

# Measuring Brand Value in an Equilibrium Framework

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We propose a structural approach to measuring brand and subbrand value using observational data. Brand value is defined as the difference in equilibrium profit between the brand in question and its counterfactual unbranded equivalent on search attributes. Our model allows us to make this computation rigorously, taking into account competitors' and retailers' reactions in the real and counterfactual situations. We illustrate our method using quarterly city-level data on ready-to-eat breakfast cereals, and compare our brand value estimates with those obtained from previously used reduced-form methods. A key advantage of our methodology is that it provides estimates of the value of brands—manufacturers and retailers—taking into account the brand's value to consumers as well as its impact on firm decisions.

*Key words:* branding; brand equity measurement; new empirical industrial organization

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## 1. Introduction

Brand equity is perhaps the single most important asset that marketing contributes to a firm. In this paper, we develop procedures for measuring brand value in an equilibrium framework using observational data on sales, prices, product attributes, and advertising.<sup>1</sup>

In our framework, brand value is the extra profit earned by a brand over and above what it would have earned based on its search attributes. Search attributes are the attributes that the consumer can see for herself before buying the product (Nelson 1970, Ford et al. 1990). The distinguishing feature of our approach is that we view the excess profit earned by a brand as a comparison between two *equilibria*: the equilibrium with the brand as it is, and a counterfactual equilibrium where the brand has “lost” its brand equity but retained its search attributes. In both equilibria, the firm is assumed to be doing the best it can using the brand resources it has at its disposal—the difference is in the resources. Thus, our approach tracks the full implications of brand equity, its impact on the

demand side—on consumers' brand choices, as well as its impact on the supply side—on manufacturer and retailer pricing decisions. This contrasts sharply with the previous literature in brand equity/value estimation, which ignores firm decision making all together.<sup>2</sup>

Because we use observational data, our brand value estimates reflect the actual choices of consumers, manufacturers, and retailers, not what they reported in surveys. Because we interpret the observed data as the product of an equilibrium, we take into account the interactions among consumers, manufacturers, and retailers, and recognize the endogeneity of prices (Villas-Boas and Winer 1999, Chintagunta 2001, Shugan 2004). Our structural model allows us to (a) separate the effect of brand equity from other influences on sales such as the product's search attributes, prices, and advertising; (b) simulate the

<sup>1</sup> By *brand equity*, we mean what the brand does for the consumer; by *brand value*, we mean what the brand does for the firm. The two are obviously related—a brand cannot do much for the firm if it does not do much for the consumer. This paper is concerned with brand value estimation, but as a by-product we get brand equity estimates as well.

<sup>2</sup> Kamakura and Russell (1993), Swait et al. (1993), Park and Srinivasan (1994), and Agarwal and Rao (1996) are primarily concerned with brand equity estimation. Ailawadi et al. (2003) and Simon and Sullivan (1993) are primarily concerned with brand value estimation. The literature can also be distinguished on whether the techniques rely on consumer survey data (Swait et al. 1993, Park and Srinivasan 1994, Agarwal and Rao 1996, Srinivasan et al. 2005) or observational marketplace data (Kamakura and Russell 1993, Simon and Sullivan 1993, Ailawadi et al. 2003). For comprehensive reviews of the literature, see Ailawadi et al. (2003) and Keller and Lehmann (2006).

consequences of a brand losing its equity on the decisions of consumers, manufacturers, and retailers; and (c) measure brand and subbrand values from the consumer, manufacturer, and retailer perspectives. This is the first paper to measure brand and subbrand values from transaction data. It is also the first paper to report brand and subbrand values from the retailer's perspective. As we discuss later in the paper, brand values for a retailer may be quite different from brand values for a manufacturer.

We illustrate our methodology on ready-to-eat breakfast cereal brands. From the IRI Infoscan Database, we have data on the quarterly market shares and prices of a variety of cereals in several U.S. cities over 20 quarters. In addition, we have data on the search attributes of the cereals, quarterly national advertising expenditures, and city demographics. Using these data, we estimate brand and subbrand values of the major cereal brands—Kellogg's, General Mills, Post, and Quaker—relative to Nabisco and compare them with those obtainable from two existing reduced-form methods: the Ailawadi et al. (2003) revenue-premium method, which calculates brand value as the difference between brand revenues and private-label revenues, and hedonic regression (Rosen 1974, Holbrook 1992), which estimates brand value as a price premium after controlling for various nonbrand factors. There are similarities and differences between our estimates and those from these alternative methods, suggesting both validity and consequentiality for our equilibrium approach. For example, while the top two brands in cereal are ordered the same in all methodologies, the rankings at the bottom differ. The gaps in brand values are also different. There are two points to note about these results. First, the difference in measures: profits in our case, price or revenue premiums in the others. Second, the difference in modeling approaches: structural in our case, reduced-form in the others. Thus, while we think that our profit premium approach has a better foundation than price or revenue premiums, our methodology provides price and revenue premiums as a by-product, and we find that our estimates of these quantities differ from their reduced-form counterparts. For example, price premiums computed structurally are uniformly lower than price premiums computed by hedonic regression, and the differences are large enough to change the ordering of Post vis-à-vis Quaker.

More important than the estimates themselves, our structural approach reveals interesting insights in the ways brand equity generates value at the firm level:

(1) Some of a brand's value may come from its ability to signal the experience attributes of a product—things a consumer cannot see before purchasing the product (Nelson 1970, Ford et al. 1990). Controlling for experience attributes in the regression, as in

Kamakura and Russell (1993), Park and Srinivasan (1994), and Kartono and Rao (2005), amounts to assuming that even without the brand consumers will know these attributes before purchasing the product. To the extent brands are differentiated on experience attributes, and brand is the means by which consumers reassure themselves that those attributes are indeed being delivered, this assumption will influence measured brand value. Using data on an experience attribute of cereals—their “mushiness” in milk—we show that Post's and Quaker's relative brand values fall significantly when we include mushiness in the regression. These brands are relatively “unmushy” in milk, and by including mushiness in the regression, we usurp brand's role in providing this information to consumers.

(2) Brand equity gives pricing power to a firm, and its loss is inevitably accompanied by a wholesale price drop. Naturally, the largest price drops are suffered by the brands that have the most to lose—the strongest brands.

(3) Our simulation experiments provide an interesting commentary on retail pass-through. The usual story on pass-through is that retailers do not pass on all of the price decreases they get at wholesale (Chevalier and Curhan 1976, Moorthy 2005). But these findings have been documented in settings where brand equities are not changing. In our experiments, brand equity losses are the triggering events. Wholesale prices fall, but this is often accompanied by an even larger retail price drop. Retailer margins get squeezed. Seen in pass-through terms, retailer pass-through on wholesale price reductions stemming from brand equity loss are often greater than 100%.

(4) When a brand loses its equity, it is not just brand switching that may occur. Category sales may fall as well. For example, people may only like a particular brand of cereal, and when that brand loses equity, they may not buy cereal at all. Said differently, brand equity affects market shares within the category as well as category sales.

(5) Manufacturers get more value from their brands than retailers. Generally speaking, retailers, being consumer-facing, should value brands more; however, retailers derive profits from many more brands than manufacturers and have more ways to maneuver. In categories with many brands, no single brand is likely to be very valuable to them.

The remainder of this paper is organized as follows. Section 2 presents our framework for estimating brand value in the context of an oligopolistic category in which multiple manufacturers sell through common retailers. Section 3 describes our data set and empirical methodology. Section 4 provides estimation results. Section 5 discusses limitations and §6 concludes.

## 2. Framework

The starting point for any measurement of brand value is the idea that brands are productive assets for a firm, just as buildings and machinery are. They are assets in the sense that they are fixed in the short term, and produce long-term benefits. For a brand to become productive, it must be built, i.e., develop brand equity, a process that takes time and money. Interest in brand value estimation comes precisely from the fact that once brand equity has been developed, it does not deplete itself instantly, continuing to deliver benefits over a period of time even after the investments that created it have been withdrawn.

The productivity of brand assets comes from both the demand and supply sides. On the demand side, it comes from the fact that an established brand encapsulates all of the marketing that has gone on for the brand since its inception, plus all of the experiences that consumers have accumulated since the brand was introduced. Now, as a result, people are aware of the brand, it is familiar (Hoyer and Brown 1990), has a personality (Aaker 1997), evokes emotional responses (Keller 2003, p. 90), and in general serves as a vehicle for recalling all the advertising-induced imagery that marketing has associated with it. On the functional side, an established brand serves as a signal of quality for the experience and credence attributes provided by the product—things that the consumer cannot see before buying the product (Nelson 1970, Wernerfelt 1988, Ford et al. 1990, Erdem 1998). This is true both on the first purchase as well as on repeat purchases. The bonding and reputational mechanisms by which brands provide these signaling functions are the subjects of papers by Klein and Leffler (1981), Shapiro (1983), and Wernerfelt (1988); for a review, see Erdem and Swait (1998).

The demand-side role of brands is well articulated in the literature. Starting with Allison and Uhl (1964), a long series of studies has noted the different responses of consumers in blind versus branded tests of products. In the Allison-Uhl study, consumers' overall opinions of beers were higher, by as much as 21%, when they were tasted branded than when they were tasted blind. Because the consumers were rating the beers immediately after tasting them, brand's role here was not one of signaling product performance. Rather, the familiarity of the brand, the imagery associated with it, and perhaps the brand's personality were responsible for enhancing consumers' ratings of the beers. Farquhar (1990, p. RC7) finds that in "matched product tests with corn flakes cereal, choice increased from 47 percent when the brand name was not known to 59 percent when the Kellogg's name was identified." Sullivan (1998) shows that the market prices of twin automobile brands—automobiles

described by *Consumer Reports* as identical or "essentially similar"—are different in the used-car market. For example, a Chevy Nova sold for 35% less than an identically specified Toyota Corolla of the same vintage, even though both were made in the same factory in Fremont, California. Smith and Park (1992, p. 300) find that brand extensions have a greater effect on market share for experience goods than for search goods. This is presumably because "with search goods, consumers can obtain useful information about quality through visual inspection and thus the importance of inferences based on a known brand name is reduced."

The supply-side effects of brand equity are less well recognized in the brand valuation literature, a deficiency we wish to correct in this paper. The basic point is easy enough to see. Consider a monopoly seller selling directly to consumers. Its demand function is  $D(\beta_b; x; p)$ , where  $\beta_b$  represents the demand-side effects of brand equity (discussed in the previous paragraph),  $x$  the search attributes of the product, and  $p$  price, and it maximizes a profit function of the form

$$\Pi = (p - c)D(\beta_b; x; p) - F, \quad (1)$$

with respect to  $p$ . Here,  $c$  and  $F$  are marginal and fixed costs, respectively, and we are assuming that  $x$ , the search attributes, and  $\beta_b$ , the effect of brand on demand, are not changeable in the short run. Assuming that the profit function satisfies the requisite differentiability and concavity conditions, and interior solutions exist, the profit-maximizing choice of  $p$  is determined by the first-order condition

$$(p - c) \frac{\partial D(\beta_b; x; p)}{\partial p} + D(\beta_b; x; p) = 0. \quad (2)$$

Clearly, the firm's optimal choice of  $p$  must be a function of  $\beta_b$ . In other words, if demand is a function of brand equity, then the variables supplied by the firm—price and other variables that affect demand—must also be. The firm with brand equity "rides" on it and sets other variables that affect demand recognizing that they will work in conjunction with brand equity. For example, in the aforementioned study of Sullivan (1998), owners of Toyota Corollas took advantage of the superior brand equity of Toyota by pricing their cars higher than Chevy Novas of the same vintage and specifications. In other words, endogeneity is a built-in feature of demand estimation for brands.

If we treat brand assets as analogous to other business assets, then they must be evaluated analogously as well. From financial theory, business assets are evaluated on the basis of the discounted net present value of cash flows they produce.<sup>3</sup> The starting point

<sup>3</sup> The Financial Accounting Standards Board's new standard for accounting for goodwill and indefinite-lived intangible assets, FAS 142, recommends this criterion.

for an evaluation of brand value must therefore be the assessment of profit flows *due to brand*.<sup>4</sup> What this really means we discuss next.

### 2.1. Definitions and Counterfactuals

Brand value, in almost any conception, involves a comparison between a factual and a counterfactual. As Keller (2003, p. 42) writes:

Although a number of different specific views of brand equity may prevail, most observers are in agreement that brand equity should be defined in terms of marketing effects that are uniquely attributable to a brand. That is, brand equity relates to the fact that different outcomes result from the marketing of a product or service because of its brand than if that same product or service had not been identified by that brand.

The central conceptual problem in measuring brand value lies in defining the counterfactual, i.e., in specifying those “different outcomes” that would result if the “same product or service had not been identified by that brand.” What happens to a product when it is shorn of its brand elements? Answering this question is not as straightforward as it may seem. It means taking a position on what things a brand should get credit for and what it should not get credit for. Measured brand value will be affected by these decisions. For example, if we assume that a product shorn of its brand elements loses “everything”—awareness, imagery, attributes—then its sales must be zero. Because even “no-name” brands achieve sales and often succeed in the marketplace, this is perhaps too strong a position to take on the importance of branding. Moreover, this assumption obviates the need to estimate brand value: by definition, every brand’s value will be its current profits. At the other extreme, one could assume that a product loses nothing when it goes from branded to unbranded. This position, too, does not make sense: every brand’s value is zero by assumption.

What assumptions are more reasonable? A product shorn of its brand elements cannot possibly be the beneficiary of any of the imagery that marketing has

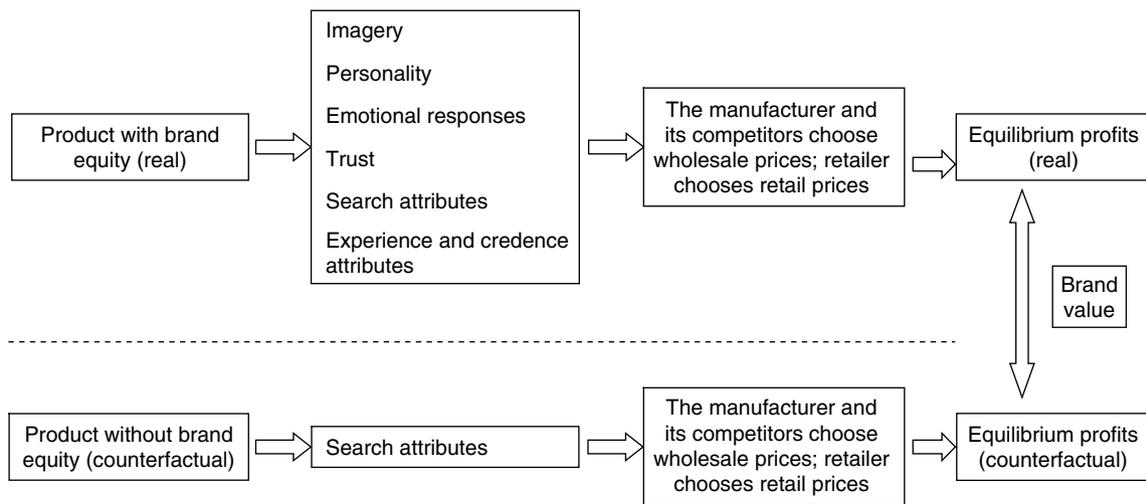
associated with the brand. This includes user imagery, usage imagery, emotional benefits, status benefits, brand personality, etc. For example, a carton of Kellogg’s Frosted Flakes without its distinctive branding elements—name, logo, pictures, color—cannot possibly evoke the imagery associated with Tony the Tiger (“They’re Gr-r-reat!”). An unbranded product also cannot, in the short run, signal the attributes that are hidden from the consumer at the time of purchase. For example, a carton of Kellogg’s Frosted Flakes without its distinctive branding elements cannot inform consumers about how the cereal will taste, or how “mushy” it will be with milk. On the other hand, it seems reasonable to assume that the product even in an unbranded state retains its search attributes—the attributes that a consumer can see for herself without using the product—and generates enough awareness to get into consumers’ consideration sets. Assuming otherwise would imply brand value equal to current brand profits, as noted above. For example, in the case of Kellogg’s Frosted Flakes, even absent the Kellogg’s brand elements, government-mandated disclosure requirements mean that the consumer can still see that a 3/4-cup serving size of the cereal has 120 calories, 12 g of sugars, etc. In short, it seems reasonable that a brand should get credit only for the imagery associated with it and for signaling its experience and credence attributes.<sup>5,6</sup>

<sup>5</sup> The previous literature on brand equity/value measurement does not discuss these issues, but implicitly takes a variety of positions. Park and Srinivasan (1994, p. 271) define brand equity as “the difference between an individual consumer’s overall brand preference and his or her multiattributed preference based on objectively measured attribute levels.” This definition implies the following counterfactual: the brand upon losing its equity retains its objectively measured attribute levels, including those of experience attributes. Thus, in their toothpaste application, they assume that brands retain their *Consumer Reports*-reported levels of “antiplaque,” “cavity prevention,” “teeth whitening,” and “breath freshening” in their unbranded states. If consumers use brands to infer such attributes, the effect is to underestimate brand equity (for brands strong on these attributes). Swait et al. (1993) define brand equity as the “equalization price”—the price at which a consumer will be indifferent between buying versus not buying the brand. This definition implicitly gives credit to the brand for everything: brand elements as well as *all* product elements—including search attributes. Brand equity will likely be biased upward. Kamakura and Russell (1993, p. 12) offer two measures: brand value and brand intangible value. The former, defined as the “value assigned to the brand by the particular segment after adjusting for situational factors (short-term price and recent advertising)” is analogous to the definition in Swait et al. (1993). The latter they define as the parts of brand value not explained by “physical attributes,” which, in their detergent application, were brightness, whiteness, and stain removal—all experience attributes. So, their brand value measure likely overreports brand equity, and their intangible brand value measure likely underreports brand equity.

<sup>6</sup> An alternative way to think about these issues is via the costs of brand rebuilding. In the long run, one might argue that the

<sup>4</sup> If we had reliable means of extrapolating from current profits to future profits, then it would be a simple matter to capitalize these profits into a net present value of the brand. For example, if current period profit flows  $\pi$  are expected to continue into the indefinite future, then brand value in NPV terms will be  $\pi/r$ , where  $r$  is the cost of capital. Estimating the future profit potential of a brand is not straightforward, however. Besides the usual difficulties attendant on prediction of future revenues and costs—product category growth or decline, entry and exit of competitors, changes in technology—there is also the particular problem of assessing the leveraging potential of a brand—line extensions, brand extensions, and co-branding. Quantifying these opportunities and threats often requires making speculative assumptions. We refrain from doing so here, choosing to rest our brand value estimates on current-period profits grounded in observed data.

Figure 1 A Framework for Measuring Brand Value



Thus, we arrive at our definition of brand value as the equilibrium profit earned by a brand in its branded state minus the equilibrium profit it would have earned if it were unbranded but considered and retained its search attributes.<sup>7</sup> Figure 1 represents this framework.

## 2.2. Measuring Brand Value in an Oligopoly with a Common Retailer

In real-world consumer goods markets, manufacturers typically have competitors and distribute through common retailers. Most brand value estimations are carried out in such institutional contexts. In this section, we describe how we can implement our framework in these real-world situations.

A basic question arises right away. With manufacturers distributing their products through retailers, whose perspective should we take when estimating brand value, the manufacturer's or the retailer's? Brands are valuable to both. We could define brand value based on the manufacturer's profit, retailer's profit, or even channel profit—the sum of manufacturer's and retailer's profits. With retailer profit,

brand will not stay in an unbranded state; it will rebrand itself and begin to deliver the same benefits that it did in its original branded state. But this transformation will not happen costlessly or immediately. The fixed costs of rebuilding the brand over time must be accounted for (otherwise, we are once again led to nonsensical positions: the product in its unbranded state is delivering the same benefits as in its branded state, with no additional cost; hence brand value must be zero). The econometrician has better tools for estimating short-term counterfactual demand than long-term counterfactual fixed costs. So, as a practical matter, it is better to focus on the demand side.

<sup>7</sup> Practically, when estimating brand value from observational data, we will not have access to an “unbranded” product. So, absolute brand value is inestimable. Instead, we measure brand value relative to another brand. We provide details on the strengths and weaknesses of this approach below.

because retailers carry multiple brands in each category, category profit becomes the profit criterion. What does a particular brand's value mean for such a retailer? We define a brand's value to a retailer as the contribution of the brand to the retailer's equilibrium category profit. In our factual-counterfactual framework, this means subtracting equilibrium category profit in the counterfactual from the equilibrium category profit in the factual, recognizing that not only will the wholesale and retail prices of the brand in question change between the two equilibria, but also the wholesale and retail prices of other brands in the category.

The supply-side effects of brand equity extend horizontally and vertically when manufacturers have competitors and distribute through intermediaries. For example, if a manufacturer raises its wholesale price to take account of its superior brand equity, then its competitors may follow suit—or they may lower their prices, recognizing their weaker brand equities. Vertically, manufacturers' actions affect retailers who buy from them and resell to consumers. For example, an increase in a manufacturer's wholesale price may trigger a retail price increase by a retailer on that brand, as well as on other brands in the category (Moorthy 2005). The equilibrium concept we use to account for these interactions has the manufacturers behaving as Stackelberg leaders with respect to the retailer and as Bertrand-Nash players among themselves.<sup>8</sup> As is common in the literature, we assume no

<sup>8</sup> There is a separate literature devoted to uncovering market structure in an oligopoly (Nevo 2001, Villas Boas 2007), and our intention is not to contribute to that literature. Still, brand value estimates are obviously sensitive to market structure assumptions, so any brand value estimation intended for application must carefully evaluate the robustness of the estimates to alternative market structure assumptions. We have estimated our model under

store competition and no side payments (allowances) from the manufacturer to the retailer. For each brand, two equilibria need to be computed: the real-world equilibrium with the brand as it is, and a counterfactual equilibrium with the brand having “lost” its equity.

Consider a product category with  $B$  brands offered by  $B$  different manufacturers. The  $B$  manufacturers distribute their products through a common retailer (cf. Sudhir 2001, Villas-Boas and Zhao 2005). The manufacturers set their wholesale prices first; the retailer takes the wholesale prices as given and sets retail prices. Each brand  $b$  is available in  $J_b$  product varieties (e.g., the Kellogg’s brand available as corn flakes and raisin bran), with each variety characterized by a search attributes vector,  $x_{b_j}$ . Let  $D_{b_j}(\beta; x; p)$  denote brand-variety  $b_j$ ’s demand as a function of the entire array of brand equities  $\beta = (\beta_1, \dots, \beta_B)$ , search attribute vectors  $x = (x_{1_1}, \dots, x_{B_{J_B}})$ , and retail prices  $p = (p_{1_1}, \dots, p_{B_{J_B}})$ .<sup>9</sup> Table 1 describes the notation used in this paper.

The retailer chooses retail prices of each product  $j$  to maximize category profit, taking as given the wholesale prices  $w = (w_{1_1}, \dots, w_{B_{J_B}})$  set by the manufacturers.<sup>10</sup> In other words, the retailer’s problem is

$$\max_p \Pi_r = \sum_{b_j=1}^{B_{J_B}} [(p_{b_j} - w_{b_j})D_{b_j}(p)], \quad (3)$$

where  $D_{b_j}(p)$  represents the longer  $D_{b_j}(\beta; x; p)$ . Thus, the retailer sums the profits over all product varieties. We have omitted fixed costs because in a comparison between factual and counterfactual, they do not change. Assuming the requisite concavity and differentiability of the profit functions, and the existence of interior solutions, this maximization exercise leads to the following first-order conditions:

$$D_{b_j}(p) + \sum_{b_k} (p_{b_k} - w_{b_k}) \frac{\partial D_{b_k}(p)}{\partial p_{b_j}} = 0, \\ j = 1, \dots, J_b, \quad b = 1, \dots, B. \quad (4)$$

the following alternative market structure assumptions: (1) colluding manufacturers behaving as Stackelberg leaders with respect to a common retailer, and (2) individual subbrands behaving as Stackelberg leaders with respect to a common retailer. The first gave estimated average gross margin for manufacturers to be 56%, whereas the second gave 38%. The estimated average gross margin under our maintained assumption was 42%. According to Cotterill (1996, Table A4), manufacturer margins in the cereal industry are 44%. Therefore, we focus on the market structure assumption in the text.

<sup>9</sup> To avoid clutter, we are omitting advertising from the demand function even though it is considered in the actual estimation that follows.

<sup>10</sup> This model can be extended to apply to short-term promotional activities such as in-store displays.

**Table 1** Notation

Symbol	Meaning
$i$	Indexes consumer
$j$	Indexes product
$b$	Indexes brand
$B$	Number of brands
$J_b$	Number of product varieties of brand $b$
$x$	Vector of search attributes
$p$	Vector of retail prices
$\beta$	Vector of brand equities
$\beta_b$	Brand equity of brand $b$
$\beta_{b_j}$	Brand equity of subbrand (product) $j$ of brand $b$
$D_{b_j}(\beta; x; p)$	Demand for product variety $b_j$
$w$	Wholesale price vector
$\Pi$	Profit
$mc$	Manufacturer’s marginal cost
*	Equilibrium value
$b0$	Brand $b$ losing equity in counterfactual experiment
$t$	Indexes city-quarter
$\xi_j$	Mean valuation of unobserved cereal characteristics
$\Delta \xi_{jt}$	City-quarter specific deviation from $\xi_j$
$\alpha, \gamma, \psi$	Coefficients on price, advertising, and search attributes
$a$	Advertising

Note that the retailer takes into account how product  $j$ ’s price affects both the profit from product  $j$  and the profits from all other products. Solving (4) yields the Bertrand-Nash equilibrium in prices. In matrix form, this can be written as

$$p^* - w = [\Omega^{p*}]^{-1} D(p^*), \quad (5)$$

where  $\Omega^{p*} = I \times D_{jk}^{p*}$ , in which  $I$  is the identity matrix and  $D_{jk}^{p*} = -(\partial D_{b_k}(p^*) / \partial p_{b_j})$ .

Given cross-sectional/time-series data on demand, observable attributes  $x$ , and retail prices  $p$  (and data on suitable instruments to control for the endogeneity of  $p$ ), we can estimate the demand function  $D_{b_j}(p)$ . This in turn gives us  $D_{jk}^{p*}$ . Substituting in (5), we can then impute the unobserved wholesale prices  $w$ .

Manufacturers take their endowments of brand equities and observable attribute vectors as a given in the short term, and choose prices for each of their varieties so as to maximize their profits. In other words, each manufacturer solves

$$\max_w \Pi_b = \sum_{j \in J_b} [(w_{b_j} - mc_{b_j})D_{b_j}(p)], \quad (6)$$

where  $mc_{b_j}$  is the marginal cost of production of product  $b_j$ . Once again, we omit fixed costs on the assumption that they do not change between factual and counterfactual. The first-order conditions are

$$D_{b_j}(p) + \sum_{k \in J_b} (w_{b_k} - mc_{b_k}) \sum_m \frac{\partial D_{b_k}(p)}{\partial p_m} \frac{\partial p_m}{\partial w_{b_k}} = 0, \\ j = 1, \dots, J_b, \quad b = 1, \dots, B. \quad (7)$$

Solving (7), we can get the following in matrix form:

$$w^* - mc = [\Omega^{w^*}]^{-1} D(p^*), \quad (8)$$

where

$$\Omega_{jk}^{w^*} = \Omega_{jk}^I \times D_{jk}^{w^*},$$

$$\Omega_{jk}^I = \begin{cases} 1 & \exists b: k, j \in J_b, \\ 0 & \text{otherwise,} \end{cases}$$

$$D_{jk}^{w^*} = - \sum_m^{B_{J_B}} \frac{\partial D_{b_k}(p)}{\partial p_m} \frac{\partial p_m}{\partial w_{b_j}}.$$

From the retailer's first-order conditions of profit maximization, (5), we can derive  $\partial p_m / \partial w_{b_k}$ , which when substituted in the above expression for  $D_{jk}^{w^*}$  yields

$$D_{jk}^{w^*} = - \left[ \frac{\partial D_{b_k}}{\partial p_1} \dots \frac{\partial D_{b_k}}{\partial p_{B_{J_B}}} \right] \Xi^{-1} \begin{bmatrix} \frac{\partial D_{b_j}}{\partial p_1} \\ \dots \\ \frac{\partial D_{b_j}}{\partial p_{B_{J_B}}} \end{bmatrix}, \quad (9)$$

where  $\Xi$  is a  $B_{J_B}$  by  $B_{J_B}$  matrix with  $kn$ th element:

$$\Xi_{kn} = \frac{\partial D_k}{\partial p_n} + \frac{\partial D_n}{\partial p_k} + [p^* - w] \begin{bmatrix} \frac{\partial^2 D_1}{\partial p_k \partial p_n} \\ \dots \\ \frac{\partial^2 D_{B_{J_B}}}{\partial p_k \partial p_n} \end{bmatrix}. \quad (10)$$

Now, (5) and (8) yield  $mc$ , the vector of marginal costs of the different manufacturers. Manufacturer  $b$ 's profits are then

$$\Pi_b^* = \sum_{j \in J_b} [(w_{b_j}^* - mc_{b_j}) D_{b_j}(p^*)], \quad b = 1, \dots, B,$$

where the superscript  $*$  indicates equilibrium values.

To calculate brand value, we need the profit that the brand would have if it did not have the brand label but retained its search attributes. For that, we need to simulate the counterfactual equilibrium. Suppose that brand  $k$  is the one in the counterfactual—all other brands retain their brand equities. We start with a new set of demand functions  $D_{b_j}^{k0}(\beta_1, \dots, 0, \dots, \beta_B; x; p)$ , which are the same as the ones above except that  $\beta_k = 0$ ; the superscript  $k0$  indicates that it is brand  $k$  that has "lost" its brand equity in this counterfactual experiment. As discussed above, the search attributes of the product do not change in the move from the factual to the counterfactual. Nor, we assume, do the marginal costs: even without the brand, the product still has the same ingredients, the same design, and the same manu-

facturing process. Other brands remain the same in terms of their brand equities and search characteristics, but their demand functions are affected by the change in firm  $k$ 's brand equity. All manufacturers may adjust their wholesale prices, and the retailer may follow with a new set of retail prices for each of the brands in the category. The first-order conditions governing these adjustments are the same as (4) and (7) except  $D_{b_j}(p)$  is replaced by  $D_{b_j}^{k0}(p)$ . The new equilibrium is

$$p^{k0*} - w^{k0*} = [\Omega^{p^{k0*}}]^{-1} D^{k0}(p^{k0*}), \quad (11)$$

$$w^{k0*} - mc = [\Omega^{w^{k0*}}]^{-1} D^{k0}(p^{k0*}). \quad (12)$$

Solving (11) and (12), and substituting in the manufacturer's profit function, yields the counterfactual equilibrium profit of manufacturer  $k$ :

$$\Pi_k^{k0*} = \sum_{j \in J_k} [(w_{k_j}^{k0*} - mc_{k_j}) D_{k_j}^{k0}(p^{k0*})].$$

Brand value for the manufacturer is then

$$\Pi_k^* - \Pi_k^{k0*}. \quad (13)$$

For the retailer, the counterfactual profit includes the lost profits from brand  $k$  plus the potential increase in sales of other brands. Therefore, the value of brand  $k$  to the retailer is

$$\sum_{b=1}^B \sum_{j=1}^{J_b} [(p_{b_j} - w_{b_j}) D_{b_j}(p^*)] - \sum_{b=1}^B \sum_{j=1}^{J_b} [(p_{b_j}^{k0*} - w_{b_j}^{k0*}) D_{b_j}^{k0}(p^{k0*})]. \quad (14)$$

### 2.3. Identification

The most fundamental identification issue in using observational data to estimate brand value is how to identify the outcomes that will result in the counterfactual equilibrium given that the counterfactual is never observed. There are two aspects to this question: how to estimate a demand function for a brand in its counterfactual state,<sup>11</sup> and how to estimate what the firm would do in the counterfactual state, i.e., the counterfactual equilibrium.

We estimate a demand function for a brand in the counterfactual situation by borrowing from the sales performance of a real brand. (This is the sense in which we need to assume that the brand in its counterfactual state continues to be considered.) Of course, real brands do have brand equities, so the

<sup>11</sup> This is not a problem with survey-based techniques such as conjoint analysis because the counterfactual can actually be created in the laboratory: the survey respondent is simply presented with a product profile without a brand name and asked to rate it.

simulation can never reveal absolute brand values, only relative brand values.<sup>12</sup> The choice of comparison brand determines how close we come to estimating absolute brand values. If there is a generic brand in the category that can be used as the baseline brand, then we come close, but even generic brands have equity. To illustrate how the simulation estimates counterfactual demand, consider a product category with three brands,  $B_1$ ,  $B_2$ , and  $S$ , the first two being the brands whose values are being estimated, and  $S$  being the baseline brand. In the demand function, we will have two dummy variables for  $B_1$  and  $B_2$  with  $(0, 0)$  on these dummy variables representing  $S$ . Note that  $B_1$  and  $B_2$  would continue to retain the search attributes that characterize their product varieties—only the brand is changing in the simulation. Thus, if  $B_1$  has two product varieties with search attribute vectors  $x_{11}$  and  $x_{12}$ ,  $B_2$  has  $x_{21}$  and  $x_{22}$ , and  $S$  has  $x_{s1}$  and  $x_{s2}$  ( $x_1$  and  $x_2$  need not be the same as  $x_s$ ), then the counterfactual with respect to  $B_1$  creates the industry  $(S, x_{11}, x_{12})$ ,  $(B_2, x_{21}, x_{22})$ , and  $(S, x_{s1}, x_{s2})$ .

Having estimated a demand function for the brand in its counterfactual state, there still remains a question of how to estimate the counterfactual equilibrium, i.e., the prices that will be chosen in the counterfactual situation. A key assumption becomes necessary: that the product in its counterfactual state retains its marginal production costs. To illustrate with the monopoly model above, if we knew the monopolist's marginal cost  $c$  in the real situation and we assumed that it would be the same in the counterfactual state, then we can go to the first-order condition, (2), plug in  $D(0; x; p)$ ,  $c$  and  $\partial D(0; x; p)/\partial p$  (having estimated the counterfactual demand function as above), and solve for  $p^0$ , the counterfactual equilibrium price. Knowing demand, price, and marginal cost in both the factual and the counterfactual states, brand value can then be estimated from (1).

Generally, however, marginal costs are not known to the econometrician. But this turns out not to be a problem. In the New Empirical Industrial Organization framework, marginal costs can be estimated from data on demand and prices using the firms' first-order conditions (Nevo 2000). To see this, consider Equation (2), the first-order condition in the monopoly model. From cross-sectional and/or time-series data on  $D$ ,  $p$ , and  $x$  (as in the cereal data), we can estimate  $D$ , the demand function, and its partial derivative,  $\partial D/\partial p$ . Substituting in (2), we can solve for  $c$ , the marginal cost in the real situation.

<sup>12</sup> Although absolute brand values can be useful (e.g., for evaluating merger and acquisition opportunities), it is often the relative brand values that matter to marketing managers. For example, a manager might be interested in comparing her brand's value against a competing brand's value to benchmark her brand.

To summarize the discussion so far, the empirical strategy for estimating brand value will be as follows:

(1) Using data on prices, search attributes, advertising, and sales, estimate the demand functions,  $D$ . This yields the demand-derivatives matrix  $\Omega^p$ .

(2) Using these estimates, and the equilibrium conditions, back out the wholesale prices first, and then the marginal costs of production.

(3) For each brand  $b = 1, \dots, B$ , simulate the counterfactual demand by setting  $\beta_b$  equal to zero in  $D$ . This yields the demand function  $D^{b0}$ , and the demand-derivatives matrix  $\Omega^{pb0}$ .

(4) For each brand  $b = 1, \dots, B$ , using  $\Omega^{pb0}$ , and the marginal costs previously estimated in Step (2), solve for the counterfactual equilibrium prices, wholesale and retail, under the assumption that manufacturers behave as Stackelberg leaders with respect to the retailer and as Nash players among themselves.

(5) Calculate brand value as the difference between the real and simulated counterfactual profits using (13) and (14).

### 3. Data and Empirical Procedures

#### 3.1. Data

We illustrate our methodology using aggregate data on ready-to-eat breakfast cereals from the IRI Infoscan Database.<sup>13</sup> These data have been previously used by Nevo (2001), to which we refer for more details. Essentially, the data set contains quarterly market shares and prices for various cereal brands in up to 65 major U.S. cities from the first quarter of 1988 until the last quarter of 1992. No data on promotional activities are available. Our estimates are based on the top 25 cereals nationally in the last quarter of 1992, listed in Table 4. Each of these top-selling cereals is associated with a brand name (General Mills, Kellogg's, Post, Quaker, and Nabisco) and a subbrand name (Honey Nut Cheerios, Life, Special K, etc.). A brand may have several subbrands. For example, besides Special K, Kellogg's has Crispix, Rice Krispies, and several other subbrands. Nabisco, however, has just one: Shredded Wheat. Although both generic and store brands are present in the category, the data pertaining to them are not usable. This is because while the national brands have uniform characteristics in all cities, the generic and store brands do not; they are not present in all city-markets, and when present, vary from city to city because of local sourcing.

We supplement the IRI Infoscan data with data from a variety of other sources. Quarterly national advertising expenditures by each cereal brand come

<sup>13</sup> We thank Ronald Cotterill, Director of the Food Marketing Policy Center at the University of Connecticut, for making this data set and data on advertising expenditures available to us.

**Table 2** Descriptive Statistics for the Market-Level Cereal Data

Brands	Market share	Price*
General Mills	0.36	0.21
Kellogg's	0.45	0.20
Post	0.07	0.23
Quaker	0.10	0.19
Nabisco	0.02	0.25

\*In dollars/serving.

from Leading National Advertisers. Data on the search attributes of cereals were collected online and in local supermarkets from cereal boxes; these include data on sugar content, fiber content, calories from fat, total calories, and whether the cereal is primarily intended for children, adults, or the whole family. We also have information on an experience attribute of cereals: “mushiness” in milk, as measured by Nevo (2001). We will include this in one of our regressions to show the consequences of controlling for experience attributes when theory suggests that one should not. Finally, city-level demographic data on income, age, household size, and population under 16 years of age (“child”) were drawn from the March Current Population Survey from each year.

Market shares are measured as a function of potential market size, defined to be one serving per capita per day. Prices are defined as dollar sales divided by number of servings sold; these were deflated using regional urban consumer price indices from the Bureau of Labor Statistics. Table 2 provides descriptive statistics for the cereal data set.

We now describe how we implement our estimation strategy with our data.

### 3.2. Estimation Procedure

We follow the basic procedures for estimating oligopoly models from aggregate data described in a series of papers: Berry (1994), Berry et al. (1995), Nevo (2000), and especially Nevo (2001). A key difference from these papers is that we consider two layers of firm decision making, manufacturers and retailer (as in Sudhir 2001), not just manufacturers. This makes a difference when estimating marginal costs and price-cost margins in the counterfactual: the retailer’s first-order conditions (5) must be considered in addition to the manufacturers’ first-order conditions (8). At the demand-estimation stage, however, our estimation procedure is essentially the same as in Nevo (2000, 2001), with a few notable deviations that we highlight below.

We start by writing consumer  $i$ ’s indirect utility for cereal  $j$  ( $j = 1, \dots, 25$ ) in city-quarter  $t$  as

$$u_{ijt} = \psi_i x_j - \alpha_i p_{jt} + \gamma a_{jt} + \xi_j + \Delta \xi_{jt} + \varepsilon_{ijt}, \quad (15)$$

where  $x_j$  is a  $K$ -vector of cereal-specific search attributes,  $p_{jt}$  is price (city and quarter-specific),  $a_{jt}$  is national advertising spending (quarter-specific, but not city-specific),  $\alpha_i$  and  $\psi_i$  are consumer-specific coefficients,  $\xi_j$  is the mean valuation of unobserved cereal characteristics,  $\Delta \xi_{jt}$  is a city-quarter specific deviation from this mean (to account for any cereal-specific unobserved characteristics that vary by city-quarter, such as local promotions), and  $\varepsilon_{ijt}$  is a mean-zero stochastic term. When not consuming any of the cereals, the consumer is assumed to be consuming an “outside good” (other breakfast options such as eggs). Operationally, we define the outside good in “cereal units” as one cereal serving per person-day minus the per-day prorated amount of cereal actually purchased.

The consumer-specific coefficients are assumed to be drawn from a multivariate normal distribution conditional on observed demographics as follows:

$$\begin{pmatrix} \alpha_i \\ \psi_i \end{pmatrix} = \begin{pmatrix} \alpha \\ \psi \end{pmatrix} + \Delta D_i + \Sigma v_i,$$

where  $v_i \sim N(0, I_{K+1})$ ,  $D_i$  is a  $d$ -vector of individual-specific demographic variables,  $\Delta$  is a  $(K + 1) \times d$  matrix of coefficients that captures how tastes for search attributes and prices vary by demographics, and  $\Sigma$  is a scaling matrix to be estimated from the data.

We include a dummy variable for each of the 25 cereals (when all these dummy variables are at zero, then the outside good is being consumed) to control for mean differences between cereals that do not vary by city or quarter.<sup>14</sup> With these fixed effects accounted for, only  $\Delta \xi_{jt}$  can be a source of endogeneity in prices, which we then control for by using average prices in other cities as an instrument (see Nevo 2001 for a discussion).<sup>15</sup>

The estimation itself is done in two stages. In the first, generalized method of moments (GMM) stage, we estimate the cereal fixed effects, the variance-covariance matrix, and the parameters for variables that vary by city-quarter, i.e., prices, advertising, and the demographic variables. In the second, generalized least-squares (GLS) stage, we regress the estimated cereal fixed effects on the cereal-specific variables that

<sup>14</sup> We also estimated a model with individual-level variation in brand preferences, but it did not improve model fit while lowering the precision of estimates. We believe the reason is, given heterogeneity in attribute tastes and price sensitivities, another layer of heterogeneity in brand intercepts is redundant.

<sup>15</sup> We compared the price elasticities obtained with our instrument to the price elasticities obtained with three additional instruments: percentage of children in each city, average wages in each city, and population density in each city. The own- and cross-price elasticities do not change significantly.

do not vary by city-quarter. Here, we deviate from Nevo (2001) in two ways. Whereas Nevo thinks of the  $j$ s as brands, we think of them as product varieties. Each product variety in our terminology has a brand (e.g., General Mills) and a subbrand (e.g., Wheaties). So, while Nevo's work is done once he has split the estimated fixed effects from the first stage into  $\psi x_j$  and  $\xi_j$ , we still have the task of splitting  $\xi_j$  into  $\beta_b$ , brand equity for the brand corresponding to cereal  $j$ , and  $\beta_{b_j}$ , subbrand equity. We do this via the following GLS specification:

$$F_j = \psi x_j + \beta_b I_{b_j} + \beta_{b_j}. \quad (16)$$

Here,  $F_j$  is the estimated fixed effect for cereal  $j$  from the first stage and  $I_{b_j}$  is a vector of four dummy variables to capture the brand identity of cereal  $j$  (one each for Kellogg's, General Mills, Post, and Quaker, with Nabisco as the baseline brand). Assuming that  $E(\beta_{b_j} | x_j, I_{b_j}) = 0$ , we can estimate  $\psi$  and  $\beta_b$  consistently by GLS using the first-stage variance-covariance matrix. Subbrand equities ( $\beta_{b_j}$ ) then fall out as residuals from this regression.<sup>16</sup> The second way we deviate from Nevo (2001) is that we do not include experience attributes (e.g., mushiness) in the vector of observed attributes  $x_j$ . As discussed earlier, part of a brand's function is to signal the experience attributes of the product. To the extent brands are differentiated on experience attributes, including them in  $x_j$  will affect the brand value estimates. Brands strong in experience attributes will be undervalued; brands weak in experience attributes will be overvalued.

With the demand estimates in place, Steps (2)–(5) of the empirical strategy are executed in sequence. In Step (3), the counterfactual step, we set  $\beta_b = 0$  in Equation (16) for each of the brands Kellogg's, General Mills, Post, and Quaker in turn (while setting subbrand equities  $\beta_{b_j}$  at the level of the Nabisco residual) to simulate their transformation into Nabisco and track the effect of this change on equilibrium prices and sales. To estimate subbrand values, we instead fix each of the  $\beta_{b_j}$  in turn to Nabisco's residual.

Confidence intervals on brand equities are calculated using a bootstrap method (Horowitz 2001). The simulation is repeated 1,000 times, drawing the coefficients for use in the simulation from the estimated joint distribution of the coefficients. The 95% confidence interval is then the 25th and 975th largest simulated values.

<sup>16</sup> Brand and subbrand equities can be expressed in dollar terms by dividing by  $\alpha$ , as in Park and Srinivasan (1994) and Chintagunta et al. (2003). These dollar values may then be interpreted as brand values from the consumer's perspective.

**Table 3** Demand for Cereal

	Parameter	Estimate
	Constant	−5.72 (0.10)**
	Price	−30.27 (4.43)**
	Advertising	0.01 (0.004)**
Nutritional content <sup>^</sup>	Sugar	−0.23 (0.01)**
	Fat	0.03 (0.001)**
	Fiber	−0.06 (0.002)
	Calories	0.08 (0.84)
Cereal types <sup>+^</sup>	All-family	−0.03 (0.001)
	Kids	−3.06 (0.28)**
	Adults	−1.32 (0.21)**
Brand coefficients <sup>++^</sup>	General Mills	1.19 (0.04)**
	Kellogg's	0.49 (0.04)**
	Post	−0.78 (0.04)**
	Quaker	0.91 (0.04)**
Standard deviations ( $\sigma$ )	Price	1.89 (6.21)
	Sugar	0.04 (0.11)
	Fat	0.03 (0.42)
	Fiber	0.21 (0.60)
	All-family	0.22 (1.91)
	Kids	0.12 (2.48)
	Adults	0.97 (1.25)
Interaction	Price * Child	0.10 (6.40)

*Notes.* Standard errors in parentheses; state dummy variables not shown. Coefficients for subbrand dummy variables not shown.

<sup>^</sup>Estimated from the second-stage regression in Equation (16).

<sup>+</sup>Base is taste-enhanced cereal (as defined in Nevo 2001).

<sup>++</sup>Brand coefficients relative to Nabisco.

\*Significant at 0.05 level; \*\*significant at 0.01 level.

## 4. Results

### 4.1. Brand Value Estimates

Table 3 shows the demand parameter estimates from the random-coefficients model. As expected, price has a negative impact on sales and advertising has a positive impact. Subbrand coefficients are not shown in the table and largely explain the negative coefficient for Post and the relatively small coefficient for Kellogg's.<sup>17</sup>

<sup>17</sup> We compared the out-of-sample predictive ability of our demand model with the following vector autoregression (VAR) model:

$$\begin{bmatrix} s_t \\ p_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^T \beta_{1sj} s_{t-j} \\ \sum_{j=1}^T \beta_{2sj} s_{t-j} \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^T \beta_{1pj} p_{t-j} \\ \sum_{j=1}^T \beta_{2pj} p_{t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix},$$

where  $s$  are the market shares and  $p$  are the prices. This is estimated using a seemingly unrelated regression. Our model fits slightly better. In particular, we used the first 15 quarters of data to estimate the model using both methods. The random coefficients model predicts the market shares of the five firms in the remaining quarters more accurately than the VAR model, although both perform well. For the 25 out-of-sample firm-quarters, the average predicted market share divided by the real market share was 1.0012 in the random coefficients model and 1.0716 in the VAR model (standard deviations were 0.0018 and 0.5676, respectively).

**Table 4** Brand Values

	Previous methods		Our methods			
			Without experience attributes		With experience attribute “mushiness”	
	Price premium <sup>#</sup>	Revenue premium <sup>^</sup>	Brand value to manufacturer <sup>^+</sup>	Brand value to retailer <sup>^+</sup>	Brand value to manufacturer <sup>^+</sup>	Brand value to retailer <sup>^+</sup>
General Mills	0.10	1,192.6 <sup>^</sup>	569.1 (567.8, 571.2)	238.4 (234.6, 239.8)	558.3 (553.9, 561.2)	233.5 (228.9, 234.4)
Kellogg’s	0.15	1,277.9	726.9 (723.9, 730.6)	294.1 (291.1, 296.3)	698.0 (685.5, 706.0)	281.4 (276.4, 285.2)
Post	0.09	111.3	27.0 (23.4, 35.9)	17.2 (11.5, 19.8)	2.6 (−7.1, 10.8)	7.3 (0.02, 10.2)
Quaker	0.04	66.6	72.6 (71.1, 76.1)	36.3 (29.7, 38.5)	60.2 (52.5, 68.3)	31.3 (24.1, 33.1)

Note. Confidence intervals (95%) in parentheses where applicable.

<sup>#</sup>Dollars/serving relative to Nabisco.

<sup>^</sup>Millions of dollars/year relative to Nabisco, assuming U.S. population of 300 million.

<sup>+</sup>Manufacturer and retailer brand values are based on the profit drop from a simulated equilibrium where the brand and its subbrands lose equity.

Brand value estimates are summarized in Table 4. Besides our profit-based estimates, we include estimates from two previously used reduced-form methods: price premiums based on hedonic regression (Holbrook 1992) and revenue premiums based on the Ailawadi et al. (2003) method (each brand’s average revenue minus Nabisco’s average revenue). Kellogg’s, for example, has a 15-cent price premium per serving and \$1,277.9 million dollars/year revenue premium over Nabisco.<sup>18</sup> The next four columns present brand value estimates from our methodology; i.e., these are the equilibrium profits to the manufacturer and the retailer from the brand after accounting for search attributes.<sup>19</sup> To show the impact of

controlling for experience attributes, we present two sets of estimates—one with an experience attribute (“mushiness”) in the demand function and one without (the one we recommend). The preferred estimates show, for example, that Kellogg’s brand has a value of \$726.9 million dollars/year relative to Nabisco from Kellogg’s perspective. From the retailer’s perspective, Kellogg’s brand has a value of \$294.1 million dollars/year.

Because the different methods compute brand value in different units, the brand value numbers themselves are not comparable, but we can compare rank orders of brand values and brand value differences. The purpose of these comparisons is not to say which is “closer to the truth”—we do not know what the truth is—but to assess to what extent our estimates agree with those produced by the other methods, and, to the extent they differ, why that might be so.<sup>20</sup> The rank order of brand values produced by the different methods is fairly similar, but there are some differences, namely, the ordering of Post vis-à-vis Quaker; our method ranks Quaker higher, whereas the reduced-form methods rank Post higher. Brand value differences also vary by method. For example, in our method, Kellogg’s brand value is over 25% higher than General Mills’, but by the Ailawadi et al. (2003) revenue premiums method, its advantage is

<sup>18</sup> Price and revenue premiums calculated from our structural model differ from these reduced-form estimates. The price premiums per serving for General Mills, Kellogg’s, Post, and Quaker over Nabisco from our model are 1.37, 1.95, 0.21, and 0.27 cents, respectively. Note that these numbers are smaller than those calculated with the reduced-form approach, and the ordering of Quaker versus Post is reversed. Structural estimates of revenue premiums (millions of dollars per year) are General Mills \$1,352.8 million, Kellogg \$1,527.0 million, Post \$245.3 million, and Quaker \$254.4 million. These are higher than their reduced-form counterparts.

<sup>19</sup> We also estimated a number of alternative models. If we assume no retailer, not surprisingly, the brand value estimates for the manufacturer turn out substantially lower (\$318.9 million for Kellogg): The wholesale prices paid by the retailer are now attributed to the manufacturer as its marginal costs. If we assume collusion between manufacturers, brand values are higher (\$946.9 million for Kellogg’s, for example). If we assume subbrand-level competition, brand values are lower (\$640.6 million for Kellogg’s). The relative brand values change little. As mentioned earlier, the estimated mark-ups suggest that manufacturer-level Bertrand competition is a reasonable market structure to use. In situations where the researcher has no independent means of assessing market structure, we suggest estimating brand values under several different market structures to get upper and lower bounds on brand value.

<sup>20</sup> Interestingly, our brand value calculations are consistent with the actual profits for Kellogg’s during this time period. According to their annual report, Kellogg’s U.S. division had operating profits of \$602.8 million in 1992 (the company profit was \$1,062.8 million). While Kellogg’s does have other products besides cereal, cereal is by far the dominant category. It was not possible to proxy cereal-related profits for the other brands from annual reports. Although the closeness of our brand value estimate to Kellogg’s 1992 profits provides some support for the external validity of our measure, we do not want to overemphasize this point.

just 7%. This could be, of course, because wholesale price differences among brands figure in our computation, but also we model the counterfactual explicitly taking into account (a) the contribution of search attributes, and (b) the responses of other manufacturers and of the retailer.

**4.1.1. Brand Value from the Perspective of the Manufacturer vs. the Retailer.** A cereal brand is apparently more valuable to its manufacturer than to a retailer who carries it. This may be because the cereal category provides a lot of variety to a retailer: two relatively strong brands that offset each other, and several weaker brands. The retailer's fortunes are not dependent on one brand. If a brand loses equity, the retailer has the opportunity to make adjustments in prices and promotions to drive sales from the affected brand to other brands in the category. This shows up in the numbers. For example, when General Mills loses equity, the simulations estimate that General Mills itself loses \$569.1 million in profits. Although retailers lose \$349.4 million in foregone sales of General Mills products, they gain \$55.3 million from the increased sale of other cereals. The overall value of the General Mills brand to the retailer is then \$294.1 million. Similar results are seen for the other brands.

**4.1.2. Role of Experience Attributes.** Our results for brand value controlling for a brand's "mushiness in milk" in the demand function (a binary variable, "mushy"/"not mushy") show that mushiness is generally a negative attribute of cereals—people prefer their cereal not to get soggy in milk—but there is some heterogeneity in this (Nevo 2001). The cereal makers, catering to this preference structure, generally make their cereals not mushy, although a few varieties are mushy. Putting the mushiness variable in the demand function amounts to assuming that brand has no signaling value for this attribute, and that consumers will know the mushiness of the cereal even without the aid of a brand. Clearly, such an assumption will change brand values, and that is what we find in Table 4.<sup>21</sup> Because Post and Quaker perform relatively well on mushiness, it is these brands that lose (relative) value when controlling for mushiness. The value of Post falls from \$27 million to near zero; the value of Quaker falls by one-sixth. Although the results for Post are striking, mushiness generally does

not account for much of the brand value. There are other experience and credence attributes that brand continues to signal, and, of course, brand continues to play a purely marketing role, adding imagery, personality, and emotional values to the cereal.

**4.1.3. Brand Value at the Subbrand Level.** Table 5 shows subbrand values, calculated from the residuals of the second-stage GLS regression. The results show that subbrands play an important role in driving overall brand value. For example, the subbrand Cheerios by itself contributes as much as 19.9% of General Mills' brand value. Quaker and Post provide an interesting contrast. Quaker's overall brand value seems to be driven primarily by the "Quaker" brand, not by its subbrands. In fact, the combined value of its subbrands (Cap'n Crunch, Life, and 100% Natural) is *less* than the value of the base brand, Nabisco; however, "Quaker" itself is a strong brand that generates high profits. In contrast, Post's overall brand value seems to be primarily driven by its subbrands, especially Grape Nuts; the umbrella brand, Post, is quite close to Nabisco in brand value, which may provide some explanation for Post's decision (as a unit of Kraft) to buy Nabisco in 1992 (the merger was approved in February 1995).

**4.1.4. Impact of Brands on Consumer Welfare.** In addition to affecting firms, brands affect consumer welfare directly by providing imagery, personality, emotional affiliation, and information on experience attributes, and indirectly by their effect on prices. Following Chintagunta et al. (2003), we calculate total consumer welfare when all brands have value and compare it to the consumer welfare in four different counterfactual situations where each brand loses value. The equilibrium effect of brands on consumer welfare is ambiguous: while brands directly generate value to consumers, brands may keep equilibrium prices high. Table 6 shows our estimates of the welfare effects of brands on consumers. General Mills and Kellogg's have strong positive effects on consumer welfare; in contrast, the consumer welfare effects of Post and Quaker are not significantly different from zero. Given the large market shares of General Mills and Kellogg's, it is perhaps not surprising that their brands have a large positive effect on consumer welfare. Interestingly, the positive effect of the Post and Quaker brands on welfare appears to be mitigated by the impact of their brands on the prices of their larger competitors.<sup>22</sup> Thus, while the Post brand may generate value to customers who buy Post products, it may lead to higher prices for the popular General Mills and Kellogg's cereals, thereby leading to a neutral impact of the Post brand on total consumer welfare.

<sup>21</sup> Kartano and Rao (2005) estimate brand values in the car market controlling for experience attributes in the demand function. However, because they do not report brand values without such controls, we cannot tell by how much their brand value estimates are affected by the inclusion of experience attributes. The fact that their demand function shows significant effects for some experience attributes—perceived quality (transmission and ignition) and satisfaction (interior features)—suggests that these attributes may be soaking up some brand equity.

<sup>22</sup> We show in the next section that General Mills and Kellogg's retail prices are higher when Post and Quaker have brand equity.

**Table 5 Subbrand Values**

	Brand value to manufacturer <sup>+</sup>	Brand value to retailer <sup>+</sup>		Brand value to manufacturer <sup>+</sup>	Brand value to retailer <sup>+</sup>
General Mills			Kellogg's		
Cinnamon Toast Crunch	15.2 (15.0, 15.4)	7.4 (7.3, 7.5)	Crispix	29.9 (29.7, 30.0)	14.2 (14.1, 14.2)
Cheerios	113.3 (113.1, 113.5)	57.3 (57.1, 57.4)	Froot Loops	60.1 (60.0, 60.1)	28.7 (28.7, 28.8)
Kix	14.6 (14.4, 14.8)	7.1 (7.0, 7.2)	Frosted Flakes	146.0 (145.4, 146.4)	71.0 (70.8, 71.2)
Raisin Nut	12.3 (12.2, 12.4)	6.0 (6.0, 6.1)	Mini-Wheats	42.3 (41.7, 42.7)	20.1 (19.9, 20.2)
Trix	30.0 (29.9, 30.0)	14.8 (14.8, 14.8)	Frosted Corn Flakes	141.6 (139.4, 143.0)	68.7 (67.9, 69.3)
Honey Nut Cheerios	73.9 (74.1, 73.8)	37.0 (36.9, 37.1)	Corn Pops	33.9 (33.7, 33.9)	16.1 (16.1, 16.1)
Lucky Charms	41.1 (41.0, 41.1)	20.4 (20.4, 20.4)	Raisin Bran	61.1 (61.0, 61.1)	29.3 (29.2, 29.3)
Total	37.1 (36.6, 37.5)	18.3 (18.1, 18.5)	Rice Krispies	89.4 (89.0, 89.6)	43.0 (42.8, 43.1)
Wheaties	32.6 (32.4, 32.7)	16.1 (16.0, 16.2)	Special K	13.8 (11.7, 14.9)	6.2 (5.6, 6.6)
Quaker			Post		
Cap'n Crunch	64.2 (64.0, 64.4)	35.5 (35.3, 35.5)	Grape Nuts	68.9 (13.4, 117.5)	28.4 (63.1, 2.8)
Life	9.4 (9.0, 9.6)	5.2 (5.0, 5.3)	Honey Bunches of Oats	21.4 (11.1, 33.1)	14.0 (6.8, 19.3)
100% Natural	-83.9 (-95.6, -77.2)	-45.7 (-52.1, -42.0)	Raisin Bran	32.9 (32.8, 32.9)	18.1 (18.1, 18.1)

Note. Confidence intervals (95%) in parentheses.

Millions of dollars/year relative to Nabisco, assuming U.S. population of 300 million.

<sup>+</sup>Manufacturer and retailer brand values are based on the profit drop from a simulated equilibrium where the subbrand loses equity.

#### 4.2. Effects of Brand Equity on Manufacturers and Retailers

One of the main advantages of our structural approach is that it enables us to simulate what would happen if one of the brands were to “lose its equity.” This allows us to better understand the drivers of brand value. Tables 7–10 describe what happens to price elasticities,<sup>23</sup> prices, and market shares when a brand’s equity becomes like Nabisco’s.

**4.2.1. Price Elasticity.** Table 7 reports the changes in own and cross-price elasticities from the real to the counterfactual (a positive number indicating an increase in elasticity in absolute terms). For example, General Mills’ own-price elasticity falls 6.31% when its equity falls to the level of Nabisco’s. The remainder of the first row shows the changes in cross-price elasticities for General Mills with respect

to other brands. Each of these cross-price elasticities increase when General Mills loses equity, signifying that price changes in the other brands influence General Mills’ market share more after it loses its equity. The cross-elasticity between General Mills and Nabisco increases the most, by 19.41%, as might be expected considering that when General Mills becomes like Nabisco, they become closer competitors (not identical competitors because their search attributes are still different). Overall, rival brands become closer substitutes to General Mills and Kellogg’s when these two powerful brands lose equity. For the weaker brands, Post and Quaker, the elasticities do not change much: they are closer to Nabisco to

**Table 6 Impact of Brand Value on Consumer Welfare**

General Mills	182.1 (179.3, 196.9)
Kellogg's	234.2 (227.3, 245.5)
Post	-20.2 (-23.8, 10.7)
Quaker	-2.5 (-8.5, 24.4)

Notes. Confidence intervals (95%) in parentheses. Values in millions of dollars.

<sup>23</sup> Even though the brand coefficients are intercepts in the utility function, changes in any of them will affect the (own) price elasticities of all brands. This is because both shares and equilibrium prices are functions of the brand coefficients. As Nevo (2000) shows, own-price elasticity is given by  $(-p_{jt}/s_{jt}) \int \alpha_i s_{ijt} (1 - s_{ijt}) dP_{it}$ , where  $s_{ijt}$  is the share of cereal  $j$  in individual  $i$ 's cereal purchases in market  $t$ .

**Table 7 Own and Cross-Price Elasticity Changes with Changes in Brand Equity (%)**

	Δ Elasticity (%) for brand in the first column with respect to retail price changes in				
	General Mills	Kellogg's	Post	Quaker	Nabisco
General Mills	−6.31 (−8.85, −4.98)	14.1 (11.9, 14.8)	18.70 (17.1, 19.4)	17.60 (15.8, 18.3)	19.41 (18.02, 20.26)
Kellogg's	18.33 (16.72, 20.27)	−9.1 (−12.9, −6.9)	23.0 (21.3, 24.6)	21.4 (19.6, 23.3)	23.63 (22.46, 25.62)
Post	3.62 (0.80, 4.06)	3.2 (0.7, 3.8)	−0.9 (−0.9, −0.2)	3.8 (0.9, 4.2)	4.22 (1.04, 4.73)
Quaker	4.52 (1.80, 5.05)	4.4 (1.6, 4.8)	5.2 (2.2, 5.7)	−1.4 (−1.5, −0.6)	4.20 (1.65, 4.90)

Note. Confidence intervals (95%) in parentheses; brands in the first column are changing their equities.

**Table 8 Market Share Changes with Brand Equity Changes (%)**

Effect on →	General Mills	Kellogg's	Post	Quaker	Nabisco
General Mills	−6.33 (−6.36, −6.29)	1.40 (1.13, 1.46)	0.28 (0.25, 0.29)	0.40 (0.35, 0.41)	0.07 (0.06, 0.07)
Kellogg's	1.41 (1.25, 1.53)	−7.75 (−7.84, −7.69)	0.34 (0.32, 0.36)	0.49 (0.45, 0.51)	0.08 (0.08, 0.09)
Post	0.30 (0.05, 0.34)	0.37 (0.06, 0.43)	−0.32 (−0.41, −0.25)	0.09 (0.02, 0.11)	0.02 (0.00, 0.02)
Quaker	0.37 (0.13, 0.42)	0.46 (0.15, 0.51)	0.08 (0.03, 0.09)	−0.88 (−0.94, −0.78)	0.02 (0.01, 0.02)

Notes. Confidence intervals (95%) in parentheses; brands in the first column are changing their equities. The total market includes the outside good, whose share changes are not reported.

**Table 9 Wholesale Price Changes with Brand Equity Changes (%)**

Effect on →	General Mills	Kellogg's	Post	Quaker	Nabisco
General Mills	−6.71 (−9.68, −5.16)	0.07 (−0.07, 0.10)	−1.02 (−1.47, −0.80)	−1.28 (−1.91, −0.99)	−0.96 (−1.36, −0.75)
Kellogg's	−0.28 (−0.47, −0.17)	−10.10 (−15.20, −7.64)	−1.26 (−1.81, −0.97)	−1.59 (−2.34, −1.19)	−1.19 (−1.68, −0.93)
Post	0.10 (−0.02, 0.10)	0.17 (0.00, 0.18)	−0.26 (−0.39, −0.20)	−0.03 (−0.07, −0.02)	−0.05 (−0.07, −0.04)
Quaker	0.07 (−0.04, 0.07)	0.16 (−0.01, 0.17)	−0.12 (−0.19, −0.10)	−0.70 (−1.04, −0.52)	−0.13 (−0.18, −0.10)

Note. Confidence intervals (95%) in parentheses; brands in the first column are changing their equities.

**Table 10 Retail Price Changes with Brand Equity Changes (%)**

Effect on →	General Mills	Kellogg's	Post	Quaker	Nabisco
General Mills	−6.52 (−9.14, −5.15)	−1.83 (−2.04, −1.05)	−2.11 (−2.54, −1.48)	−2.60 (−3.11, −1.80)	−1.89 (−2.30, −1.34)
Kellogg's	−2.05 (−2.37, −1.90)	−9.75 (−13.88, −7.47)	−2.47 (−3.03, −2.19)	−3.03 (−3.70, −2.69)	−2.22 (−2.75, −1.96)
Post	−0.81 (−0.85, −0.09)	−0.87 (−0.94, −0.10)	−0.91 (−0.96, −0.24)	−0.99 (−1.04, −0.14)	−0.70 (−0.73, −0.10)
Quaker	−0.90 (−0.94, −0.18)	−0.96 (−1.02, −0.18)	−0.91 (−0.94, −0.23)	−1.43 (−1.49, −0.59)	−0.80 (−0.82, −0.21)

Note. Confidence intervals (95%) in parentheses; brands in the first column are changing their equities.

begin with, so the counterfactual does not represent a big change.<sup>24</sup>

**4.2.2. Market Shares.** Table 8 shows differences between actual and counterfactual market shares. The manufacturer who loses equity loses a great deal of share, while rivals gain. Interestingly, when major brands such as General Mills or Kellogg's lose brand equity, they lose 2.9 and 3.3 times, respectively, the combined sales gain of all the other firms. Category sales suffer as a result. This shows branding has value not only with respect to rivals in the category, but also in making the category as a whole more attractive.

**4.2.3. Wholesale and Retail Prices.** Tables 9 and 10 show differences between actual and counterfactual wholesale and retail prices, respectively. Both are matrices: when a brand's equity changes, it has a ripple effect on the entire industry; all brands adjust their prices. What happens to wholesale prices when a brand's equity falls to the level of Nabisco's? The results (see Table 9), although noisy because of the compounding of many simulated values, show that own wholesale prices drop and the players with the most equity drop their wholesale prices the most and generally have competitors that react most strongly. By contrast, weak brands evoke weak reactions. The one notable exception is that Kellogg's and General Mills do not drop wholesale prices much (or at all) in response to the other losing brand equity. This may be a consequence of the less competitive environment for the brand that maintains its equity. Retail prices also fall when a brand loses equity (Table 10). Interestingly, Quaker has a larger own-price reaction than Post, even though the hedonic regression shows a higher price premium for Post. Reduced-form and structural estimates of price premiums may thus be sufficiently different to change conclusions qualitatively. The lower wholesale price on the brand losing equity coupled with an increase in own-price elasticity at the retail level (because of the brand losing equity) induces the retailer to reduce prices throughout the category even when other brands' wholesale prices are unchanged or rising. This illustrates the different considerations that go behind brand competition at the manufacturer level and category management at the retail level, as discussed in Moorthy (2005). In many cases, the retail price drop exceeds the wholesale price drop, squeezing retail margins. Seen in pass-through terms, retailer pass-through on wholesale price reductions stemming from brand equity loss are often greater than 100%. This contrasts with the usual finding that retailers do not pass on all

of the price decreases they get at wholesale (Chevalier and Curhan 1976, Moorthy 2005). Our results suggest that when brand equities are changing, the retailer is more inclined to pass through.

## 5. Limitations and Future Research

Although our method for estimating brand value is better grounded theoretically, and more rigorously operationalized than existing methods, it is not without its limitations. Some of these limitations are particular to our data set—which a richer data set might overcome—still, we do not mean to imply that we have exhausted the possibilities for improving/refining the methodology. Some ideas are discussed below.

We have argued forcefully for keeping search attributes out of the brand value calculation, the theory being that these attributes can be seen by the consumer independent of brand. But “searchness” of an attribute is a matter of degree, and arguably, to some extent in the eye of the beholder. What is missing typically is any information on the ability or inclination of consumers to observe so-called search attributes. To the extent that some search attributes are costly to observe and brand serves as a short-cut to infer them (Erdem and Swait 2004), our method, by treating them as observable, will underestimate or overestimate brand value (depending on whether a brand's products are strong or weak in these attributes). By the same token, if relevant search attributes such as promotions are correlated with brand and observed by the consumer, but missing in the data (as in ours), then, too, brand values will be mismeasured. Our method, by forcing discussion of this issue contributes positively to our understanding of brand value, and provides a way to assess its sensitivity to alternative assumptions (as we demonstrated by comparing brand values with and without experience attributes in the regression).

Advertising plays an important role in reducing search costs and in building and maintaining brand value. We assume current advertising to be exogenous and past advertising to affect current sales only through brand equity. Of these, the first is more difficult to justify. Current advertising is endogenous and likely to respond to changes in brand equity. In addition, endogenizing advertising (and/or promotions) may be a way to relax the assumption that costs do not change when brand equity “falls” in the counterfactual. Again, given the limitations of our data set including national-level advertising and a lack of a viable instrument, we believe we have made reasonable compromises. Nevertheless, understanding the impact of brand values on current advertising/promotion expenditures is an interesting research topic. We speculate that endogenizing advertising will

<sup>24</sup>To avoid cluttering up the paper, we only present elasticity changes, not the elasticities. The elasticity numbers range from  $-5.61$  for Kellogg's to  $-7.73$  for Nabisco. These are at the high end of the estimates listed in Bijmolt et al. (2005).

reduce our brand value estimates because companies have another tool to mitigate the effect of the loss of the brand. If true, this implies that we overestimate brand value.<sup>25</sup> Still, without further analysis, the full equilibrium effects of endogenous advertising are unknown. We leave this for future research.

Currently, our models are static, and we base our brand value estimates on observed short-term profits. As discussed in footnote 4, if there are reliable means to forecast future profits, then it is a simple matter to capitalize current and future profits into an NPV-based measure of brand value (as is done commercially by agencies such as Interbrand). The static formulation may be justified in the cereal category considering its maturity (see, e.g., Sriram et al. 2007, which finds stability in brand equities in the toothpaste category). Nevertheless, a multiperiod formulation, with the dynamics of brand-building and harvesting fully modeled, will be a useful contribution. Brand assets would be viewed as depletable, renewable resources in this formulation. Such a model might use, for the demand side, Erdem and Keane's (1996) formulation of the dynamics of quality perceptions. A firm's current actions would be interpreted as a combination of "harvesting" the brand and "investing" in it. In addition, such a model will recognize that a brand can do many more things in a longer time frame than we have given it credit for in this paper. For example, it can be extended and co-branded. The data requirements for estimating such a full-blown model are, however, quite high.

Our model contains several assumptions about retailer behavior that may influence the results. We assume that there is a single monopolistic retailer and that retailers stock all brands. Modeling retail competition (perhaps along the lines of Villas-Boas and Hellerstein 2006) and retail stocking decisions may provide a deeper understanding of the influence of the retail environment on brand values.

Finally, another particularly promising possibility is to combine the advantages of survey methodology with those of observational data in an integrated model. Although consumer surveys have been justly criticized for not providing reliable indications of consumer behavior, they may nevertheless be useful in identifying utility components (Horsky et al. 2006). Survey-based techniques such as conjoint analysis have the advantage of flexibility: freed from the constraints of observational data, brand and subbrand equity can be estimated absolutely (instead of relatively, as here) and more cleanly separated from the effects of product attributes. If these data are collected contemporaneously with observational data on sales, prices, and promotions, then survey-based estimates

of brand equity can be used as direct inputs into the indirect utility function. The equilibrium framework still applies, tracking the industry-wide supply-side effects of brand equity. More generally, we agree with Gupta and Zeithaml (2006), who cite links between customer metrics, competition, and brand value as fruitful avenues of future research.

## 6. Conclusion

Measuring brand value—what a brand brings to a firm—is ultimately an exercise in measuring two things: (1) what the brand does for the consumer (we have called this *brand equity*), and (2) how brand equity affects a firm's competitive position, its position in the supply chain, and its decisions.

A brand should be given credit for some things, but not everything. Specifically, a brand brings to a product imagery, personality, emotions, and status, and on the performance side, information on what the product delivers on the things consumers cannot see for themselves—its experience and credence attributes. On the other hand, a consumer does not need a brand to see the product's search attributes. Besides this conceptual clarification, the other major contribution of this paper is a methodology to track the implications of brand equity at the firm level taking account of competitors' and retailers' reactions. Using observations on sales, prices, advertising, and product attributes for various brands in the breakfast cereal category, we estimate each brand's profit contribution to the manufacturer and to the retailer, and compare these estimates to brand values estimated by previously used methods.

Our methodology offers several advantages over current procedures. First, it produces brand value estimates in profit terms, not price premiums, quantity premiums, or revenue premiums, all of which are components of profits, not profits. This emphasis on profit accords well with received theory in accounting and finance, and with Financial Accounting Standard Board (FASB) rules for evaluating intangible assets and goodwill. Second, our methodology is based on observational data—what consumers and firms actually did in the marketplace, not what they reported in surveys. Third, by taking an equilibrium approach, we account for the impact of brand on the entire market: on the firm manufacturing the product, its competitors, as well as the retailer through whom the product reaches the consumer. Our results show that both manufacturers and retailers get value out of brands, although their values could be quite different. Fourth, we derive separate measures of brand and subbrand values, and show that subbrand value varies across brands. Finally, our structural methods allow us to simulate the thought experiment of a brand's equity changing, and measure its impact on price elasticities, market shares, and margins.

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