



Marketing Science

Publication details, including instructions for authors and subscription information:
<http://pubsonline.informs.org>

Assessing the Consequences of a Channel Switch

Xinlei (Jack) Chen, George John, Om Narasimhan,

To cite this article:

Xinlei (Jack) Chen, George John, Om Narasimhan, (2008) Assessing the Consequences of a Channel Switch. Marketing Science 27(3):398-416. <https://doi.org/10.1287/mksc.1070.0311>

Full terms and conditions of use: <https://pubsonline.informs.org/Publications/Librarians-Portal/PubsOnLine-Terms-and-Conditions>

This article may be used only for the purposes of research, teaching, and/or private study. Commercial use or systematic downloading (by robots or other automatic processes) is prohibited without explicit Publisher approval, unless otherwise noted. For more information, contact permissions@informs.org.

The Publisher does not warrant or guarantee the article's accuracy, completeness, merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications, or inclusion of an advertisement in this article, neither constitutes nor implies a guarantee, endorsement, or support of claims made of that product, publication, or service.

Copyright © 2008, INFORMS

Please scroll down for article—it is on subsequent pages



With 12,500 members from nearly 90 countries, INFORMS is the largest international association of operations research (O.R.) and analytics professionals and students. INFORMS provides unique networking and learning opportunities for individual professionals, and organizations of all types and sizes, to better understand and use O.R. and analytics tools and methods to transform strategic visions and achieve better outcomes.

For more information on INFORMS, its publications, membership, or meetings visit <http://www.informs.org>

Assessing the Consequences of a Channel Switch

Xinlei (Jack) Chen

The Sauder School of Business, University of British Columbia, Vancouver, BC Canada V6T 1Z2,
jack.chen@sauder.ubc.ca

George John, Om Narasimhan

The Carlson School of Management, University of Minnesota, Minneapolis, Minnesota 55455
{johnx001@umn.edu, naras002@umn.edu}

Switching marketing channels is an expensive and 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-ounces package. Absent these increases, Pepsi should *not switch*. Our methodology and results speak to both managers contemplating a channel switch and antitrust authorities faced with the task of evaluating the consequences of a change in vertical structure.

Key words: channel structure; new empirical industrial organization; oligopoly competition

History: This paper was received June 8, 2004, and was with the authors 10 months for 3 revisions; processed by Tülin Erdem. Published online in *Articles in Advance* April 7, 2008.

1. Introduction

Decisions to change a product's marketing channel are both expensive and difficult to undo.¹ 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,² whereas Powerade and All Sport have each been distributed through their own direct store delivery (DSD)³ channels. Pepsi acquired Quaker Oats in

2002, making it feasible to switch Gatorade to Pepsi's DSD channel. As it turned out, apparently 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 postmerger?

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 subdivided into four classes of issues. Pricing effects (e.g., double marginalization; see Moorthy 1987) are the first class here, followed by moral hazard

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 nonintegrated* or *separated* channel in our analysis.

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.

and specific investment problems (often referred to collectively as transaction costs; e.g., see Mathewson and Winter 1984, 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 interbrand price competition through delegation, i.e., the equivalent of using the wholesaler channel. The intuition is that channel structures can soften interbrand 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, because 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.⁴

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 2007; Besanko et al. 1998, 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 examine 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 differences in shares, profits, etc. Formally, this requires us to model (i) *heterogeneous channel structures*, e.g., one competitor using a wholesaler channel while another uses a DSD channel, (ii) *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 (iii) *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 (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-ounces package. We find that efficiency effects generally outweigh strategic effects in this context. Indeed, the single biggest deterrent to switching

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.

Gatorade to DSD turns out to be this channel's elevated distribution costs. In terms of implications for antitrust 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 ounces, 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 toward 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 §7.

2. Research Context

Sports drinks are noncarbonated "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.⁵ 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 nonintegrated*. On the other hand, Powerade and All Sport utilize the two-tier DSD systems of Coca-Cola and Pepsi, respectively. In these DSD systems, each manufacturer grants an exclusive territory to a local bottler that 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 that were either partially or fully vertically integrated with their manufacturer (*Beverage Digest* 1998). Indeed, in 1989, Pepsi owned its bottlers in 23 of the 24 most heavily populated markets in the United States, while Coca-Cola had an equity position in bottlers serving 21 of these 24 markets (*Beverage Digest* 1989).

⁵ The retail channel accounts for 93.6% of total dollar sales, so we ignore the small volumes going through nonretail channels.

Table 1 Product Categories with Heterogeneous Channels

Category	Product and channel
Potato chips	DSD: Frito-Lay, Old Dutch Wholesale: Wahoos, Best Yet
Cookies	DSD: Nabisco (Ritz, Kraft), Keebler (Club), Pepperidge Farm Wholesale: Best Yet
Ice cream	DSD: Häagen-Dazs, Ben & Jerry's, Edy's Wholesale: Breyers, Kemps

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

Brand	Market share (%)	Distribution channel
Pepsi's All Sport	3	DSD
Coke's Powerade	11	DSD
Quaker Oats Gatorade	83	Wholesale channel
Others	3	

Note. The above information is obtained from *Beverage Digest* (2001).

DSD bottlers are franchisees that 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*⁶ channel than the wholesaler channel described above. Table 2 summarizes the channel structure in the sports drink market.

Further Institutional Details. DSD⁷ channels account for almost 25% of supermarket volume, and are prominent in categories such as beverages, breads, greeting cards, and snacks. DSD products 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 that 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 (i) manufacturing costs incurred inside the factory, (ii) carrying/transportation⁸ costs incurred inside the distribution center and the truck going to the retailer, and (iii) 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.⁹ 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 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 stockouts 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 unclear.¹⁰

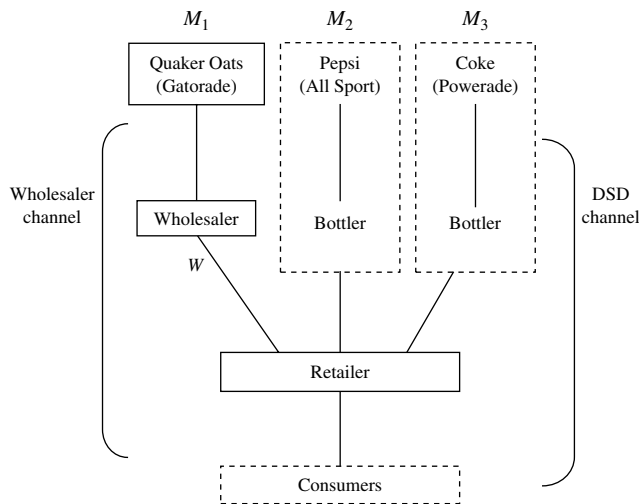
⁶ To be completely precise, the channel is partially vertically integrated, because there is an independent downstream retailer. In that sense, the switch we analyze is equivalent to examining the impact of partial vertical integration.

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).

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.

¹⁰ One could ask: Why don't we see cases where the manufacturer contracts with a wholesaler for the same level of services as the

Figure 1 The Sports Drink Market

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

$$U_{ijts} = \alpha_{ijs} + X_{jts}\beta + \theta_{is}p_{jts} + \xi_{jts} + \varepsilon_{ijts};$$

$$i = 1, \dots, I; j = 1, \dots, J; t = 1, \dots, T; s = 1, \dots, S, \quad (1)$$

where α_{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, ξ_{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 ε_{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 α_{ijs} term and to distinguish it from the ξ_{jts} term. The α_{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— α_{ijs} also captures this effect, which we label the channel effect. Thus the α_{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 α_{ijs} term as the product preference,¹² understanding that it consists of two components—intrinsic product preference and channel effect.

Consider the ξ_{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 ξ_{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 α_{ijs} and θ_{is} to vary across consumers, as a function of demographic store-specific variables (further details are provided in the Technical Appendix at <http://mktsci.journal.informs.org>). Given 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.

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 1991) is probably needed to justify the existence of these two institutional forms.

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.

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_t denote the total number of products in the market in week t ($N_t = \sum_i N_{it}$). F_{it} denotes the set of products produced by manufacturer M_i in week t . Thus, F_t 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 backward, so we start with the retailer's problem.

3.2.1. 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:

$$\max_{p_{jt}, j \in F_{it}} \Pi_{R_{it}} = \sum_{j \in F_{it}} (p_{jt} - w_{jt} - c_{jt}^R) Q_{jt}(p) \quad i = 1, 2, 3,$$

where w_{jt} is the wholesale price for product j at time t , c_{jt}^R 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

$$Q_{jt} + \sum_{k \in F_{it}} (p_{kt} - w_{kt} - c_{kt}^R) \frac{\partial Q_{kt}}{\partial p_{jt}} = 0 \quad \forall j \in F_{it}. \quad (2)$$

¹³ Although the bottlers actually manufacture the product in the DSD systems, we shall refer to the brand owners (Pepsi, Coke) as the manufacturers.

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

$$PCM_t^R = p_t - w_t - c_{jt}^R = -(TR \cdot \Delta_{1t})^{-1} Q_t, \quad (3)$$

where Δ_{1t} is an $N_t \times N_t$ matrix of marketing response to retail price, with

$$\Delta_{1t}(i, j) = \frac{\partial Q_{jt}}{\partial p_{it}} \quad \forall i, j \in F_t.$$

TR is an $N_t \times N_t$ matrix indicating the retailer's pricing strategy. In the brand management case, this is given by

$$TR(k, j) = \begin{cases} 1 & \text{if } k, j \in F_{it}, i = 1, 2, 3 \\ 0 & \text{otherwise.} \end{cases}$$

Q_t is a vector of quantities, and $TR \cdot \Delta_{1t}$ is the element-by-element product of two matrices. We show how to calculate Δ_{1t} in the Technical Appendix at <http://mktsci.pubs.informs.org>.

3.2.2. 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., $w_{kt}^{M_1} = c_{kt}^w \forall j \in F_{1t}$.

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

$$\max_{w_{jt}, j \in F_{1t}} \Pi_{wt} = \sum_{j \in F_{1t}} (w_{jt} - w_{jt}^{M_1} - c_{jt}^w) Q_{jt}(p).$$

The first-order conditions are

$$Q_{jt} + \sum_{k \in F_{1t}} (w_{kt} - w_{kt}^{M_1} - c_{kt}^w) \frac{\partial Q_{kt}}{\partial w_{jt}} = 0 \quad \forall j \in F_{1t}. \quad (4)$$

Similarly, the objective functions for M_2 and M_3 are

$$\max_{w_{jt}, j \in F_{it}} \Pi_{Mit} = \sum_{j \in F_{it}} (w_{jt} - c_{jt}^{M_i}) Q_{jt}(p) \quad i = 2, 3,$$

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

$$Q_{jt} + \sum_{k \in F_{it}} (w_{kt} - c_{kt}^{M_i}) \frac{\partial Q_{kt}}{\partial w_{jt}} = 0 \quad \forall j \in F_{it}, i = 2, 3. \quad (5)$$

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

$$PCM_t = -(T_t \cdot \Delta_{2t})^{-1} Q_t, \quad (6)$$

where

$$[PCM_t]_j = \begin{cases} w_{jt} - w_{jt}^{M_1} - c_{jt}^w & \forall j \in F_{1t} \\ w_{jt} - c_{jt}^{M_i} & \forall j \in F_{it} \quad i = 2, 3. \end{cases}$$

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

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

We show how to calculate Δ_{2t} in the Technical Appendix. T_i is an $N_t \times N_t$ matrix indicating strategic interactions among W , M_2 , and M_3 .

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

In stage 1, knowing the response of other firms, M_1 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.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 (1995) procedure as detailed in Nevo (2000). Briefly, we first solve for the mean utility numerically using the BLP (1995) 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 instrumental variables (IV) regression (using suitable instruments for price), and use the residuals from this regression as the residuals in a generalized method of moments (GMM) estimation.¹⁵

¹⁴ An advantage of sequential estimation is that it avoids contamination of demand side estimates because of 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 (2007).

¹⁵ More precisely, we use the method of simulated moments (Pakes and Pollard 1989) with 30 simulation draws.

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 prices, with appropriate superscripts as before. The pricing equations for the retailer practicing brand management are

$$\begin{aligned} p_{jt} &= w_{jt} + f(c_j^R \gamma^R) + \lambda_R \widehat{PCM}_{R,jt} + \varepsilon_{1jt} \quad \forall j \in F_{1t} \\ w_{jt} &= f(c_j^{M_1+W} \gamma^{M_1+W}) + \lambda_{M_1} \widehat{PCM}_{M_1,jt} \\ &\quad + \lambda_W \widehat{PCM}_{W,jt} + \varepsilon_{2jt} \quad \forall j \in F_{1t} \end{aligned} \quad (7)$$

for products from M_1 , and

$$\begin{aligned} p_{jt} &= w_{jt} + f(c_j^R \gamma^R) + \lambda_R \widehat{PCM}_{R,jt} + \varepsilon_{1jt} \quad \forall j \in F_{it}; \quad i = 2, 3 \\ w_{jt} &= f(c_j^{M_i} \gamma^{M_i}) + \lambda_{M_i} \widehat{PCM}_{M_i,jt} + \varepsilon_{2jt} \quad \forall j \in F_{it}; \quad i = 2, 3 \end{aligned} \quad (8)$$

for products from M_2 and M_3 , respectively.

These pricing equations consist of $2N_t$ simultaneous equations, with the γ 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 (2007), the parameters are estimated using constrained GMM techniques, with the λ '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 $u'_i Z_t$, where Z denotes a vector of instruments. More formally, the orthogonality conditions are $E[u'_i Z_t | Z_t] = 0$. 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 data set 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 stockkeeping unit) for each store on a weekly basis. Although 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. Because 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 ounces of sports drinks in a week, our market size measure (in ounces) is $10 \times (\text{number of consumers visiting}$

Table 3 Demographic Information across Stores

Variable	Mean	S.D.	Min.	Max.
Age60	0.1775	0.0639	0.0581	0.3074
Ethnic	0.1627	0.2025	0.0242	0.9957
Income	10.6140	0.3051	9.8671	11.2362
Hvalmean	148.63	47.13	64.35	267.39
Shopindx	0.7347	0.2435	0.0000	0.9863
Cubdist	6.2995	3.7586	0.1321	17.8560
Omnidist	7.6019	5.2540	0.9662	31.4040

Notes. Income: Log median income.

Age60 (%): Percentage of population more than age 60.

Ethnic (%): Percentage of population that are Black or Hispanic.

Hval: Mean household value.

Shopindx: Ability to shop: Percentage 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.

the store). Market shares for each store are volumes divided by this market size measure.¹⁷

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.

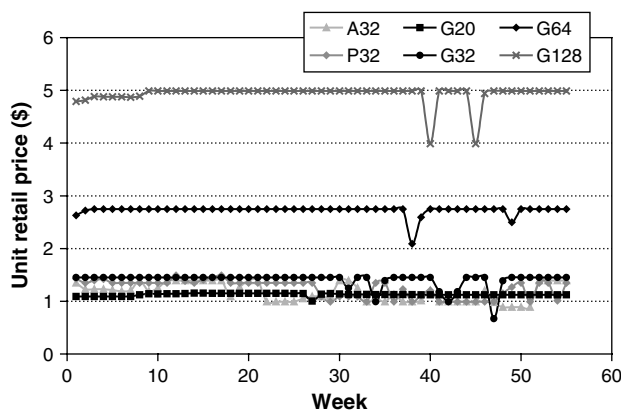
5.2. Instruments

5.2.1. Instruments for Price. Recall that the ξ_{jts} 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 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 2007, 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 (i) 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

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.

¹⁷ We checked the robustness of our estimates using different definitions of the total market, e.g., defining the per person consumption as 3.3 ounces. Our results are qualitatively robust to such changes.

Figure 2 Retail Price Variation^a

Note. ^a: Data for one randomly chosen store.

with wholesale prices) and (ii) they are likely to be uncorrelated with the unobserved ξ term. This seems reasonable, if one thinks of some of the time-varying effects ξ 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 (because 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. Because we do not know the proper lag a priori, we regressed retail price on these instrumental variables constructed at various lags, and found that four-week lagged measures performed best ($R^2 = 0.8465$). We therefore use four-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. To get a sense of the

Table 5 Descriptive Statistics for Input Prices

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

Notes. Variable definition and data sources:

Sugar: Sugar price (Coffee, Sugar, and Cocoa Exchange).

Plastic bottle: Producer price index for plastic bottles (The Bureau of Labor Statistics).

Interest rate 1: Federal funds effective rate (Federal Reserve).

Interest rate 2: Commercial Paper three month (Federal Reserve).

W_SD: Average hourly earnings of production workers in bottled and canned soft drinks industry (The Bureau of Labor Statistics).

W_G: Average hourly earnings of production workers in grocery stores (The Bureau of Labor Statistics).

W_G_IL: Average hourly earnings of production workers in grocery stores, Illinois (The Bureau of Labor Statistics).

W_W: Average hourly earnings of production workers in wholesale industry (The Bureau of Labor Statistics).

W_W_IL: Average hourly earnings of production workers in wholesale industry, Illinois (The Bureau of Labor Statistics).

W_IN: Average hourly earnings, in dollars, Indiana (The Bureau of Labor Statistics).

W_IL: Average hourly earnings, in dollars, Illinois (The Bureau of Labor Statistics).

E_C_IL: Average revenue per KWH—Commercial (¢/KwH), Illinois (Energy Information Administration).

E_I_IL: Average revenue per KWH—Industrial (¢/KwH), Illinois (Energy Information Administration).

E_I_IN: Average revenue per KWH—Industrial (¢/KwH), Illinois (Energy Information Administration).

magnitude of the endogeneity and heterogeneity issues, we also ran two other specifications—an ordinary least squares (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 ounces, 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.

Table 4 Descriptive Statistics for Brand-Size Combinations

Product	Retail price (\$/oz.)	Wholesale price (\$/oz.)	Promotion (%)	Market share
All Sport 32 oz.	0.0356	0.0245	0.5863	0.0053
Powerade 32 oz.	0.0383	0.0257	0.3296	0.0039
Gatorade 20 oz.	0.0541	0.0382	0.0167	0.0076
Gatorade 32 oz.	0.0415	0.0296	0.1045	0.0189
Gatorade 64 oz.	0.0403	0.0291	0.0359	0.0232
Gatorade 128 oz.	0.0378	0.0280	0.0362	0.0193

Table 6 Demand Estimation

Variable	Random coefficients model	
	Coefficient	S.E.
All Sports 32 oz.	−2.8865**	0.1826
Powerade 32 oz.	−2.5188**	0.1871
Gatorade 20 oz.	1.6610**	0.2462
Gatorade 32 oz.	−0.9233**	0.1940
Gatorade 64 oz.	−0.6952**	0.1851
Gatorade 128 oz.	−0.9380**	0.1739
Price	−133.3054**	4.5262
S.D. price	5.0463**	0.0669
Summer	0.6403**	0.0123
Promotion	0.3667**	0.0392
Income	0.8895**	0.3361
Age60	−9.1908**	0.6310
Ethnic	−4.0721**	0.3214
Hval	−0.0188**	0.0014
Shopindx	1.2797**	0.3540
Cub	0.1068**	0.0119
Omni	0.0201**	0.0070
Price * Income	5.3646	7.8190
Price * Age60	149.4965**	14.740
Price * Ethnic	59.3851**	7.1697
Price * Hval	0.4133**	0.0331
Price * Shopindx	−28.5514**	8.1706
Price * Cub	1.3451**	0.2788
Price * Omni	0.5718**	0.1695

Notes. 1. *Significant at 5% level; **significant at 1% level.

2. The demographic variables are mean centered in the estimation.

3. GMM criterion function = 1.96×10^{-2} ; p -value for Hansen's J test = 0.36.

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 ounces 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 more than 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. Because the

Table 7 Elasticity Matrix

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

Notes. Elasticity (Row i , Column j) = $\partial \ln Q_i / \partial \ln p_j$.

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

Numbers in parenthesis represent the 95% confidence interval from parametric bootstrapping.

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

Table 8a Cost Estimation for Retailer Assuming Brand Management

Variable	Coefficient	S.E.
All Sport	0.0023**	0.0002
Powerade	0.0045**	0.0003
Gatorade	−0.0001	0.0001
Size 20	0.0076**	0.0001
Size 32	0.0009**	0.0001
Size 64	0.0001**	0.0001
W-G-IL	0.0026**	0.0012
W-G	0.0037**	0.0013
E-C-IL	−0.0004**	0.0001

Notes. 1. *Significant at 5% level; **significant at 1% 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.

W-G-IL (\$/hr.): Average hourly earnings, grocery stores, Illinois (The Bureau of Labor Statistics).

W-G (\$/hr.): Average hourly earnings of production workers, grocery stores, US (The Bureau of Labor Statistics).

E-C-IL (¢/KWh): Average revenue per KWh—Commercial, Illinois (Energy Information Administration).

Table 8b Upstream Cost Estimation Assuming Vertical Coordination

Variable	Coefficient	S.E.
All Sport	0.0108**	0.0005
Powerade	0.0132**	0.0004
Gatorade	0.0150**	0.0002
Size 20	0.0151**	0.0003
Size 32	0.0006**	0.0003
Size 64	0.0000	0.0003
Sugar	−0.0003	0.0003
Plastic bottle	0.0008**	0.0002
Interest rate 1	0.0018**	0.0009
Interest rate 2	0.0075**	0.0013
Wage (soft drink industry)	0.0093**	0.0022
<i>All Sport</i>		
Wage Illinois	0.0016	0.0046
Electricity (industrial) Illinois	−0.0068**	0.0007
<i>Powerade</i>		
Wage Illinois	0.0449**	0.0034
Electricity (industrial) Illinois	0.0006	0.0009
<i>Gatorade</i>		
Wage Indiana	0.0182**	0.0039
Electricity (industrial) Indiana	0.0159**	0.0032
Wage (wholesale)	0.0048	0.0046
Wage (wholesale) Illinois	0.0266**	0.0078
Electricity (commercial) Illinois	−0.0067**	0.0006

Notes. 1. *Significant at 5% level; **significant at 1% 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.

products.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, because 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, it is natural to ask the following question: How large does the preference gain for Gatorade have to be to 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.

Because 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 (i) manufacturers, (ii) wholesaler or DSD bottler, and (iii) 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_i} , of this composite entity derived from the pricing equations for the DSD channels. These costs can be usefully regarded as

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 at <http://mktsci.journal.informs.org>.

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_1+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 nonlinear functions of the retail and wholesale prices.

For M_1 , we have

$$\begin{aligned} p_{jt} &= w_{jt} + f(c_j^R \hat{\gamma}^R) + \widehat{PCM}_{R,jt} \quad \forall j \in F_{1t} \\ w_{jt} &= f(c_j^{M_1+W} \hat{\gamma}^{M_1+W}) + \widehat{PCM}_{M_1,jt} + \widehat{PCM}_{W,jt} \quad (9) \\ &\quad \forall j \in F_{1t}, \end{aligned}$$

and for M_2, M_3 , we have

$$\begin{aligned} p_{jt} &= w_{jt} + f(c_j^R \hat{\gamma}^R) + \widehat{PCM}_{R,jt} \quad \forall j \in F_{it}; i = 2, 3 \\ w_{jt} &= f(c_j^{M_i} \hat{\gamma}^{M_i}) + \widehat{PCM}_{M_i,jt} \quad \forall j \in F_{it}; i = 2, 3. \end{aligned} \quad (10)$$

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

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 (i) Gatorade's manufacturing costs remain unchanged,²⁰ (ii) its distribution costs change to the distribution cost associated with Pepsi's DSD system, (iii) retailing costs remain unchanged, and (iv) 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 from the (in)efficiency 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

¹⁹ While we estimate demand over a 54-week sample period, we have only 50 weeks on the supply side, because we use four-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, because every game features coordinated pricing. Also, 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.

Table 9 What-If Analysis Results

	Scenario	Brand	Retail price (\$/oz.)	Wholesale price (\$/oz.)	Market share	Retailer profit (\$/week)	Channel profits (\$/week)	Change in firm profits (\$/week)	Change in consumer welfare (\$/week)	Change in social welfare (\$/week)
Base case	Model prediction (Gatorade in wholesaler, All Sport in DSD, Powerade in DSD)	A	0.0346	0.0229	0.00513	547.3	749.2			
		P	0.0377	0.0241	0.00287	294.9	393.2			
		G	0.0430	0.0304	0.05278	7,597.8	8,953.3			
1a	All three brands in DSD (All Sport and Gatorade collude)	A	0.0349 (+0.9%)	0.0232 (+1.3%)	0.00503 (−1.9%)	568.4 (+3.9%)	769.2 (+2.7%)	−1,801.9	−778.9	−2,580.8
		P	0.0376 (−0.3%)	0.0239 (−0.8%)	0.00300 (+4.5%)	306.5 (+3.9%)	403.7 (+2.7%)			
		G	0.0443 (+3.0%)	0.0319 (+4.9%)	0.04704 (−10.9%)	6,750.9 (−11.1%)	7,935.1 (−11.4%)			
1b	Consider both production cost and distribution cost: all three brands in DSD (All Sport and Gatorade collude)	A	0.0355 (+2.6%)	0.0239 (+4.4%)	0.00409 (−20.3%)	428.9 (−21.6%)	653.9 (−12.7%)	5,930.4	2,072.4	8,002.8
		P	0.0381 (+1.1%)	0.0245 (+1.7%)	0.00254 (−11.5%)	259.6 (−12.0%)	359.7 (−8.5%)			
		G	0.0405 (−5.8%)	0.0273 (−10.2%)	0.06896 (+30.7%)	10,316.1 (+35.8%)	12,447.9 (+39.0%)			
1c	All three brands in DSD (no collusion between All Sport and Gatorade)	A	0.0345 (−0.3%)	0.0227 (−0.9%)	0.00533 (+3.9%)	534.0 (−2.4%)	756.5 (+1.0%)	−1,891.6	−695.2	−2,586.8
		P	0.0376 (−0.3%)	0.0239 (−0.8%)	0.00298 (+3.8%)	308.7 (+4.7%)	406.1 (+3.3%)			
		G	0.0443 (+3.0%)	0.0318 (+4.6%)	0.04734 (−10.3%)	6,704.6 (−11.8%)	7,934.2 (−11.4%)			
2a	Effect of enhancing brand preference: all three brands in DSD (All Sport and Gatorade collude) $\Delta DG = 0.2068$	A	0.0350 (+1.2%)	0.0233 (+1.7%)	0.00479 (−6.6%)	507.0 (−7.4%)	731.0 (−2.4%)	−122.9	−95.1	−218.0
		P	0.0377 (+0.0%)	0.0241 (+0.0%)	0.00288 (+0.3%)	295.8 (+0.3%)	394.1 (+0.2%)			
		G	0.0449 (+4.4%)	0.0323 (+6.3%)	0.05214 (−1.2%)	7,531.6 (−0.9%)	8,953.3 (+0.0%)			
2b	Consumer welfare: all three brands in DSD (All Sport and Gatorade collude) $\Delta DG = 0.2339$	A	0.0350 (+1.2%)	0.0234 (+2.2%)	0.00475 (−7.4%)	503.5 (−8.0%)	727.7 (−2.9%)	122.8	0	122.8
		P	0.0377 (+0%)	0.0241 (+0%)	0.00286 (−0.3%)	294.1 (−0.3%)	392.5 (−0.2%)			
		G	0.0450 (+4.6%)	0.0323 (+6.3%)	0.05283 (+0.1%)	7,645.9 (+0.6%)	9,094.8 (+1.6%)			
2c	Social welfare: all three brands in DSD (All Sport and Gatorade collude) $\Delta DG = 0.2244$	A	0.0350 (+1.2%)	0.0234 (+2.2%)	0.00477 (−7.0%)	504.7 (−7.8%)	728.7 (−2.7%)	34.1	−34.1	0
		P	0.0377 (+0%)	0.0241 (+0%)	0.00288 (+0.3%)	294.8 (−0.0%)	393.2 (0%)			
		G	0.0450 (+4.6%)	0.0323 (+6.3%)	0.05259 (−0.4%)	7,604.7 (+0.1%)	9,043.7 (+1.0%)			
3a	Effect of enhancing brand preference: All Sport and Gatorade in wholesaler, Powerade in DSD (no collusion between All Sport and Gatorade) $\Delta DA = -0.1825$	A	0.0328 (−5.2%)	0.0210 (−8.3%)	0.00517 (+0.8)	549.0 (+0.3%)	749.2 (+0.0%)	3.3	113.8	117.1
		P	0.0377 (+0.0%)	0.0241 (+0.0%)	0.00287 (+0.0%)	295.2 (+0.1%)	393.6 (+0.1%)			
		G	0.0430 (+0.0%)	0.0304 (+0.0%)	0.05278 (+0.0%)	7,598.1 (0.0%)	8,953.9 (+0.0%)			
3b	Effect of enhancing product preference: all three brands in DSD (All Sport and Gatorade collude) $\Delta DG = 0.1825$	A	0.0350 (+1.2%)	0.0233 (+1.7%)	0.00482 (−6.0%)	510.2 (−6.8%)	734.0 (−2.0%)	−339.3	−178.4	−517.7
		P	0.0377 (+0.0%)	0.0240 (−0.4%)	0.00289 (+0.7%)	297.3 (+0.8%)	395.5 (+0.6%)			
		G	0.0449 (+4.4%)	0.0322 (+5.9%)	0.05151 (−2.4%)	7,430.8 (−2.2%)	8,828.6 (−1.4%)			

Notes. 1. A: All Sport; P: Powerade; G: Gatorade.

2. All results are averaged across 50 weeks.

3. Upstream channel profits refer to (i) sum of manufacturer and wholesaler's profits in wholesaler channel and (ii) manufacturer's profits in DSD channel.

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 postswitch 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 postmerger world to create synergies that reduce Gatorade's manufacturing cost.²² 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, because 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/ounces, roughly 33% of existing manufacturing costs for Gatorade 32 ounces). 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 profit neutral? This number is \$0.0018/ounces, or roughly, 14% of Gatorade's existing manufacturing cost (32 ounces).

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.²³ 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 θ_{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 preswitch is

$$CV_{is} = \frac{\log(\sum_{j=0}^J \exp(V_{jis}^0)) - \log(\sum_{j=0}^J \exp(V_{jis}^1))}{\theta_{is}}.$$

For a store, the expected consumer welfare change is

$$\Delta W_s = M_s \int_{-\infty}^{\infty} \cdots \int CV_{is} \phi(v) dv,$$

where M_s is the market measure of store s .

The expected consumer welfare change for the retail chain is

$$\Delta W = \sum_s \Delta W_s.$$

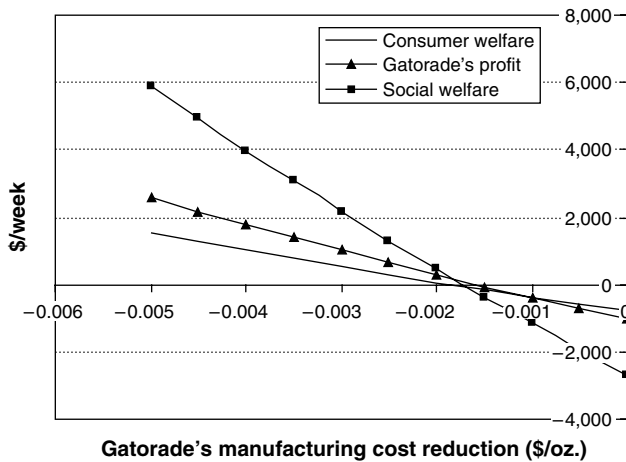
The social welfare calculation yields \$0.0017/ounces, which is roughly 13% of existing manufacturing costs for Gatorade 32 ounces. This number is very similar to the profit breakeven calculated earlier, suggesting that policy consequences would be virtually identical, whether based on profit considerations 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 breakeven 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,

²² We thank an anonymous reviewer for suggesting this line of reasoning.

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).

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

but continuing to distribute it through its DSD system.²⁴ 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. Because 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 breakeven 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 \$8,953.30. 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 \$7,935.10 (Column 8, Row 7). Denote Gatorade's fraction of this profit as b_{DSD} . If $b_{DSD} \geq (8,953.30/7,935.10) * b_W$, 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 Trade-off: Increased Cost vs. 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 POS promotion activities, etc. To the extent that consumers are responsive to these efforts, such 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. Because distribution costs decline as a result of 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

²⁴ As mentioned earlier, this is precisely what Pepsi did do, in an apparent concession to antitrust authorities.

through an increase in the time-invariant α_{ijs} term, which captures preferences arising from intrinsic product characteristics as well as preference arising from channel service levels. Second, the demand increase might be because of unobservable shocks, which are captured by the time-varying ξ_{jts} term. Our goal is to pinpoint the channel effect, but as discussed earlier, our α_{ijs} 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 α_{ijs} , 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, stockouts, 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 breakeven calculation.

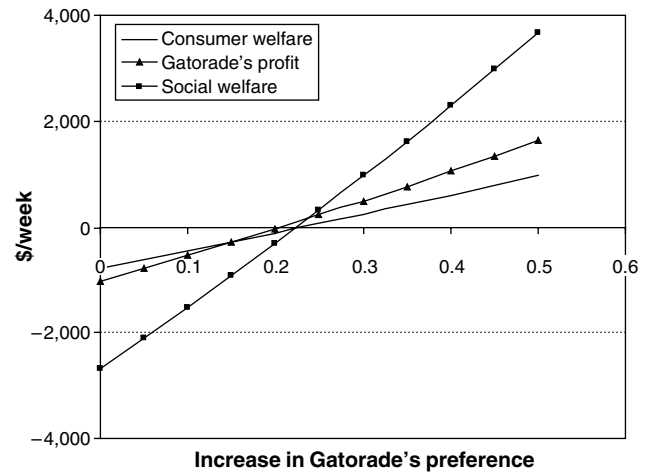
We equate Gatorade's preswitch upstream profits with its postswitch profits, and solve the amount by which Gatorade's product preference would have to increase to offset the enhance costs of DSD.²⁶ This calculated quantity increase in Gatorade's product dummy is 0.2068, which is equivalent to the demand increase arising from a price cut of 4.96¢ for a 32-ounces 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 ounces. The 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 32-ounces package of Gatorade.

Clearly, all three criteria give very similar results. This is demonstrated in Figure 4, which plots Gatorade's profits, consumer welfare, and social welfare as a function of changes in Gatorade's product preference.

²⁵ We do not consider the ξ_{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 α_{ijs} is time invariant, while ξ_{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.

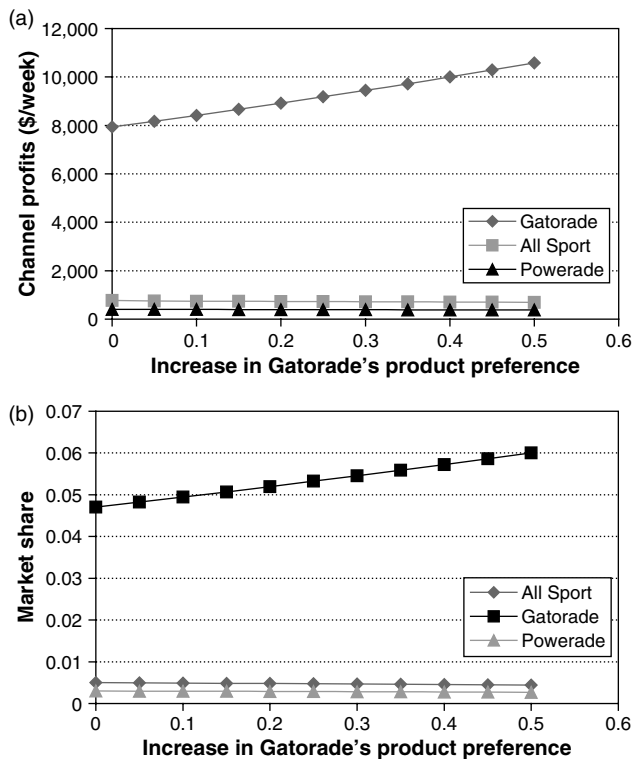
²⁶ It is important to emphasize that the breakeven calculation is illustrative of how much demand would need to change, not the costs of changing it.

Figure 4 Changes in Welfare as a Function of Changes in Gatorade 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 (i) increase prices, (ii) increase market share, or (iii) implement some combination of (i) and (ii). We address this issue by recomputing Scenarios 2a–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 5(a) and 5(b). 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.

Figure 5 (a) Profit Changes as a Function of Changes in Gatorade Product Preference; (b) Market Share Changes as a Function of Changes in Gatorade Product Preference

Lower Bound of Demand Shift Permissible for All Sport in Wholesaler Channel (Scenarios 3a, b). We perform an analysis identical to the above, assuming that All Sport moves from its existing DSD channel to a wholesaler channel.²⁷ 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 preswitch upstream profits to its postswitch 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 32-ounces 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 recompute the new prices, market shares, and profits. Gatorade's market share drops 2.4% and profits drop 1.4%. Note that because the magnitude of the demand enhancement effect here is smaller than that in Scenario 2 (Gatorade's breakeven), 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, espe-

cially 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-ounces 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

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

²⁷ We thank an anonymous reviewer for suggesting this analysis.

²⁸ Details of the calculation are in the Technical Appendix at <http://mktsci.journal.informs.org>.

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 toward 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.²⁹ 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 noncarbonated 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 2005³⁰), 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 subline, 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.

Acknowledgments

This paper is based on the first author’s doctoral dissertation. The authors are listed alphabetically and contributed equally to the paper. The authors thank Rajesh Chandy, Sam Kortum, Rakesh Niraj, Jaideep Prabhu, and Myles Shaver for helpful comments on earlier drafts.

References

- Anderson, E., D. C. Schmittlein. 1984. Integration of the sales force: An empirical examination. *RAND J. Econom.* **15**(Autumn) 385–395.
- Berry, S. T., J. Levinsohn, A. Pakes. 1995. Automobile prices in market equilibrium. *Econometrica* **63**(July) 841–890.
- Berto Villas-Boas, S. 2007. Vertical contracts between manufacturers and retailers: Inference with limited data. *Rev. Econom. Stud.* **74**(2) 625–652.
- Besanko, D., J. P. Dube, S. Gupta. 2003. Competitive price discrimination strategies in a vertical channel using aggregate data. *Management Sci.* **49**(9) 1121–1138.
- Besanko, D., S. Gupta, D. Jain. 1998. Logit demand estimation under competitive pricing behavior: An equilibrium framework. *Management Sci.* **44**(11) 1533–1547.
- Beverage Digest*. 1989. (May 12).
- Beverage Digest*. 1998. (December 11).

²⁹ We thank the editor for suggesting these extensions.

³⁰ The Gatorade and Propel numbers are taken from Nielsen Monitor-Plus.

- Beverage Digest*. 2001. (February 9).
- Bonanno, G., J. Vickers. 1988. Vertical separation. *J. Indust. Econom.* **36**(March) 257–265.
- Chintagunta, P. K., A. Bonfrer, I. Song. 2002. Investigating the effects of store-brand introduction on retail demand and pricing behavior. *Management Sci.* **48**(October) 1242–1267.
- Chintagunta, P. K., J. P. Dube, V. Singh. 2003. Balancing profitability and consumer welfare in a supermarket chain. *Quant. Marketing and Econom.* **1** 111–147.
- Dutta, S., J. B. Heide, M. Bergen. 1999. Vertical territorial restrictions and public policy: Theories and industry evidence. *J. Marketing* **63**(October) 121–134.
- Grocery Manufacturers of America. 2002a. E-commerce opportunities in direct store delivery (e-DSD): A presentation of the Grocery Manufacturers Association. *UConnect Conf.*, Salt Lake City, UT.
- Grocery Manufacturers of America. 2002b. Full-shelf satisfaction—Reducing out-of-stocks in the grocery channel: An in-depth look at DSD categories. Grocery Manufacturers of America and Roland Berry, Washington, D.C.
- Hoch, S. J., B.-D. Kim, A. L. Montgomery, P. E. Rossi. 1995. Determinants of store-level price elasticity. *J. Marketing Res.* **32** 17–30.
- John, G., B. A. Weitz. 1988. Forward integration into distribution: An empirical test of transaction cost analysis. *J. Law, Econom. Organ.* **4**(Fall) 337–355.
- Kadiyali, V., P. Chintagunta, N. Vilcassim. 2000. Manufacturer-retailer channel interactions and implications for channel power: An empirical investigation of pricing in a local market. *Marketing Sci.* **19**(Spring) 127–148.
- Mathewson, F., R. A. Winter. 1984. An economic theory of vertical restraint. *RAND J. Econom.* **15**(Spring) 27–38.
- McGuire, T. W., R. Staelin. 1983. An industry equilibrium analysis of downstream vertical integration. *Marketing Sci.* **2**(Spring) 161–191.
- Moorthy, K. S. 1987. Managing channel profits: Comment. *Marketing Sci.* **6**(Autumn) 375–379.
- Nevo, A. 2000. A practitioner's guide to estimation of random coefficients logit models of demand. *J. Econom. Management Strategy* **9**(Winter) 513–548.
- Nevo, A. 2001. Measuring market power in the ready-to-eat cereal industry. *Econometrica* **69**(March) 307–342.
- Newey, W., D. McFadden. 1994. Large sample estimation and hypothesis testing. R. F. Engle, D. McFadden, eds. *Handbook of Econometrics*, Vol. 4. North-Holland, Amsterdam, 2211–2245.
- Pakes, A., D. Pollard. 1989. Simulation and the asymptotics of optimization estimators. *Econometrica* **57**(5) 1027–1057.
- Pinkse, J., M. E. Slade. 2004. Mergers, brand competition, and the price of a pint. *Eur. Econom. Rev.* **48**(3) 617–643.
- Raju, J., Z. J. Zhang. 2005. Channel coordination in the presence of a dominant retailer. *Marketing Sci.* **24**(2) 254–262.
- Rey, P., J. Stiglitz. 1995. The role of exclusive territories in producers' competition. *RAND J. Econom.* **26**(Autumn) 431–451.
- Rovell, D. 2005. *First in Thirst: How Gatorade Turned the Science of Sweat into a Cultural Phenomenon*. AMACOM, New York.
- Slade, M. 1998. Strategic motives for vertical separation: Evidence from retail gasoline. *J. Law Econom. Organ.* **14**(1) 84–113.
- Sudhir, K. 2001. Structural analysis of manufacturer pricing in the presence of a strategic retailer. *Marketing Sci.* **20**(Summer) 973–980.
- Villas-Boas, J. M., Y. Zhao. 2005. Retailers, manufacturers, and individual consumers: Modeling the supply chain in the ketchup marketplace. *J. Marketing Res.* **42**(1) 83–95.
- Wall Street Journal*. 2006. Bottlers' suits challenge Coke distribution plan. (February) 20–21.
- Williamson, O. 1991. Strategizing, economizing, and economic organization. *Strategic Management J.* **12** 75–94.