margins for $W$, $M_2$, and $M_3$ are

$$PCM_{t} = -(T_{t} \cdot \Delta_{2t})^{-1} Q_{t}$$

where,

$$[PCM_{t}]_{ij} = \begin{cases} w_{jt} - w_{jt}^{M_{i}} - c_{jt}^{w} & \forall \ j \in F_{1t} \\ w_{jt} - c_{jt}^{M_{i}} & \forall \ j \in F_{it}, \ i = 2,3 \end{cases}$$

$\Delta_{2t}$ is an $N_t \times N_t$ matrix of marketing response to wholesale price, with

$$\Delta_{2t}(i, j) = \frac{\partial Q_{jt}}{\partial w_{jt}} \forall i, j \in F_{t}$$

We show how to calculate $\Delta_{2t}$ in the Technical Appendix.

$T_{t}$ is an $N_t \times N_t$ matrix indicating strategic interactions among $W$, $M_2$ and $M_3$,

$$T_{t}(k, j) = \begin{cases} 1 & \text{if } k, j \in F_{it} \\ 0 & \text{otherwise} \end{cases}$$

In stage 1, knowing the response of other firms, $M_f$ chooses prices for its products, equal to their marginal costs.

### 4. ESTIMATION

There are two preliminary methodological considerations. First, we employ a sequential estimation approach, wherein we start by estimating the demand function, and use these estimates to estimate the cost (margin) for supply models. This approach generates consistent and efficient
estimates for the demand side, and consistent, albeit inefficient, estimates for the supply model\textsuperscript{14}. Second, we instrument for price to avoid the downward endogeneity bias in the price coefficient.

4.1 Customer Demand Estimation

The principal outputs sought are the means and standard deviation of the coefficients of price, brand and the other variables in the random coefficient logit model (equation 1). We use the BLP procedure as detailed in Nevo (2000). Briefly, we first solve for the mean utility numerically using the BLP contraction mapping procedure. This yields a linear equation relating mean utility to the product preference dummies, prices, and other exogenous variables. From this, we run an IV regression (using suitable instruments for price), and use the residuals from this regression as the residuals in a GMM estimation\textsuperscript{15}.

4.2 Supply Model Estimation

The principal outputs sought are the marginal costs. Prior work has used two main approaches, with some efforts (e.g., Pinkse and Slade 2004) relying on external cost information, and other efforts (e.g., Besanko et al. 1998; Nevo 2001; Villas-Boas and Zhao 2005) estimating marginal costs through the pricing equations. We employ a hybrid approach. Let $c$ denote costs, with a superscript $M$, $W$, or $R$ indicating the manufacturer, wholesaler, and retailer respectively. Recall that each game leads to a certain implied price-cost margin; with estimates of demand-side parameters in place, we can calculate this price-cost margin for each game. This, in turn, leads to a supply equation where observed prices (wholesale or retail) can be expressed in terms of costs and margins. The costs, in turn, can be expressed in terms of a vector of input prices, such as wage rates (for the retailer) and plastic and sugar prices (for the manufacturer), as well as brand and size dummies. The following set of equations capture this formally.

Let PCM denote the price cost margin for each firm, with appropriate subscripts for the retailer and the manufacturers, and let $f(c, \gamma)$ denote the cost function expressed in terms of input

\textsuperscript{14} An advantage of sequential estimation is that it avoids contamination of demand side estimates due to specification error on the supply side. However, one needs to correct the variance-covariance matrix of the supply side estimates, because of the use of estimated parameters from the demand side in estimating the second stage. We do this following an approach suggested by Newey and McFadden (1994), and Berto Villas-Boas (2004).

\textsuperscript{15} More precisely, we use MSM estimation (Pakes and Pollard 1989) with 30 simulation draws.
prices, with appropriate superscripts as before. The pricing equations for the retailer practicing brand management are:

\begin{equation}
\begin{align*}
  p_{jt} &= w_{jt} + f(c_j^R \gamma^R) + \lambda_R \hat{PCM}_{R,j} + \epsilon_{1j} + \forall j \in F_t \\
  w_{jt} &= f(c_j^{M+w} \gamma^{M+w}) + \lambda_{M1} \hat{PCM}_{M1,j} + \lambda_{W} \hat{PCM}_{W,j} + \epsilon_{2j} + \forall j \in F_t
\end{align*}
\end{equation}

for products from \( M_1 \), and

\begin{equation}
\begin{align*}
  p_{jt} &= w_{jt} + f(c_j^R \gamma^R) + \lambda_R \hat{PCM}_{R,j} + \epsilon_{1j} + \forall j \in F_t; i = 2,3 \\
  w_{jt} &= f(c_j^{M,i} \gamma^{M,i}) + \lambda_{M,i} \hat{PCM}_{M,i,j} + \epsilon_{2j} + \forall j \in F_t; i = 2,3
\end{align*}
\end{equation}

for products from \( M_2 \) and \( M_3 \) respectively.

These pricing equations consist of \( 2N_t \) simultaneous equations, with the \( \gamma \) parameters to be estimated. Note that the price-cost margins in the above equations are not exogenous variables – they depend, for instance, on the response of shares to prices, which itself depends on prices. The endogeneity problem is similar to the one encountered on the demand side, and the solution is, as in that case, to instrument. Following Berto Villas-Boas (2004) the parameters are estimated using constrained GMM techniques, with the \( \lambda \)’s constrained equal to 1.

We end with a brief description of the moment conditions used in our GMM estimation. For ease of exposition, let \( u_t \) denote the prediction error for both the unobserved product attributes and the marginal costs for week \( t \). The moment conditions can be written as \( u_t'Z_t \), where \( Z \) denotes a vector of instruments. More formally, the orthogonality conditions are \( E[u_t'Z_t|Z_t] = 0 \). The instruments used are described in detail in our section on Empirical Analysis.

## 5. EMPIRICAL ANALYSIS

### 5.1 Data

Our data are from mid 1995 to late 1996. These data are principally drawn from a larger scanner based dataset collected at a supermarket chain in Chicago (Dominick’s Finer Foods), and made available by the Marketing Department of the University of Chicago\(^{16}\). The data set contains price to the retailer (wholesale price), price to the consumer (retail price), volume, and promotion of each UPC (bar code found on each stock keeping unit) for each store on a weekly basis. Although

\(^{16}\) In addition we used data on input prices – these are discussed in the section on Instruments, and described in further detail in Table 5.
these data have been extensively described elsewhere, we comment on the wholesale prices as they are quite central to the channel analysis. Dominick’s records wholesale prices at the average acquisition cost of inventory. Furthermore, these recorded numbers are the input costs used by managers in the plans. As such, they appear to be economically relevant to pricing decisions.

The pattern of observations for the promotion data shows that promotions vary across different sizes for the same brand. We therefore define each size of each brand as a “product” and analyze the market at the brand-size level.

Our estimation sample consists of 6 products carried by 68 stores over a 54 week period from roughly the end of 1995 to the end of 1996. Since our analysis is at the store level, we follow prior work (Chintagunta et al. 2003; Hoch et al. 1995) and use a number of demographic variables to specify differences across stores. These include income, age, and ethnicity, in addition to variables proxying for the competitive conditions faced by stores (e.g., distance from the nearest discount store). A complete list of these demographic variables, along with their descriptive statistics is given in Table 3. In addition, Figure 2 illustrates retail price variation for all products at a single store.

Finally, we define the size of the sports drinks market as follows. For each store, we observe the total number of consumers who visit each week. Assuming each consumer potentially consumes 10 oz. of sports drinks in a week, our market size measure (in ounces) is 10*(number of consumers visiting the store). Market shares for each store are volumes divided by this market size measure17.

The descriptive statistics in Table 4 show that Gatorade is the most expensive brand and has the largest share of sales. All Sport is the cheapest brand and has the second largest market share. Powerade is more expensive than All Sport, but it has the smallest share. Both All Sport and Powerade are more frequently promoted than Gatorade. Notice that the outside good’s market share is more than 90%. Thus, category penetration is still quite low, which accords with the high growth rate of the category.

5.2 Instruments

5.2.1 Instruments for Price

Recall that the $\xi_{jt}$ terms in equation 1 represent unobserved time varying features or demand shocks. It is highly likely that these time-varying shocks are correlated with the chosen prices, thus

17 We checked the robustness of our estimates using different definitions of the total market, e.g., defining the per person consumption as 3.3oz. Our results are qualitatively robust to such changes.
creating a potential endogeneity bias. We account for the endogeneity of prices by instrumenting for the price variable as follows.

We used lagged input prices multiplied by the product dummy as our instruments for price (Berto Villas-Boas 2004; Chintagunta et al. 2002). Our instruments included average wages of production workers, sugar prices, the producer price index for plastic bottles, and the federal funds effective rate (to proxy price of capital). In addition we also use input prices at the retail level, such as wage rates for grocery stores in Illinois. The logic behind using these specific instruments is a) input prices, such as the price of plastic and energy prices, would be correlated with retail prices (the link with wholesale prices is easier to see, and retail prices are very highly correlated with wholesale prices), and b) they are likely to be uncorrelated with the unobserved $\xi$ term. This seems reasonable, if one thinks of some of the time-varying effects $\xi$ captures, e.g., shelf space changes and stock-outs. It is very unlikely that input prices would reflect these shocks. The multiplication with product dummies is meant to ensure variation across products in the instruments (since most of them are generic, otherwise), and to allow for different products to use inputs differently (e.g., the Gatorade bottle may use more plastic than All Sport or Powerade). A complete list of instruments, along with their descriptive statistics, is given in Table 5. Since we do not know the proper lag a priori, we regressed retail price on these instrumental variables constructed at various lags, and found that 4-week lagged measures performed best ($R^2 = 0.8465$). We therefore use 4-week lagged instrumental variables in our estimations.

5.2.2 Instruments for Price-Cost Margins

On the supply side, the price-cost margins are the only endogenous variables. We use lagged price-cost margins as instruments for price-cost margins. We tried various lags and settled on one through four-period lagged price-cost margins as the best instruments ($R^2 = 0.9863$ for the retailer and 0.7598 for the manufacturer).

5.3 Results

5.3.1 Consumer Demand

The consumer demand results are reported in Table 6. In order to get a sense of the magnitude of the endogeneity and heterogeneity issues, we also ran two other specifications - an OLS estimation, and a simple logit estimation with instruments for price. Note that the OLS estimation
estimates the impact of a vector of demand variables on market shares, treating all the covariates as exogenous, and not accounting for unobserved heterogeneity. The simple logit model instruments for price, but does not account for unobserved heterogeneity. The random coefficients logit model both instruments for price and controls for unobserved heterogeneity. We find that accounting for price endogeneity makes a significant difference – the mean price sensitivity under OLS is −82.88, while that under simple logit estimation is −113.50. For instance, for Gatorade 32 oz. these estimates imply an own-price elasticity of −3.21 for the OLS model and −4.40 for the simple logit model, a 37% difference. Controlling for unobserved heterogeneity also makes a difference - the price coefficient is −113.50 for the simple logit model versus −133.30 for the random coefficients model, suggesting an own-price elasticity for Gatorade 32 oz. of −4.4 versus −4.9 respectively, a 12% difference.

Turning to the reported estimates (Table 6), first observe that Gatorade is the most popular brand (highest product preference, on average) followed by Powerade and All Sport. Second, the mean price coefficient is significantly negative (−133.30) and heterogeneous (S.D. price = 5.0463, significant at 1%), indicating different price sensitivity across customers. Third, both promotion (0.36) and the seasonal effect of summer (0.64) are positive and significant, which is consistent with the nature of this product category. Fourth, demographic and competitive characteristics that vary by store seem to have a significant effect on demand, and are of the right sign. For instance, the coefficient on Age60 (-9.19) suggests that as the percentage of shoppers over the age of 60 increases, the probability of purchasing in the sports drink category decreases. Similarly, the coefficient on Cub (0.10) suggests that as the distance from the nearest Cub Food store increases, the probability of purchasing in the sports drink category from the relevant Dominick’s store increases. Finally, except for Income, all the interactions between store demographics and prices, which represent observed heterogeneity in price sensitivities, are significant.

Table 7 gives the mean price elasticities for each brand-size. The dominance of Gatorade in the market is clear. In general, own-price elasticities are significantly greater than cross-price elasticities. One can tentatively conclude a number of things from this matrix. First, the pricing behavior of competitors is likely to have little impact on Gatorade. Second, price changes by Gatorade are likely to lead to changes in primary demand, rather than brand switching. Finally, note that the elasticity magnitudes are determined partly by the share of the outside good. Since this happens to be close to 90% in our case, cross-price elasticities are expectedly low, and most volume increases would come from category expansion.
The information at hand suffices for rough estimates of the possible strategic effects. Since the magnitude of the effect is directly related to the magnitude of cross-price elasticities, it is easy to see that the strategic effect is small in this market. Whether one considers joint pricing of All Sport and Gatorade, or the softening of competition through delegation, the incentives for collusion are small.

5.3.2 Supply Model
Tables 8a and 8b show the retailing costs and upstream costs for each of the products\textsuperscript{18}. Recall that for DSD, the upstream costs are comprised of manufacturing, carrying and handling costs, whereas for the wholesaler channel, they are comprised of manufacturing and carrying costs only. To compare the two channels, we need to isolate the distribution cost component from these estimates. The distribution cost component in either channel equals the total upstream cost minus the manufacturing cost. We discuss the identification of the distribution cost component briefly in the next section, and in detail in the Technical Appendix.

6. WHAT-IF ANALYSES
In this section, we study the potential consequences of Pepsi switching Gatorade into its DSD system. The ability to do such analysis is precisely the strength of using a structural approach, since we are interested in evaluating a prospective channel switch. Further, since we have argued that DSD channels offer higher service levels (albeit at higher cost) that could increase demand, we address the following question: How large a preference gain for Gatorade would overcome the cost increase arising from switching to the DSD channel?

Our analysis proceeds as follows. First, conditioning on the estimated demand function and cost structure, we calculate the equilibrium price, volume, and profit for each product for the best-fitting as-is model (viz., $M_1$ and $W$ coordinate vertically, $M_2$ and $M_3$ engage in Bertrand competition, and the retailer follows a brand management rule). Call this the base case. We then calculate the equilibrium price, volume, and profit for each product under the revised industry model for each what-if scenario, and compare them to the base case.

\textsuperscript{18} Cost estimates for all the games estimated, as well as moment-based tests to pick between the games, are reported in the Technical Appendix.
Since the costs estimated from the supply side are crucial to the counterfactual analysis that follows, we briefly discuss the identification of the distribution cost component. Each channel has costs associated with a) manufacturers, b) wholesaler or DSD bottler, and c) retailer. Notice, however, that our pricing equations involve combinations of some costs arising from observational limitations and/or game specifications.

Our games model manufacturers and bottlers in the DSD channels as composite entities. Furthermore, we do not observe prices to the bottlers from the manufacturers. As such, our econometric estimates in Table 8b show the upstream costs, $c^{M^c}$, of this composite entity derived from the pricing equations for the DSD channels. These costs can be usefully regarded as the expense of Powerade and All Sport going to market through Coke’s and Pepsi’s DSD systems respectively. Each manufacturer plus bottler margin can be obtained after deducting these costs from the price charged to the retailer.

For the counterfactuals, however, we need the distribution cost of the DSD channel – this is what is relevant if Gatorade is switched into the DSD channel. In the Technical Appendix, we show how publicly available accounting information is used to infer the ratio of the distribution cost to the upstream cost. Our calculated ratio of distribution cost to upstream cost for the DSD channel is $\theta_D = 0.40$.

Turning to the wholesaler channel, our econometric estimation yields the upstream cost, $c^{M^c+W}$. As above, this cost is the expense of Gatorade going to market through the wholesaler channel. Again, for our counterfactual experiments we need the distribution cost of the wholesaler channel. As above, we use publicly available accounting information and a methodology similar to the case of the DSD channel to infer the ratio of distribution costs to upstream costs. Our calculated ratio of distribution cost to upstream cost for the wholesaler channel is $\theta_W = 0.177$.

Finally, at the retailer level we observe prices to the retailer from both the wholesaler and the two bottlers, so our econometric estimates yield $c^r$ directly in Table 8a.

### 6.1 Base Case: Status Quo

Conditioning on estimated demand coefficients and cost estimates, we calculate the status quo equilibrium as follows. We solve the nonlinear system below for equilibrium prices (retail and wholesale) by using the observed values of the exogenous variables. The equations are identical to the earlier supply equations (equations 7 and 8), except for two differences. First, we now use the
estimated cost parameters (the $\hat{\gamma}$ estimates). Second, the price-cost margins are themselves non-linear functions of the retail and wholesale prices.

For $M_1$ we have:

(9) \[ p_{jt} = w_{jt} + f(c_j^{R} \hat{\gamma}^R_t) + PCM_{R,jt} \quad \forall \ j \in F_{1t} \]
\[ w_{jt} = f(c_j^{M+W} \hat{\gamma}^{M+W}_t) + PCM_{M,jt} + PCM_{W,jt} \quad \forall \ j \in F_{1t} \]

and for $M_2, M_3$ we have:

(10) \[ p_{jt} = w_{jt} + f(c_j^{R} \hat{\gamma}^R_t) + PCM_{R,jt} \quad \forall \ j \in F_{it}; i = 2,3 \]
\[ w_{jt} = f(c_j^{M} \hat{\gamma}^{M}_t) + PCM_{M,jt} \quad \forall \ j \in F_{it}; i = 2,3 \]

After solving for these prices, we calculate the share and volume for each product. Table 9 shows these calculations aggregated to the brand level and averaged over the 50-week observation period\(^{19}\). In each case, we also compute the change in consumer welfare, profits, and social welfare.

### 6.2 What-if Scenario: Gatorade moves to Pepsi’s DSD system

In order to compute the effects of Pepsi switching Gatorade ($M_1$) to its DSD channel, we need to specify the revised institutional structure with some precision.

**Scenario 1a:** On the demand side we assume that consumers’ mean preference for Gatorade is unchanged by the switch to Pepsi’s DSD channel, and that the potential market size remains unchanged. On the supply side we assume that a) Gatorade’s manufacturing costs remain unchanged\(^{20}\), b) its distribution costs change to the distribution cost associated with Pepsi’s DSD system, c) retailing costs remain unchanged, and d) the remaining two manufacturers play Bertrand-Nash with Pepsi maximizing profits of Gatorade and All Sport jointly to reflect its ownership of both brands. The retailer continues to follow the brand management rule from the base case.

What are the possible gains and losses to Pepsi as compared to the base case\(^{21}\)? Pepsi stands to gain from the strategic effect of pricing Gatorade and All Sport jointly. However, it stands to lose

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\(^{19}\) While we estimate demand over a 54-week sample period, we have only 50 weeks on the supply side, since we use 4-lagged price-cost margins as instruments. All our counterfactuals are therefore run for a 50-week period.

\(^{20}\) We relax this assumption in the counterfactual to follow.

\(^{21}\) Observe that removing double marginalization is never an advantage, since every game features coordinated pricing. Also, in order to isolate the magnitude of effects in play here, we do not consider changes in profit split or changes in service levels caused by the switch. We consider both these effects shortly.
from the (in)e
c
eficiency effect of moving Gatorade to a costlier DSD channel. We compute the net outcomes next.

We assemble the relevant costs as follows. The new upstream costs (sum of manufacturing and distribution costs) for Powerade and All Sport remain the same as with the base case, while the upstream costs for Gatorade change. We detail how to compute the new upstream cost for Gatorade in the Technical Appendix. The retailer costs remain the same as in the base case for all products.

Examining the manufacturers’ and retailer’s profit maximization problems, we have a system of nonlinear equations in which wholesale price, \( w_t \) and retail price, \( p_t \) are unknown. For each week, we insert the observed values of the exogenous variables, such as promotion and summer dummy, into these equations to solve for \( w_t \) and \( p_t \). We use these solutions to calculate the market share, volume, and upstream profit for each product. Table 9 (Scenario 1a) shows these quantities averaged over the 50-week observation period, and aggregated to the brand level.

**Summarizing Outcomes:** Gatorade’s post-switch market share and upstream profits decrease 10.9% and 11.4% respectively. Meanwhile, All Sport’s market share decreases 1.9%, but its upstream profit increases 2.7%. Finally, Powerade’s market share increases by 4.5% and profits increase by about 2.7%. Pepsi would clearly lose by switching Gatorade to its DSD system.

### 6.2.1 Gatorade’s Manufacturing Cost Declines After Switch (Scenario 1b)

In the scenario above, we assumed that the manufacturing cost of Gatorade remained the same after the switch to Pepsi’s DSD channel. One might argue that each party’s strengths might be leveraged in a post merger world to create synergies that reduce Gatorade’s manufacturing cost. Specifically, we assume that Gatorade’s manufacturing cost now reduces to All Sport’s manufacturing cost level. This implies that Gatorade’s total upstream cost is identical to that of All Sport, since it inherits All Sport’s distribution cost after the switch. Estimating this counterfactual (Table 9, Scenario 1b) shows that Gatorade’s profits go up 39% and its market share goes up 30.7%. This is because of the large fall in total upstream costs for Gatorade (cost reduction of $0.0042/oz, roughly 33% of existing manufacturing costs for Gatorade 32 oz.). To put this in perspective, we pose a related question: How much does Gatorade’s manufacturing cost have to fall for the switch to be

\[ \text{\textsuperscript{22}} \text{We thank an anonymous reviewer for suggesting this line of reasoning.} \]
profit neutral? This number is $0.0018/oz., or roughly, 14% of Gatorade’s existing manufacturing cost (32 oz.).

Clearly, any leveraging of manufacturing cost efficiencies after the merger is good for Gatorade. However, how likely are such manufacturing cost decreases? Some insight is obtained from noting that Gatorade is produced via a ‘hot-fill’ process, while both All Sport and Powerade are manufactured using a cheaper ‘cold-fill’ process. If Pepsi acquires Gatorade, it has the choice of switching Gatorade to its bottlers’ existing cold-fill system, or else setting up a hot-fill system de novo. Either option has advantages and drawbacks. Our conversations with industry participants suggest that the taste of a beverage depends on the process used. As such, switching production methods might reduce costs, but might also adversely affect product preference. In sum, manufacturing cost reductions are likely, but so are downward demand shifts.

We can also calculate the amount by which Gatorade’s manufacturing cost would have to fall for the change to be neutral in terms of social welfare. Social welfare is the sum of two components – producer welfare (the sum of firms’ profits) and consumer welfare. We briefly discuss the calculation for consumer welfare, since producer welfare is straightforward to calculate. We calculate a break even in terms of consumer welfare using Hicksian (compensating) variation, which is the dollar amount by which consumers would need to be compensated to keep their level of utility the same before and after the change. Denote an individual i’s utility of income, for store s, as \( \theta_{is} \). Suppose the channel switch changes a consumer’s evaluation of an alternative from \( V^0 \) to \( V^1 \). Then the dollar amount by which consumer \( i \) must be compensated to be as well-off post-switch, as she was pre-switch is:

\[
CV_{is} = \frac{\log\left(\sum_{j=0}^{J} \exp(V_{jis}^0)\right) - \log\left(\sum_{j=0}^{J} \exp(V_{jis}^1)\right)}{\theta_{is}}
\]

For a store, the expected consumer welfare change is:

\[
\Delta W_s = M_s \int_{-\infty}^{\infty} \ldots \int CV_{is} \phi(\nu) d\nu
\]

where \( M_s \) is the market measure of store \( s \).

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23 In a hot-fill system, exactly as the name suggests, bottles are filled with a beverage hot enough to sterilize the inside of the bottle. This had always been done with glass bottles, because pouring a hot liquid into a plastic bottle would cause the latter to warp when the liquid cooled. Gatorade pioneered the use of hot-fill plastic bottles. This was a significant technological leap, with immediate dividends – changing from glass to plastic bottles is credited with an almost 25% increase in sales volume within a year (Rovell 2005).
The expected consumer welfare change for the retail chain is:

\[ \Delta W = \sum \Delta W_s. \]

The social welfare calculation yields $0.0017/oz, which is roughly 13% of existing manufacturing costs for Gatorade 32 oz. This number is very similar to the profit break-even calculated earlier, suggesting that policy consequences would be virtually identical, whether based on profit considerations or social welfare. This is seen in Figure 3, which plots Gatorade’s profits, consumer welfare, and social welfare as a function of changes in Gatorade’s manufacturing cost. The break even numbers are very similar using any of these criteria.

The next counterfactual proposes to separate the efficiency effects from the strategic effects.

### 6.2.2 No Joint Pricing of All Sport and Gatorade (Scenario 1c)

This simulation is identical to Scenario 1a, except that Pepsi now chooses prices for Gatorade and All Sport independently. Institutionally, this would represent Pepsi divesting All Sport, but continuing to distribute it through its DSD system. The difference from Scenario 1a is the change in the strategic effect – Pepsi can no longer benefit from any collusion in price setting between Gatorade and All Sport. As above, we solve the new games and obtain the predicted outcomes. We compare the results from this counterfactual against scenario 1a and attribute the difference solely to the impact of removing collusive pricing.

**Results:** From Table 9 (Scenario 1c), it is clear that there is very little impact on either Gatorade or Powerade (as compared to scenario 1a). Gatorade’s profits decline by about 90¢/week (0.01%) while Powerade’s profits increase by $2.40/week (0.59%). Wholesale prices for both brands barely change. All Sport’s retail and wholesale prices decline, while market shares and profits go up slightly.

**Summarizing Results: Should Pepsi Switch Gatorade?** Our results give us insight into the net effects of Gatorade’s switch to DSD as well as the magnitudes of the components of this net effect. Regarding the components of the effect, the evidence above suggests that the strategic effect is much smaller than the efficiency effect in that there is a large cost effect shown in scenario 1a while there is a negligible collusion effect shown in scenario 1c. Regarding the net effect, the simulation so far tells us that expected upstream profits are 11.4% smaller if Pepsi switches Gatorade (unless the switch is
accompanied by a minimum of a 14% decline in manufacturing cost). On the face of it, Pepsi should not switch Gatorade to its DSD channel. We explore the conditions under which this conclusion might be reversed.

The Importance of Share of Profit: Note that the decline in upstream profits from Gatorade’s switch to DSD cannot be separated out into Pepsi’s own profits versus its DSD bottler’s profits without additional information about the manner in which the parties split the profits. Since this split is not determinate from the game model itself, we draw on two contrasting perspectives to gain insight into the nature of the split. From the literature on power in franchised channels, one might argue that Pepsi exerts more control over its bottler than it does over a wholesaler. As such, its share of upstream profits is likely to be greater in the DSD channel. This increase might well offset the 11.4% decline in upstream profits per se. By contrast, a Coasian efficiency view would hold that parties choose institutional regimes that yield the highest total profits. Clearly this latter view would argue against the switch to a DSD channel.

Regardless of which view one holds, we can compute the break-even increase in profit share that offsets the decline in upstream profit. Note that the upstream profits (Table 9, Column 8, Row 4) of Gatorade in the base case (wholesaler channel) are $8953.3. Denote Gatorade’s fraction of this profit in the wholesaler channel as $b_w$. If Gatorade is switched to Pepsi’s DSD system, the profit declines to $7935.1 (Column 8, Row 7). Denote Gatorade’s fraction of this profit as $b_{DSD}$. If $b_{DSD} \geq (8953.3/ 7935.1) * b_w$, which equals 1.13*b_w, then Pepsi should switch Gatorade to the DSD channel. In other words, Pepsi needs a 13% increase in its share of upstream profits to make the switch feasible.

One final effect has yet to be studied, namely, the increase in demand that might result from the higher service levels that DSD channels provide. We turn to this task below.

6.2.3 Examining the DSD Tradeoff: Increased Cost versus Enhanced Demand (Scenarios 2,3)

Efficiency arguments suggest that firms would seek out the lowest cost channel to execute desired activities. This leads to a trade-off, because the DSD channel, while being more expensive, also provides higher levels of in-store marketing activities, e.g., better shelf stocking, better point-of-sale promotion activities, etc. To the extent that consumers are responsive to these efforts, such

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24 As mentioned earlier, this is precisely what Pepsi did do, in an apparent concession to anti-trust authorities.
activities should raise demand. How much would demand have to increase to offset the increased costs of the DSD channel? Alternatively, one could pose the converse of this question by considering a situation where All Sport switches from the DSD channel to a wholesaler. Since distribution costs decline due to the switch, the relevant question would be: what is the maximum demand decrease that All Sport can afford, while still breaking even? We address each of these questions below.

**Demand Enhancement Needed for Gatorade In DSD Channel (Scenario 2):** In our model, demand enhancement manifests itself in two ways. The first way is through an increase in the time-invariant $\alpha_{ij}$ term, which captures preferences arising from intrinsic product characteristics as well as preference arising from channel service levels. Second, the demand increase might be due to unobservable shocks, which are captured by the time-varying $\xi_{jts}$ term. Our goal is to pinpoint the channel effect, but as discussed earlier, our $\alpha_{ij}$ term denotes both intrinsic product preference and the channel effect, because we cannot isolate the components. As such, we calculate the magnitude of demand enhancement needed using $\alpha_{ij}$, whilst recognizing that the channel switch is unlikely to impact the intrinsic product preference part of it\(^{25}\). Ideally, we would have information on the factors that would affect demand, i.e., shelf space, stock-outs, etc. We could then estimate a model of the choice of effort level by the channel member, which would take into account the cost of such effort and its impact on demand. Absent such data, we fall back on a simpler break-even calculation.

We equate Gatorade’s pre-switch upstream profits with its post-switch profits, and solve the amount by which Gatorade’s product preference would have to increase to offset the enhance costs of DSD\(^{26}\). This calculated quantity increase in Gatorade’s product dummy is 0.2068, which is equivalent to the demand increase arising from a price cut of 4.96¢ for a 32oz. package of Gatorade. To put this in perspective, note that this is roughly a 3.7% price cut, while the average promotional price cut in the data is about 20%. We perform a similar calculation to calculate the break-even in terms of consumer welfare (using Hicksian compensating variation) as well as social welfare. The calculated increase required in Gatorade’s product dummy under the consumer welfare criterion is 0.234, which is equivalent to the demand increase arising from a 5.63¢ price cut for Gatorade 32 oz.. The

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\(^{25}\) We do not consider the $\xi_{jts}$ term when focusing on the demand enhancement, because our emphasis is on enduring institutional differences between channels, not on transitory demand changes that might arise from a one-week change in shelf space allocation. It is useful to reiterate that $\alpha_{ij}$ is time invariant, while $\xi_{jts}$ varies with time and has a zero mean. The latter is thus better viewed as a ‘shock’, positive or negative, while the former is a more enduring difference.

\(^{26}\) It is important to emphasize that the break-even calculation is illustrative of how much demand would need to change, not the costs of changing it.
equivalent number using the social welfare criterion is 0.2244, which is equivalent to the demand increase arising from a price cut of 5.39¢ for a 32oz. package of Gatorade.

Clearly, all three criteria give very similar results. This is demonstrated in Figure 5, which plots Gatorade’s profits, consumer welfare, and social welfare as a function of changes in Gatorade’s product preference.

**Equilibrium Outcomes:** What are the equilibrium prices given these levels of increase in Gatorade product preference with a switch to DSD? The answer to this question is not straightforward because Gatorade could a) increase prices, b) increase market share, or c) implement some combination of a) and b). We address this issue by re-computing Scenarios 2a, 2b, and 2c in Table 9, with Gatorade’s product preference set equal to our computed values under the profit, consumer welfare, and social welfare criteria respectively. Since the three criteria yield very similar outcomes, we discuss the social welfare case. Compared to the base case (no switch), retail prices go up 4.6%. To put this in perspective, recall that the retail price after switch, assuming no product preference increase (scenario 1a) was 3.3% over the base. Evidently, Gatorade prices do not increase very much from an increase in preference for its products. Turning to market share outcomes, we see that market share decreases 0.4%. By comparison, without the product preference increase, the comparable number was a 10.9% decrease. To sum up, the product preference increase arising from the DSD channel leads principally to a much smaller reduction in volume.

The sensitivity of these equilibrium profit and market share outcomes to the size of the improvement in product preference is shown in Figures 4a and 4b. The relatively small impact on competition stands out. All Sport and Powerade market shares and upstream profits change by small amounts, which are dwarfed by the increases in Gatorade’s volume, share and upstream profits. In fact, our computations reveal that most of the increase to Gatorade derives from new customers (the outside good in the model). Thus, moving Gatorade to Pepsi’s DSD system appears to be a fruitful way to increase the primary demand for this product and category.

**Lower Bound Of Demand Shift Permissible for All Sport in Wholesaler Channel (Scenario 3a,b):** We perform an analysis identical to the above, assuming that All Sport moves from its existing DSD channel to a wholesaler channel27. We assume manufacturing costs remain the same. As before, we calculate the lower bound for the demand shift (decrease) permissible by equating All Sport’s pre-

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27 We thank an anonymous reviewer for suggesting this analysis.
switch upstream profits to its post-switch profits. The new prices and market shares are given in Table 9 as Scenario 3a. The calculated value for All Sport’s product preference decrease is –0.1825. This is equivalent to the demand decrease arising from a price increase of 4.38¢ for a 32oz. package of All Sport, roughly 3.8% on average. In scenario 3b, we apply this magnitude of change to Gatorade’s switch from wholesaler to DSD, and re-compute the new prices, market shares and profits. Gatorade’s market share drops 2.4% and profits drop 1.4%. Note that since the magnitude of the demand enhancement effect here is smaller than that in scenario 2 (Gatorade’s break-even), Gatorade is slightly worse off in this case than it was in scenario 2.

6.3 Summing up the What-if Analyses

We summarize the outcomes of our econometric estimation as well as the counterfactuals above, especially the magnitudes of the efficiency and strategic effects that comprise the total effect.

Efficiency Effects: Recall that our efficiency effects included pricing effects, physical distribution costs, and service level changes. Both the fact that the wholesaler channel is vertically coordinated (which removes double marginalization) and that distribution costs are higher in the DSD channel (by about 65%) suggest that efficiency is not a reason to switch to DSD. It is easy to see that the fall in profits from the switch (11.4%, scenario 1a) is driven largely by these factors. Finally, our simulations describe the extent to which Gatorade product preference would have to be enhanced through service level changes to overcome the losses from higher distribution costs. This number is equivalent to the demand enhancement arising from a price cut of 4.96¢ for a 32 oz. package.

Strategic Effects: There are two types of strategic effects at play here. First, the fact that Pepsi owns Gatorade gives it the ability to jointly price Gatorade and All Sport (the brand it already owned). This horizontal merger effect was addressed in Scenario 1c, and was found to be very small. In addition, and more subtly, the prior literature has pointed to the ability of the upstream principals to soften competition between themselves by inserting an intermediate layer (delegation). This is precisely what a shift from a DSD to a wholesaler channel would do. Following Bonanno and Vickers (1988), we calculate the magnitude of this vertical strategic effect, and find it is insignificantly different from zero.28

28 Details of the calculation are in the Technical Appendix.
7. FUTURE RESEARCH AND CONCLUSIONS

The central question this paper tried to answer was: How can one assess the outcomes of a channel change, given the multiple causal influences at work? We have tried to answer this question for a specific context, viz. Gatorade being moved into Pepsi’s DSD system. This is the first study to explicitly model and estimate the equilibrium effects of a channel change, while accommodating multiple levels of competition, both horizontal and vertical, and heterogeneous channels. Our empirical analysis examines the impact of different channel structures on profits, consumer welfare, and social welfare. While we find that the switch to a costlier channel has the expected deleterious consequences on social welfare, we are able to provide bounds on both demand enhancement and cost reduction that would justify the switch. This is useful to both managers and antitrust authorities. The utility to the former is fairly clear – the counterfactual analyses in the paper can be used to calculate a number of outcomes, such as market shares, profits, and prices, when contemplating a channel switch. A manager can thus analyze a variety of scenarios (e.g., possible values for demand enhancement, possible lowering of manufacturing cost, possible reactions by competitors) before deciding on a course of action.

As for antitrust authorities, although they are leaning more heavily towards structural analysis of the type undertaken here for horizontal mergers, there is little attention to assessing vertical effects. Indeed as we remarked earlier, there is no template at present to evaluate vertical mergers. At best, vertical mergers are presumptively viewed as benign unless there are horizontal mergers involved as well. Since horizontal mergers often involve vertical changes, as in the case at hand, our method is a useful addition to the analysis of both horizontal and vertical mergers. Finally, one can follow a similar approach to address a number of other vertical issues of interest, such as exclusive dealing and exclusive territories. The presumptive efficiency properties of these vertical contracts can be compared against potential adverse outcomes given data on the vertical ties.

How generalizable are our principal results? For instance, is the strategic effect larger than the efficiency effect in other contexts? A fruitful line of inquiry would be to estimate the impact of a channel change in markets with a number of more equally sized competitors, and where the category is reasonably saturated. Both these factors would enhance the magnitude of cross-price elasticities, and presumably the strategic effect. While we cannot generalize about the primacy of efficiency effects from our data, these inquiries would enable us to shed light on the empirical ramifications of the ‘economizing versus strategizing’ debate initiated by Williamson (1991). Along similar lines,
there has been discussion lately about the role dominant retailers can play in a channel (Raju and Zhang 2005). For instance, Coca-Cola is facing law suits from some of its bottlers because of a recent decision to bypass its DSD system and deliver Powerade to Wal-Mart’s warehouses, reflecting the latter’s preferences (Wall Street Journal, 2006). It would be interesting to examine the dynamics of a channel switch decision in the presence of a dominant retailer.

The preceding discussion suggests limitations of this work that could provide opportunities for further research. Perhaps most importantly, we were unable to disentangle the various sources of efficiency effects, and the impact of various factors leading to enhanced demand under DSD. One could do this by explicitly modeling intermediaries making effort decisions about service levels, given costs of effort. This does not involve new modeling challenges, but it does require more data. Principally, we need data on activities undertaken in both channels, such as delivery frequency and stocking frequency, which would let us model a cost function explicitly.

Second, our approach has, for reasons of both tractability and data availability, focused on only some aspects of Pepsi’s strategy. It is unclear, for instance, whether in the larger scheme of things, PepsiCo’s strategy for Gatorade turns on production or marketing considerations. To address the issue more completely, one would have to consider Gatorade’s role in PepsiCo’s broader product line. For instance, while we have alluded to manufacturing cost and manufacturing method differences (cold versus hot fill), PepsiCo’s hot-fill facility in Indianapolis distributes a number of non-carbonated drinks beyond Gatorade, including Propel, Tropicana and other juices. This, along with high advertising expenditures on Gatorade, Propel, and other noncarbonated products ($183 million on Gatorade and $53 million on Propel in 2005), suggests that Gatorade is part of a more general noncarbonated beverage marketing strategy for Pepsi. Finally, the paper is silent on a host of issues surrounding product innovation, that could well affect consumer demand, perhaps in interaction with the channel switch. Thus, PepsiCo recently touted the innovativeness of the new Gatorade Rain sub-line, as well as announced a 140,000-square-foot expansion of Gatorade’s AmeriPlex facility to centralize warehousing and distribution. To sum, it would be fruitful to examine the specific institutional features of our research context in greater detail, and attempt to incorporate them in future models.

29 We thank the Editor for suggesting these extensions.
30 The Gatorade number is from Beverage Digest, while the Propel number is from Nielsen Monitor-Plus.
Table 1: Product Categories with Heterogeneous Channels

<table>
<thead>
<tr>
<th>Category</th>
<th>Product &amp; channel</th>
</tr>
</thead>
</table>
| Potato Chips| **DSD:** Frito Lay, Old Dutch  
              **Wholesale:** Wahooos, BestYet |
| Cookies     | **DSD:** Nabisco (Ritz, Kraft), Keebler (Club), Pepperidge Farm  
              **Wholesale:** BestYet |
| Ice Cream   | **DSD:** Haagen-Dazs, Ben & Jerry, Edy’s  
              **Wholesale:** Breyers, Kemps |

Table 2: Sports Drink Market: Channel Structure and U.S. Market Share in 2000

<table>
<thead>
<tr>
<th>Brand</th>
<th>Market Share (%)</th>
<th>Distribution Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pepsi’s All Sport</td>
<td>3</td>
<td>DSD</td>
</tr>
<tr>
<td>Coke’s Powerade</td>
<td>11</td>
<td>DSD</td>
</tr>
<tr>
<td>Quaker Oats Gatorade</td>
<td>83</td>
<td>Wholesale channel</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Note: The above information is obtained from *Beverage Digest.*
Table 3: Demographic Information Across Stores

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>S. D.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE60</td>
<td>0.1775</td>
<td>0.0639</td>
<td>0.0581</td>
<td>0.3074</td>
</tr>
<tr>
<td>ETHNIC</td>
<td>0.1627</td>
<td>0.2025</td>
<td>0.0242</td>
<td>0.9957</td>
</tr>
<tr>
<td>INCOME</td>
<td>10.6140</td>
<td>0.3051</td>
<td>9.8671</td>
<td>11.2362</td>
</tr>
<tr>
<td>HVALMEAN</td>
<td>148.63</td>
<td>47.13</td>
<td>64.35</td>
<td>267.39</td>
</tr>
<tr>
<td>SHOPINDX</td>
<td>0.7347</td>
<td>0.2435</td>
<td>0.0000</td>
<td>0.9863</td>
</tr>
<tr>
<td>CUBDIST</td>
<td>6.2995</td>
<td>3.7586</td>
<td>0.1321</td>
<td>17.8560</td>
</tr>
<tr>
<td>OMNIDIST</td>
<td>7.6019</td>
<td>5.2540</td>
<td>0.9662</td>
<td>31.4040</td>
</tr>
</tbody>
</table>

Income: Log median income
Age60 (%): % of population over age 60
Ethnic (%): % of population that are black or Hispanic
HVAL: Mean household value
Shopindx: Ability to shop: % of population with car and single family house
Cub (miles): The distance from the nearest Cub Foods
Omni (miles): The distance from the nearest Omni.

Table 4: Descriptive Statistics for Brand-Size Combinations

<table>
<thead>
<tr>
<th>Product</th>
<th>Retail Price ($/oz)</th>
<th>Wholesale Price ($/oz)</th>
<th>Promotion (%)</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sport 32 oz.</td>
<td>0.0356</td>
<td>0.0245</td>
<td>0.5863</td>
<td>0.0053</td>
</tr>
<tr>
<td>Powerade 32 oz.</td>
<td>0.0383</td>
<td>0.0257</td>
<td>0.3296</td>
<td>0.0039</td>
</tr>
<tr>
<td>Gatorade 20 oz.</td>
<td>0.0541</td>
<td>0.0382</td>
<td>0.0167</td>
<td>0.0076</td>
</tr>
<tr>
<td>Gatorade 32 oz.</td>
<td>0.0415</td>
<td>0.0296</td>
<td>0.1045</td>
<td>0.0189</td>
</tr>
<tr>
<td>Gatorade 64 oz.</td>
<td>0.0403</td>
<td>0.0291</td>
<td>0.0359</td>
<td>0.0232</td>
</tr>
<tr>
<td>Gatorade 128 oz.</td>
<td>0.0378</td>
<td>0.0280</td>
<td>0.0362</td>
<td>0.0193</td>
</tr>
</tbody>
</table>
Table 5: Descriptive Statistics for Input Prices

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar (cents/lb)</td>
<td>11.771</td>
<td>1.184</td>
<td>9.870</td>
<td>14.980</td>
</tr>
<tr>
<td>Plastic Bottle</td>
<td>124.118</td>
<td>2.534</td>
<td>120.500</td>
<td>128.500</td>
</tr>
<tr>
<td>Interest rate 1 (%)</td>
<td>5.584</td>
<td>0.321</td>
<td>5.080</td>
<td>6.210</td>
</tr>
<tr>
<td>Interest rate 2 (%)</td>
<td>5.673</td>
<td>0.301</td>
<td>5.120</td>
<td>6.240</td>
</tr>
<tr>
<td>W_SD ($/hr)</td>
<td>12.749</td>
<td>0.255</td>
<td>12.160</td>
<td>13.290</td>
</tr>
<tr>
<td>W_G ($/hr)</td>
<td>8.367</td>
<td>0.147</td>
<td>8.150</td>
<td>8.640</td>
</tr>
<tr>
<td>W_G IL ($/hr)</td>
<td>9.543</td>
<td>0.088</td>
<td>9.340</td>
<td>9.670</td>
</tr>
<tr>
<td>W_W ($/hr)</td>
<td>12.276</td>
<td>0.178</td>
<td>11.970</td>
<td>12.590</td>
</tr>
<tr>
<td>W_W IL ($/hr)</td>
<td>12.514</td>
<td>0.145</td>
<td>12.310</td>
<td>12.830</td>
</tr>
<tr>
<td>W_IN ($/hr)</td>
<td>12.844</td>
<td>0.260</td>
<td>12.400</td>
<td>13.520</td>
</tr>
<tr>
<td>W_IL ($/hr)</td>
<td>13.145</td>
<td>0.209</td>
<td>12.740</td>
<td>13.490</td>
</tr>
<tr>
<td>E_C IL (¢/KwH)</td>
<td>7.973</td>
<td>0.594</td>
<td>6.890</td>
<td>8.920</td>
</tr>
<tr>
<td>E_I_IN (¢/KwH)</td>
<td>3.932</td>
<td>0.057</td>
<td>3.820</td>
<td>4.080</td>
</tr>
<tr>
<td>E_I IL (¢/KwH)</td>
<td>5.290</td>
<td>0.419</td>
<td>4.700</td>
<td>6.090</td>
</tr>
</tbody>
</table>

Variable Definition and Data Sources:
Sugar: Sugar price (Coffee, Sugar and Cocoa Exchange).
Interest rate 1: Federal funds effective rate (Federal Reserve).
Interest rate 2: Commercial Paper 3 month (Federal Reserve).
E_C IL: Average Revenue Per KWH -Commercial (¢/KwH), IL (Energy Information Administration)
E_I IL: Average Revenue Per KWH -Industrial (¢/KwH), IL (Energy Information Administration)
E_I IN: Average Revenue Per KWH -Industrial (¢/KwH), IL (Energy Information Administration)
<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sports 32oz</td>
<td>-2.8865**</td>
<td>0.1826</td>
</tr>
<tr>
<td>Powerade 32oz</td>
<td>-2.5188**</td>
<td>0.1871</td>
</tr>
<tr>
<td>Gatorade 20oz</td>
<td>1.6610**</td>
<td>0.2462</td>
</tr>
<tr>
<td>Gatorade 32oz</td>
<td>-0.9233**</td>
<td>0.1940</td>
</tr>
<tr>
<td>Gatorade 64oz</td>
<td>-0.6952**</td>
<td>0.1851</td>
</tr>
<tr>
<td>Gatorade 128oz</td>
<td>-0.9380**</td>
<td>0.1739</td>
</tr>
<tr>
<td>Price</td>
<td>-133.3054**</td>
<td>4.5262</td>
</tr>
<tr>
<td>S.D. price</td>
<td>5.0463**</td>
<td>0.0669</td>
</tr>
<tr>
<td>Summer</td>
<td>0.6403**</td>
<td>0.0123</td>
</tr>
<tr>
<td>Promotion</td>
<td>0.3667**</td>
<td>0.0392</td>
</tr>
<tr>
<td>Income</td>
<td>0.8895**</td>
<td>0.3361</td>
</tr>
<tr>
<td>Age60</td>
<td>-9.1908**</td>
<td>0.6310</td>
</tr>
<tr>
<td>Ethnic</td>
<td>-4.0721**</td>
<td>0.3214</td>
</tr>
<tr>
<td>Hval</td>
<td>-0.0188**</td>
<td>0.0014</td>
</tr>
<tr>
<td>Shopindx</td>
<td>1.2797**</td>
<td>0.3540</td>
</tr>
<tr>
<td>Cub</td>
<td>0.1068**</td>
<td>0.0119</td>
</tr>
<tr>
<td>Omni</td>
<td>0.0201**</td>
<td>0.0070</td>
</tr>
<tr>
<td>Price*Income</td>
<td>5.3646</td>
<td>7.8190</td>
</tr>
<tr>
<td>Price*Age60</td>
<td>149.4965**</td>
<td>14.740</td>
</tr>
<tr>
<td>Price*Ethnic</td>
<td>59.3851**</td>
<td>7.1697</td>
</tr>
<tr>
<td>Price*Hval</td>
<td>0.4133**</td>
<td>0.0331</td>
</tr>
<tr>
<td>Price*Shopindx</td>
<td>-28.5514**</td>
<td>8.1706</td>
</tr>
<tr>
<td>Price*Cub</td>
<td>1.3451**</td>
<td>0.2788</td>
</tr>
<tr>
<td>Price*Omni</td>
<td>0.5718**</td>
<td>0.1695</td>
</tr>
</tbody>
</table>

**Note:**
1. ** Significant at 1% level; * Significant at 5% level
2. The demographic variables are mean-centered in the estimation.
3. GMM criterion function =1.96 x10^-2; p-value for Hansen’s J test = 0.36.
Table 7: Elasticity Matrix

<table>
<thead>
<tr>
<th></th>
<th>A32</th>
<th>P32</th>
<th>G20</th>
<th>G32</th>
<th>G64</th>
<th>G128</th>
</tr>
</thead>
<tbody>
<tr>
<td>A32</td>
<td>-4.545</td>
<td>0.062</td>
<td>0.027</td>
<td>0.313</td>
<td>0.475</td>
<td>0.381</td>
</tr>
<tr>
<td></td>
<td>(-4.825,-4.282)</td>
<td>(0.040,0.084)</td>
<td>(0.015,0.048)</td>
<td>(0.217,0.395)</td>
<td>(0.353,0.581)</td>
<td>(0.274,0.473)</td>
</tr>
<tr>
<td>P32</td>
<td>0.098</td>
<td>-4.999</td>
<td>0.030</td>
<td>0.274</td>
<td>0.419</td>
<td>0.326</td>
</tr>
<tr>
<td></td>
<td>(0.066,0.134)</td>
<td>(-5.307,-4.711)</td>
<td>(0.017,0.055)</td>
<td>(0.191,0.351)</td>
<td>(0.310,0.517)</td>
<td>(0.236,0.411)</td>
</tr>
<tr>
<td>G20</td>
<td>0.012</td>
<td>0.009</td>
<td>-6.724</td>
<td>0.036</td>
<td>0.052</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>(0.008,0.017)</td>
<td>(0.006,0.012)</td>
<td>(-7.238,-4.165)</td>
<td>(0.025,0.049)</td>
<td>(0.037,0.069)</td>
<td>(0.030,0.058)</td>
</tr>
<tr>
<td>G32</td>
<td>0.082</td>
<td>0.045</td>
<td>0.021</td>
<td>-4.936</td>
<td>0.734</td>
<td>0.492</td>
</tr>
<tr>
<td></td>
<td>(0.055,0.111)</td>
<td>(0.029,0.061)</td>
<td>(0.012,0.038)</td>
<td>(-5.320,-4.596)</td>
<td>(0.555,0.877)</td>
<td>(0.350,0.613)</td>
</tr>
<tr>
<td>G64</td>
<td>0.079</td>
<td>0.044</td>
<td>0.020</td>
<td>0.468</td>
<td>-4.440</td>
<td>0.507</td>
</tr>
<tr>
<td></td>
<td>(0.054,0.109)</td>
<td>(0.029,0.060)</td>
<td>(0.011,0.036)</td>
<td>(0.324,0.588)</td>
<td>(-4.823,-4.110)</td>
<td>(0.362,0.638)</td>
</tr>
<tr>
<td>G128</td>
<td>0.085</td>
<td>0.046</td>
<td>0.022</td>
<td>0.419</td>
<td>0.675</td>
<td>-4.472</td>
</tr>
<tr>
<td></td>
<td>(0.058,0.115)</td>
<td>(0.030,0.062)</td>
<td>(0.012,0.041)</td>
<td>(0.291,0.523)</td>
<td>(0.512,0.809)</td>
<td>(-4.822,-4.168)</td>
</tr>
</tbody>
</table>

Note: Elasticity (Row i, Column j) = \( \frac{\partial \ln Q_i}{\partial \ln p_j} \)

A: All Sport; P: Powerade; G: Gatorade

Numbers in parenthesis represent the 95% confidence interval from parametric bootstrapping.
Table 8a: Cost Estimation for Retailer Assuming Brand Management

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>S. E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sport</td>
<td>0.0023**</td>
<td>0.0002</td>
</tr>
<tr>
<td>Powerade</td>
<td>0.0045**</td>
<td>0.0003</td>
</tr>
<tr>
<td>Gatorade</td>
<td>-0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>Size 20</td>
<td>0.0076**</td>
<td>0.0001</td>
</tr>
<tr>
<td>Size 32</td>
<td>0.0009**</td>
<td>0.0001</td>
</tr>
<tr>
<td>Size 64</td>
<td>0.0001**</td>
<td>0.0001</td>
</tr>
<tr>
<td>W-G-IL</td>
<td>0.0026**</td>
<td>0.0012</td>
</tr>
<tr>
<td>W-G</td>
<td>0.0037**</td>
<td>0.0013</td>
</tr>
<tr>
<td>E-C-IL</td>
<td>-0.0004**</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Note:
1. ** Significant at 1% level; * Significant at 5% level
2. The input prices are mean-centered in the estimation.
3. GMM criterion function = 0.2415; p-value for Hansen’s J test = 0.21.

E-C-IL (¢/KwH): Average Revenue Per KWH -Commercial, Illinois (Energy Information Administration)

Table 8b: Upstream Cost Estimation Assuming Vertical Coordination

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>S. E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Sport</td>
<td>0.0108**</td>
<td>0.0005</td>
</tr>
<tr>
<td>Powerade</td>
<td>0.0132**</td>
<td>0.0004</td>
</tr>
<tr>
<td>Gatorade</td>
<td>0.0150**</td>
<td>0.0002</td>
</tr>
<tr>
<td>Size 20</td>
<td>0.0151**</td>
<td>0.0003</td>
</tr>
<tr>
<td>Size 64</td>
<td>0.00006**</td>
<td>0.0003</td>
</tr>
<tr>
<td>Sugar</td>
<td>-0.0003</td>
<td>0.0003</td>
</tr>
<tr>
<td>Plastic Bottle</td>
<td>0.0008**</td>
<td>0.0002</td>
</tr>
<tr>
<td>Interest Rate 1</td>
<td>0.0018**</td>
<td>0.0009</td>
</tr>
<tr>
<td>Interest Rate 2</td>
<td>0.0075**</td>
<td>0.0013</td>
</tr>
<tr>
<td>Wage (Soft Drink Industry)</td>
<td>0.0093**</td>
<td>0.0022</td>
</tr>
<tr>
<td>All Sport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage IL</td>
<td>0.0016</td>
<td>0.0046</td>
</tr>
<tr>
<td>Electricity (industrial) IL</td>
<td>-0.0068**</td>
<td>0.0007</td>
</tr>
<tr>
<td>Powerade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage IL</td>
<td>0.0449**</td>
<td>0.0034</td>
</tr>
<tr>
<td>Electricity (industrial) IL</td>
<td>0.0006</td>
<td>0.0009</td>
</tr>
<tr>
<td>Gatorade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage IN</td>
<td>0.0182**</td>
<td>0.0039</td>
</tr>
<tr>
<td>Electricity (Industrial) IN</td>
<td>0.0159**</td>
<td>0.0032</td>
</tr>
<tr>
<td>Wage (wholesale)</td>
<td>0.0048</td>
<td>0.0046</td>
</tr>
<tr>
<td>Wage (wholesale) IL</td>
<td>0.0266**</td>
<td>0.0078</td>
</tr>
<tr>
<td>Electricity (Commercial) IL</td>
<td>-0.0067**</td>
<td>0.0006</td>
</tr>
</tbody>
</table>

Note:
1. ** Significant at 1% level; * Significant at 5% level
2. The input prices are mean-centered in the estimation.
3. GMM criterion function =0.1964; p-value for Hansen’s J test = 0.27.
<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Case</strong> Model Prediction (Gatorade in Wholesaler, All Sport in DSD, Powerade in DSD)</td>
<td>A</td>
<td>0.0346</td>
<td>0.0229</td>
<td>0.00513</td>
<td>547.3</td>
<td>749.2</td>
<td>-1801.9</td>
<td>-778.9</td>
<td>-2580.8</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0377</td>
<td>0.0241</td>
<td>0.00287</td>
<td>294.9</td>
<td>393.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0430</td>
<td>0.0304</td>
<td>0.05278</td>
<td>7597.8</td>
<td>8953.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1a</strong> All 3 brands in DSD (All Sport and Gatorade Collude)</td>
<td>A</td>
<td>0.0349 (+0.9%)</td>
<td>0.0232 (+1.3%)</td>
<td>0.00503 (-1.9%)</td>
<td>568.4 (+3.9%)</td>
<td>769.2 (+2.7%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0376 (-0.3%)</td>
<td>0.0239 (-0.8%)</td>
<td>0.00300 (+4.5%)</td>
<td>306.5 (+3.9%)</td>
<td>403.7 (+2.7%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0443 (+3.0%)</td>
<td>0.0319 (+4.9%)</td>
<td>0.04704 (-10.9%)</td>
<td>6750.9 (-11.1%)</td>
<td>7935.1 (-11.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1b</strong> Consider both Production cost and Distribution Cost: All 3 brands in DSD (All Sport and Gatorade Collude)</td>
<td>A</td>
<td>0.0355 (+2.6%)</td>
<td>0.0239 (+4.4%)</td>
<td>0.00409 (-20.3%)</td>
<td>428.9 (-12.7%)</td>
<td>653.9 (-8.5%)</td>
<td>5930.4</td>
<td>2072.4</td>
<td>8002.8</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0381 (+1.1%)</td>
<td>0.0245 (+1.7%)</td>
<td>0.00254 (-11.5%)</td>
<td>259.6 (-12.0%)</td>
<td>359.7 (-8.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0405 (-5.8%)</td>
<td>0.0273 (-10.2%)</td>
<td>0.06896 (+30.7%)</td>
<td>10316.1 (+35.8%)</td>
<td>12447.9 (+39.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1c</strong> All 3 brands in DSD (No Collusion Between All Sport and Gatorade)</td>
<td>A</td>
<td>0.0345 (-0.3%)</td>
<td>0.0227 (-0.9%)</td>
<td>0.05033 (+3.9%)</td>
<td>354.0 (-2.4%)</td>
<td>756.5 (+1.0%)</td>
<td>1891.6</td>
<td>-695.2</td>
<td>-2586.8</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0376 (-0.3%)</td>
<td>0.0239 (-0.8%)</td>
<td>0.00298 (+3.8%)</td>
<td>308.7 (+4.7%)</td>
<td>406.1 (+3.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0443 (+3.0%)</td>
<td>0.0318 (+4.6%)</td>
<td>0.04734 (-10.3%)</td>
<td>6704.6 (-11.8%)</td>
<td>7934.2 (-11.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2a</strong> Effect of Enhancing Brand Preference: All 3 Brands in DSD (All Sport and Gatorade Collude) ΔDG=0.2068</td>
<td>A</td>
<td>0.0350 (+1.2%)</td>
<td>0.0233 (+1.7%)</td>
<td>0.04797 (+6.6%)</td>
<td>507.0 (-7.4%)</td>
<td>731.0 (-2.4%)</td>
<td>122.9</td>
<td>-95.1</td>
<td>-218.0</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0377 (+0.0%)</td>
<td>0.0241 (+0.9%)</td>
<td>0.00288 (+0.3%)</td>
<td>295.8 (+0.2%)</td>
<td>394.1 (+0.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0449 (+4.4%)</td>
<td>0.0323 (+6.3%)</td>
<td>0.05214 (-1.2%)</td>
<td>7531.6 (-0.9%)</td>
<td>8953.3 (+0.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2b</strong> Consumer welfare: All 3 Brands in DSD (All Sport and Gatorade Collude) ΔDG=0.2339</td>
<td>A</td>
<td>0.0350 (+1.2%)</td>
<td>0.0234 (+2.2%)</td>
<td>0.0475 (+7.4%)</td>
<td>503.5 (-8.0%)</td>
<td>727.7 (-2.9%)</td>
<td>122.8</td>
<td>0</td>
<td>122.8</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0377 (+0.0%)</td>
<td>0.0241 (+0.9%)</td>
<td>0.00286 (-0.3%)</td>
<td>294.1 (-0.2%)</td>
<td>392.5 (+0.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>0.0450 (+4.6%)</td>
<td>0.0323 (+6.3%)</td>
<td>0.05283 (+0.1%)</td>
<td>7645.9 (+0.6%)</td>
<td>9094.8 (+1.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2c</strong> Social welfare: All 3 Brands in DSD (All Sport and Gatorade Collude)</td>
<td>A</td>
<td>0.0350 (+1.2%)</td>
<td>0.0234 (+2.2%)</td>
<td>0.0477 (-7.0%)</td>
<td>504.7 (-7.8%)</td>
<td>728.7 (-2.7%)</td>
<td>34.1</td>
<td>-34.1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.0377 (+0.0%)</td>
<td>0.0241 (+0%)</td>
<td>0.00288 (+0.3%)</td>
<td>294.8 (-0.0%)</td>
<td>393.2 (-0.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: What-if Analysis Results
<table>
<thead>
<tr>
<th>3a</th>
<th>Effect of Enhancing Brand Preference: All Sport and Gatorade in Wholesaler, Powerade in DSD (No Collusion Between All Sport and Gatorade)</th>
<th>ΔDG=0.2244</th>
<th>G</th>
<th>0.0450 (+4.6%)</th>
<th>0.0323 (+6.3%)</th>
<th>0.05259 (-0.4%)</th>
<th>7664.7 (+0.1%)</th>
<th>9043.7 (+1.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.0328 (-5.2%)</td>
<td>0.0210 (-8.3%)</td>
<td>0.00517 (+0.8)</td>
<td>549.0 (+0.3%)</td>
<td>749.2 (+0.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.0377 (+0.0%)</td>
<td>0.0241 (+0.0%)</td>
<td>0.00287 (+0.1%)</td>
<td>295.2 (+0.1%)</td>
<td>393.6 (+0.1%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>0.0430 (+0.0%)</td>
<td>0.0304 (+0.0%)</td>
<td>0.05278 (+0.0%)</td>
<td>7598.1 (0.0%)</td>
<td>8953.9 (+0.0%)</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3b</th>
<th>Effect of Enhancing Product Preference: All 3 Brands in DSD (All Sport and Gatorade Collude)</th>
<th>ΔDG=0.1825</th>
<th>G</th>
<th>0.0449 (+4.4%)</th>
<th>0.0322 (+5.9%)</th>
<th>0.05151 (-2.4%)</th>
<th>7430.8 (-2.2%)</th>
<th>8828.6 (-1.4%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.0350 (+1.2%)</td>
<td>0.0233 (+1.7%)</td>
<td>0.00482 (-6.0%)</td>
<td>510.2 (-6.8%)</td>
<td>734.0 (-2.0%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.0377 (+0.0%)</td>
<td>0.0240 (+0.4%)</td>
<td>0.00289 (+0.7%)</td>
<td>297.3 (+0.8%)</td>
<td>395.5 (+0.6%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>0.0449 (+4.4%)</td>
<td>0.0322 (+5.9%)</td>
<td>0.05151 (-2.4%)</td>
<td>7430.8 (-2.2%)</td>
<td>8828.6 (-1.4%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. A: All Sport; P: Powerade; G: Gatorade
2. All results are averaged across 50 weeks.
3. Upstream channel profits refer to (a) sum of manufacturer and wholesaler’s profits in wholesaler channel, and (b) manufacturer’s profits in DSD channel.
Figure 1: The Sports Drink Market

- **M₁**
  - Quaker Oats (Gatorade)
  - Wholesaler

- **M₂**
  - Pepsi (All Sport)
  - Bottler

- **M₃**
  - Coke (Powerade)
  - Bottler

- Wholesaler Channel

- DSD Channel

- Retailer

- Consumers
Figure 2: Retail Price Variation

![Retail Price Variation Graph]

\(^a\): Data for one randomly chosen store

Figure 3: Changes in Welfare as a Function of Gatorade’s Manufacturing Cost Reduction

![Welfare Changes Graph]
Figure 4a: Profit Changes as a Function of Changes in Gatorade Product Preference

Figure 4b: Market Share Changes as a Function of Changes in Gatorade Product Preference
Figure 5: Changes in Welfare as a Function of Changes in Gatorade Product Preference

![Graph showing changes in welfare as a function of changes in Gatorade's preference. The graph plots consumer welfare, Gatorade's profit, and social welfare against the increase in Gatorade's preference. The axes are labeled as follows: $Week on the y-axis, and Increase in Gatorade's Preference on the x-axis.]
REFERENCES


Grocery Manufacturers of America (2002a), “E-Commerce Opportunities in Direct Store Delivery.”


