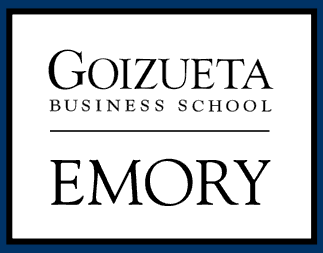

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Linking Consumer-Based Brand Equity to Market Performance: An Integrated Approach to Brand Equity Management

Ben Kartono, Cornell University

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Linking Consumer-Based Brand Equity to Market Performance: An Integrated Approach to Brand Equity Management

Benjamin Kartono[*]

Vithala R. Rao[†]

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[*] Corresponding author

[†] Benjamin Kartono is a doctoral candidate (email: bk66@cornell.edu, tel: 607-255-5517, fax: 607-254-4590) and Vithala R. Rao is the D.W. Malott Professor of Management and Professor of Marketing and Quantitative Methods (email: vrr2@cornell.edu, tel: 607-255-3987, fax: 607-254-4590) at the Johnson Graduate School of Management, Cornell University, Ithaca, NY 14853. The authors thank Sachin Gupta, Vrinda Kadiyali, Martin Wells, and seminar participants at Cornell University and the 2005 INFORMS Marketing Science Conference for valuable feedback and suggestions, and gratefully acknowledge financial support provided by the Marketing Science Institute and the Zyman Institute of Brand Science for the completion of this research.

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Abstract

Most of the extant research on brand equity has looked at the issue from the perspective of either the consumer or the firm. In this paper, we propose an integrated approach to brand equity management by developing an econometric model of supply and demand that captures the structural link between consumer-based brand equity and the brand's market performance and accounts for strategic firm competition in pricing and advertising. We model consumer-based brand equity using a logit model that accounts for the product's physical characteristics, marketing mix variables, as well as consumer mindset measures of perceived quality and satisfaction with the brand. We model the brand's market performance using financial measures of the brand's profit, profit premium, revenue, and revenue premium. We empirically test our model using data from the U.S. automobile industry. Our results suggest the existence of a strong structural link between consumer-based brand equity and the brand's market performance, and illustrate the value of the former in accounting for changes in the latter and in helping managers make optimal brand equity management decisions.

Key words: Brand equity, brand management, choice models, competition, econometric models, marketing metrics

1. Introduction

Brand equity is one of the most valuable assets that a firm can have, and brand equity measurement and management continue to be important areas of research in both academia and industry. Most of the extant research on brand equity has looked at the issue from the perspective of either the consumer or the firm. Brand equity research from a consumer's perspective usually involves collecting data on consumer mindset measures of brand equity from the consumer through surveys or experiments, and using the data to assess the consumer's perceptions, feelings, and attitudes towards the brand. It may also involve collecting data on the consumer's revealed preference behavior, using self-reported or actual purchase data, and using it to assess the incremental value that the brand name has on the consumer's utility and her resulting choice behavior. On the other hand, brand equity research from a firm's perspective generally involves the use of observed market data to assess the brand's financial value to the firm. The market in question could be a geographic or physical product market, where performance measures such as market share or profit can be used, or it could be a financial market, where performance measures such as the firm's stock price or other financial variables may be used to assess the brand's value.

While studying brand equity using either a consumer-based or a firm-based approach has yielded valuable insights on the different ways that brand equity can be measured and managed, there is a need to better understand the link between the brand metrics obtained from the two perspectives. In particular, there is a general consensus that a brand's performance in the marketplace is determined in part by consumer perceptions, behavioral intentions, and attitudes toward the brand. For example, Srivastava and Shocker (1991) propose that brand equity comprises of two components: brand strength, which consists of the set of associations and behaviors on the part of the brand's customers, channel members, and parent company that allows the brand to enjoy a competitive advantage; and brand value, which is the financial outcome of management's ability to strategically leverage brand strength (the basis of brand value) to produce profits. Researchers such as Aaker and Jacobson (1994, 2001) and Kim, Kim, and An (2003) have also shown the existence of a relationship between measures of consumer brand perceptions and the brand's financial performance. In addition, related streams of research have looked at the link between marketing and financial metrics, such as those between consumer satisfaction and a firm's market performance (e.g. Anderson, Fornell, and Lehmann 1994; Gomez, McLaughlin, and Wittink 2003), as well as the relationship between consumer brand ratings and a firm's market share and penetration (e.g. Baldinger and Rubinson 1996). These studies, among others, suggest that studying brand equity solely from the perspective of either the firm or the consumer may be inadequate. While assessing brand equity from the perspective of the firm can provide a measure of the financial value of the brand to the firm, it neglects the fundamental basis of the brand equity concept, which suggests that the equity of a brand is not merely a dollar-metric value but also an intangible asset residing in the minds of consumers. Such a

firm-centric approach also does not assess how this financial value may be affected by changes in these consumer mindset measures[1] of brand equity. Similarly, while measuring brand equity from the perspective of the consumer gives an indication of the value that the brand name provides to the consumer in the form of the consumer's favorable (or otherwise) attitudes or perceptions of the brand, or the increase in the consumer's utility provided by the brand name, it does not show how these mindset measures can be translated into more tangible measures of a brand's financial value or its market performance, which may be more useful for managers. A simultaneous firm-based and consumer-based approach to measuring and managing brand equity will not only have significant implications for firms attempting to improve the equity of their brands on both fronts, but will also be useful in developing a more complete picture of the brand equity concept.

In this paper, we propose an integrated approach to measuring and managing brand equity using an econometric model of supply and demand that takes into account both the perspectives of the firm and the consumer and illustrates the structural link between consumer- and firm-based measures of brand equity. We model firm-based brand equity in the form of product market performance measures of the brand's profit, profit premium, revenue, and revenue premium, and model consumer-based brand equity using a logit model that not only accounts for the product's physical characteristics, price, and advertising, but also consumer mindset measures of brand equity in the form of the consumer's perceived quality and satisfaction with the brand. We also study the importance of incorporating such consumer mindset data in a model of brand equity management vis-à-vis excluding such data, and discuss its managerial usefulness in understanding a brand's equity positioning among competing brands and in assessing and predicting the brand's performance in the market

The rest of the paper is organized as follows. In the next section, we present a selected review of the brand equity measurement and management literature. In Section 3, we explain the motivation for studying the link between consumer-based brand equity and the brand's market performance, present a conceptual framework for our integrated brand equity management model, and show how the framework can be implemented using an econometric model of supply and demand. We describe the model in detail in Section 4 and provide an empirical application of the model in Section 5. We conclude with a discussion of managerial implications and future research directions in Section 6.

2. Brand Equity Measurement and Management

Since the concept of brand equity began gaining widespread attention in the 1980s, many different methods of defining and measuring brand equity have been proposed, many of which lack a common

[1] We use the phrase 'consumer mindset measures' to represent all brand equity measures based on the consumer mindset, such as satisfaction, perceptions, attitudes, feelings, and so on.

ground. This phenomena is not surprising, because depending on the nature of the product and the market, firms may have different brand management objectives, and no single method of conceptualizing and measuring brand equity may be applicable to all brands. There is a general agreement, however, that brand equity can be defined and measured in terms of the marketing effects or outcomes that can be uniquely attributed to a brand relative to the effects or outcomes for the same product had it not been identified by that brand (Keller 2003). Other than a few notable exceptions (e.g. Srinivasan, Park, and Chang 2004; Kim et al. 2003), the extant literature on brand equity measurement typically approach the problem exclusively from either the perspective of the consumer or the firm. Keller and Lehmann (2003) divide brand equity measures into three categories: customer[2] mindset, product market outcome, and financial outcome measures.

2.1 Brand Equity from the Perspective of the Consumer

Customer mindset measures as defined by Keller and Lehmann (2003) include "everything that exists in the minds of customers with respect to a brand (e.g. thoughts, feelings, experiences, images, perceptions, beliefs, and attitudes)" and encompass a wide variety of both quantitative and qualitative measures of brand equity. Such measures of consumer-based brand equity have received considerable attention in both academia (e.g. Aaker 1991, 1996; Keller 1993, 2003; Erdem and Swait 1998; Swait, Erdem, Louviere, and Dubelaar 1993) as well as industry (e.g. Young and Rubicam's 'Brand Asset Valuator'; Total Research Corporation's 'Equitrend'; Landor Associates' 'Image Power'). For example, Keller (2003) and Keller and Lehmann (2003) suggest that customer mindset measures can be summarized by five key dimensions that include brand awareness, associations, attitudes, attachment, and activity. Aaker (1991) proposes a brand equity model which consists of the four mindset measures of brand loyalty, brand awareness, perceived quality, and brand associations, as well as a measure of other proprietary brand assets, such as trademarks, patents, and channel relationships. In an empirical study that compares various consumer-mindset measures of brand equity, Agarwal and Rao (1996) find that most of the common measures (with the exception of unaided recall) as conceptualized by Aaker (1991) and Keller (1993) have convergent validity and are hence appropriate measures of the brand equity construct.

For the most part, consumer-based brand equity models study the way a brand is perceived in a consumer's mind by collecting primary data directly from the consumer through interviews, surveys or experiments. A number of studies, however, have also used firm-based (e.g. scanner) data on the consumer's revealed preference behavior to measure brand equity by defining it as a form of incremental utility which a product's brand name provides to the consumer, and measure brand equity as a component of the consumer's utility in a choice model under a random utility framework (McFadden 1974). For

[2] We use the terms 'customer' and 'consumer' interchangeably.

example, Kamakura and Russell (1993) use household panel data to decompose the brand constant in a logit choice model into a 'Brand Tangible Value', which measures the customer's valuation of the brand based on tangible product attributes after discounting for price and recent advertising, and 'Brand Intangible Value', which measures the residual value not directly attributable to the physical product and serves as a measure of the product's brand equity. Such utility-based models have also been developed using choice models estimated from consumer survey data. Examples include Park and Srinivasan (1994), who calculate brand equity as the difference between a consumer's overall utility from a brand and her utility based only on objective product attributes, and Swait et al. (1993), who define brand equity as the consumer's implicit valuation of the brand in a market with differentiated brands relative to a market with no brand differentiation.

2.2 Brand Equity from the Perspective of the Firm

Studies that measure brand equity from the perspective of the firm consider brand equity as the value of the brand to the firm and encompass most of the product market outcome and financial outcome measures of brand equity categorized by Keller and Lehmann (2003). Product outcome measures consist of marketplace performance indicators such as revenue, profit, or price premium, and they are usually calculated from observed market data (e.g. Holbrook 1992; Ailawadi, Lehmann, and Neslin 2003). When calculated as a premium measure, they are computed with respect to a base brand that can be a generic or private label brand, the industry average, or a competing national brand with a lower equity relative to the other brands in the market. Financial outcome measures consider the value that shareholders and firms place on the brand as a financial asset, and may include various performance indicators of the brand's or firm's value observed in financial markets. Examples of studies with this approach include Simon and Sullivan (1993) who use financial market data to calculate brand equity as a component of the residual market value of a firm after accounting for the firm's tangible assets, and Mahajan, Rao and Srivastava (1994), who assess the importance of brand equity under acquisition decisions.

2.3 The Link Between Consumer-Based Brand Equity and Market Performance

While most of the existing literature on brand equity measurement has adopted either a distinctively consumer-based or a firm-based approach, a number of recent studies have started to look into the link between consumer-based brand equity and the brand's market performance. For example, Srinivasan et al. (2004) calculate the effect of a consumer's incremental choice probability of purchase on a brand's contribution margin to the firm, and Kim et al. (2003) examine the correlation between consumer-based measures of a brand's perceived quality, awareness, loyalty, and image, and the firm's revenue. Other researchers include Aaker and Jacobson (1994) who use regression methods to show the association

between perceived quality and a firm's stock price, and Aaker and Jacobson (2001), who show that brand attitude can predict a firm's stock value and future earnings in high-technology markets. In addition, there is a rich, complementary stream of research that specifically examines the link between customer satisfaction (a key component of consumer-based brand equity) and firm performance, particularly in service-oriented sectors and industries. For example, Kotler (1991) suggests that high customer satisfaction ratings are generally believed to be the best indicator of a firm's future earnings. Anderson et al. (1994), using data across a wide variety of industries in Sweden, find that a positive link exists between customer satisfaction and profitability (measured in the form of returns on investment), and they propose that satisfaction with the product is a function of the customer's perceived quality, expectations, and price of the product. More recently, Gomez et al. (2003), in the context of the retail industry, find evidence that changes in customer satisfaction can significantly affect sales performance, particularly satisfaction with a store's service levels.

The results from the above studies provide strong evidence of the existence of a link between consumer- and firm-based measures of brand equity. However, many of these studies are primarily descriptive in nature and are based on 'reduced-form' approaches, which cannot adequately explain the structural link between the two kinds of brand equity measures and the rationale behind the underlying consumer and firm behavior that is reflected in the observed data. In other words, these studies do not provide information on *how* consumer-based brand equity affects the brand's market performance, and as a result, provides little guidance on what managers can do (in terms of optimal marketing decisions) to maximize their brands' equities. The purpose of this paper is to develop a model that explores this structural link between consumer-based brand equity and firm-based brand equity measured in the form of the brand's product market performance. In the process, we will also illustrate the role of consumer-based brand equity in predicting and explaining changes in the brand's market performance, and provide managers with new tools to make optimal brand equity management decisions.

3. An Integrated Approach to Managing Brand Equity

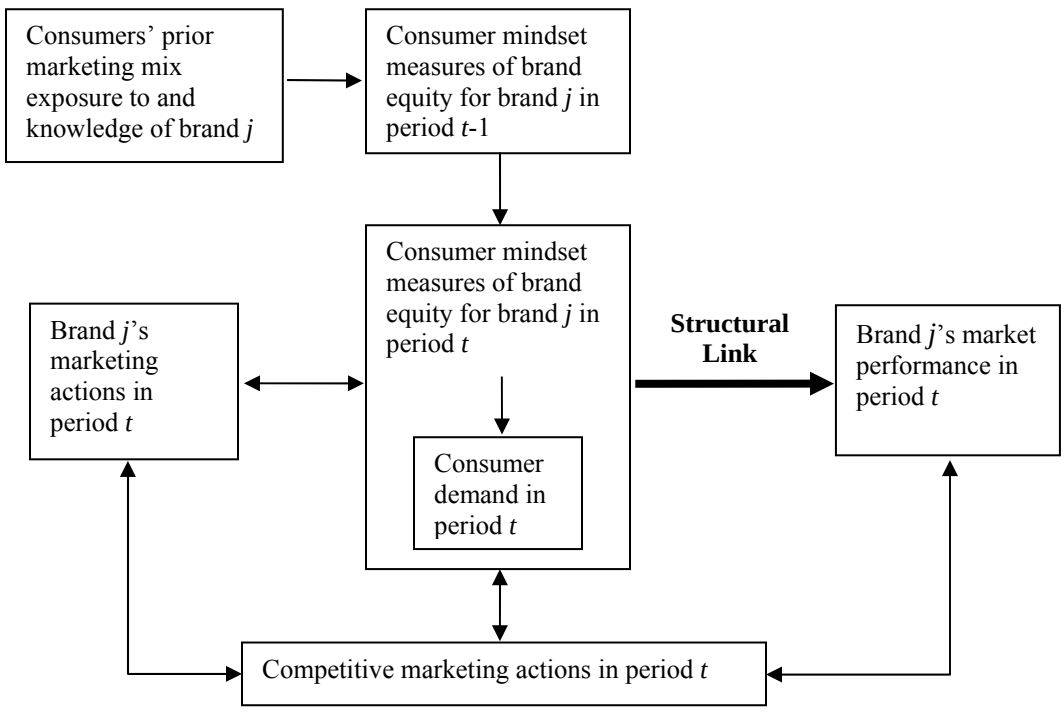
Understanding the structural link between consumer- and firm-based measures of brand equity will not only enable us to better understand how brand equity metrics based on the consumer mindset affects actual brand performance but will also be potentially useful for managers. For example, managers may be interested in better understanding how measures of consumer brand perceptions or attitudes (e.g. ratings of perceived quality obtained from a consumer survey) translate into more tangible, market outcome measures like profit or revenue, and whether such consumer-mindset measures are useful in predicting demand and the corresponding market performance of their products. Additionally, managers may also be interested in understanding how strategic marketing actions on their part affect these measures of

consumer-based brand equity and what they can do, through their marketing activities, to improve these measures and their brands' corresponding market performance.

Keller (2003) proposes a conceptual model of the sources and outcomes of brand equity which demonstrates the link between a firm's marketing actions, customer mindset measures of brand equity, and the brand's market performance. In the first stage of this Brand Value Chain, the firm invests in a comprehensive marketing program which leads to the development of a set of customer brand attitudes and perceptions in the second stage. In the third stage, these customer mindset measures affect the performance of the brand in the market (which can be measured by various product market outcome measures of brand equity) and leads to the fourth and final stage, where brand equity is manifested in the form of stock price, price to earnings ratio, and other measures of firm and shareholder value.

In this paper, we propose a model for an integrated approach to brand equity management that builds upon the first three stages of Keller's (2003) brand value chain and accounts for the structural relationship between consumer mindset measures of brand equity, the brand's market performance, as well as the firm's optimal marketing actions,. We illustrate our conceptual model in Figure 1.

Figure 1: Conceptual Model of Brand Equity Management



We consider a market consisting of H competing firms. Both the product category and industry within which these firms compete, as well as the firms' brand names, are assumed to be mature and familiar to all potential customers. Each firm, h, produces a set of J_h products or brands, and the total number of brands available to a consumer at time t is given by $\sum_{h=1}^{H} J_{ht} = J_t$. At any point in time, say t-1, every consumer is assumed to have a prior set of feelings and perceptions towards any brand j and all other brands available to her in the market. These consumer mindset measures for brand j are the result of the cumulative effects of all the marketing mix activities that the consumer has been exposed to, as well as all her prior knowledge of and experience with the brand. The same consumer mindset measures measured in period t depends in part on the same measures as at the end of the previous period, t-1, and the marketing mix activities that the consumer is exposed to in the current period. At the aggregate brand level, these consumer mindset measures affect the market demand for the brand in the period, which in turn affects the brand's performance, measured in the form of a specific market outcome measure of brand equity. At the same time, the firm's marketing actions and the market performance for brand j depend not only on consumer mindset measures and the resulting demand but also on the strategic marketing activities of its competitors within the period. Competitive effects on brand j's market performance occur through the consumer's brand choice decision, while competitive effects on the firm's marketing activities occur through the firm's strategic response to its competitors' marketing actions. We thus model the structural link between consumer mindset measures of brand equity and the brand's market performance through the demand function, and we show how we translate this model into an estimable mathematical model in the next section.

4. Model

To parameterize the conceptual model, we develop an econometric model of supply and demand that incorporates the firm's equity maximizing behavior as well as the consumer's utility maximizing behavior in a logit choice model. The benefits of adopting an equilibrium approach towards studying demand and competitive marketing behavior among firms has been well-documented (e.g. see Chintagunta, Kadiyali, and Vilcassim 2003 for a recent review of structural models of competition) and is particularly useful for our purposes because it not only enables us to model the link between consumer-based and product market performance measures of firm-based brand equity via the interdependency between supply and demand but also enables us to study firms' competitive equity-maximizing behavior. Consumer utility and demand for each brand depends on product attributes such as price, advertising expenditure, and physical characteristics as well as various consumer-based measures of brand equity. On the supply side, firms maximize a selected product market outcome measure of brand equity under specific game-

theoretic assumptions of competitive pricing and advertising behavior. We describe our model in detail in the following sections.

4.1 Modeling Consumer-Based Brand Equity

We model consumer-based brand equity using a logit choice model within a random utility framework. To facilitate the development of our theoretical framework, we first describe the demand model assuming that consumers are homogeneous, and present the model which accounts for consumer heterogeneity in the next section.

The utility derived by consumer *i* from purchasing brand *j* at time *t* is given by:

$$U_{ijt} = \beta_{jt} + \sum_{p} \delta_p Z_{pjt} + \xi_{jt} + \varepsilon_{ijt} \quad (1)$$

where Z_{pjt} is the *p*th observed product characteristic, ξ_{jt} reflects other product characteristics affecting consumer utility which are unobserved by the researcher, ε_{ijt} is the random component of the consumer's utility for the product, and β_{jt} represents the consumer's residual preference for brand *j* after taking into account objective, tangible product characteristics. The modeling of β_{jt} as a parameter that may change over time follows the formulation in Chintagunta and Rao (1996) and it serves as a measure of the overall consumer-based brand equity in each period. We decompose β_{jt} into a time invariant and time-varying component as follows:

$$\beta_{jt} = \beta_{j0} + \sum_{q} \pi_q X_{qjt} \quad (2)$$

where X_{qjt} is the *q*th consumer-mindset measure of brand equity in the present period, captured in the form of perceptual measures such as perceived quality and satisfaction, and β_{j0} is the consumer's residual preference for brand *j* not captured by X_{qjt}. We propose that X_{qjt} is determined both by the same consumer mindset measures as at the end of the last period as well as the marketing activities of the brand in the present period. For the *q*th consumer-mindset measure of brand equity, we decompose X_{qjt} into the following:

$$X_{qjt} = \gamma_{0q} + \gamma_{1q} X_{qjt-1} - \alpha_q p_{jt} + \mu_q \ln(A_{jt}) \quad (3)$$

where X_{qjt-1} is the measure of *q* in the previous period, p_{jt} is the price of a unit of the product, and A_{jt} denotes the firm's total advertising expenditure for brand *j* in the current period. Advertising expenditure

enters the equation as a concave function to capture the diminishing effects of advertising over time (e.g. Little 1979; Lilien, Kotler, and Moorthy 1992).

We propose that the consumer mindset measures of brand equity in any period *t* are determined in part by the firm's marketing actions in the current period as well as the consumer's prior knowledge and perceptions of the brand. These effects are cumulative and X_{qjt-1} is assumed to subsume all of the consumer's prior brand perceptions and knowledge as well as the cumulative effects of the firm's marketing mix efforts as at the end of the last period, *t*-1. Each consumer mindset measure *q* in the current period, X_{qjt}, is then determined by both X_{qjt-1} as well as the firm's marketing mix decisions in the current period, captured by p_{jt} and $\ln(A_{jt})$. The parameter γ_{0q} captures any residual value of X_{qjt} not accounted for by X_{qjt-1} and the firm's marketing efforts. Substituting (3) into (2) for all *q*, we get the following expression for β_{jt}:

$$\beta_{jt} = \beta_{j0} + \sum_q \pi_q (\gamma_{0q} + \gamma_{1q} X_{qjt-1} - \alpha_q p_{jt} + \mu_q \ln(A_{jt})) \quad (4)$$

We define $\gamma_q = \pi_q \gamma_{1q}$, $\alpha = \sum_q \pi_q \alpha_q$, $\mu = \sum_q \pi_q \mu_q$, and $\beta_j = \beta_{j0} + \sum_q \pi_q \gamma_{0q}$. Substituting these new parameters[3] into (1), the consumer's utility function for brand *j* is thus modeled as:

$$U_{ijt} = \beta_j + \sum_q \gamma_q X_{qjt-1} + \sum_p \delta_p Z_{pjt} - \alpha p_{jt} + \mu \ln(A_{jt}) + \xi_{jt} + \varepsilon_{ijt} \quad (5)$$

The parameter β_j represents the consumer's intrinsic, non-varying preference for brand *j* and also serves as a measure of the static component of consumer-based brand equity for *j* that stays constant over the period of observation.

Our model development assumes in theory that β_j is estimated at the level of the brand. In practice, however, depending on the number of brands in the market or the objective of the research, the estimation of β_j at the individual product or brand level may not be feasible or appropriate. For instance, regardless of whether a firm practices a corporate branding, mixed branding or a house of brands strategy[4], one may be interested in estimating the equity of the corporate brand (or one of the firm's parent brands) instead of the equity of each individual brand produced by the firm (e.g. estimating the

[3] The components of the parameters in (4) are not separable. However, we can still obtain estimates of each parameter by first obtaining the parameter estimates of the utility function in (5) from the demand function and running separate regressions of current-period brand perceptions on previous period perceptions, price, and advertising, as represented by the equations in (3). Using the estimates from these regressions, the value of each parameter in (4) can then be calculated.

[4] The reader is referred to Rao, Agarwal and Dahlhoff (2004) for more details on the three possible types of firm manifest branding strategies and their relationship with the intangible value of the firm.

equity of the Toyota brand instead of the equities of individual product brands like the Toyota Camry). To this end, brand dummy variables at the appropriate level of specification (corporate, parent, or product brand) can be used in the model.

4.2 Consumer Heterogeneity

We account for consumer heterogeneity at the individual-level following the random coefficients logit model used in Berry, Levinsohn, and Pakes (1995). We divide the utility of each consumer into a brand-level mean utility component and an individual-specific deviation from that mean. This involves the addition of a set of interaction terms to the utility function that captures the interactions between product attributes that have random coefficients, the individual consumer's unobserved tastes for these product attributes, and the corresponding deviation parameters. The utility model in (5) can be re-written as:

$$U_{ijt} = \sum_{k=1}^{K} x_{jkt}\theta_{1k} + \xi_{jt} + \sum_{k=1}^{K'} \sigma_k x_{jkt} \nu_{ik} + \varepsilon_{ijt} \qquad (6)$$

where, in the first summation term, x_{jkt} refers to the same *K* product attributes (including marketing mix variables) as in (5) and in the second summation term, x_{jkt} refers to the *K'* ($\leq K$) product attributes that have random coefficients, σ_k is a parameter that captures the deviation in consumer utility from the mean utility level for attribute *k*, and ν_{ik} is an individual-specific taste variable for each attribute. We draw ν_{ik} from a standard normal distribution and normalize it such that it has mean 0 and variance 1, so that the mean and variance of the marginal utilities with respect to each product attribute are θ_{1k} and σ_k^2 respectively. We set $U_{i0t} = \varepsilon_{i0t}$ and set the utility from the outside good to zero. Let the deterministic component of the utility function in (6) be represented by:

$$V_{ijt} = \sum_{k=1}^{K} x_{jkt}\theta_{1k} + \xi_{jt} + \sum_{k=1}^{K'} \sigma_k x_{jkt} \nu_{ik} \qquad (7)$$

Assuming that ε_{ijt} is distributed i.i.d. Type I Extreme Value across all brands and consumers, the probability of a consumer *i* buying a brand *j* in period *t* is given by:

$$s_{ijt} = \frac{\exp(V_{ijt})}{1 + \sum_{k=1}^{J} \exp(V_{ikt})} \qquad (8)$$

The market share of brand *j* is then obtained by integrating (8) over the joint distribution of consumer characteristics, ν:

$$s_{jt} = \int_{v} \frac{\exp(V_{ijt})}{1 + \sum_{k=1}^{J} \exp(V_{ikt})} P(v) d(v) \quad (9)$$

At the aggregate brand level, the effect of consumer mindset measures of brand equity on brand *j*'s market performance thus occurs through the demand function represented by s_{jt}.

4.3 Modeling Firm-Based Brand Equity in the form of Market Performance

A number of firm-based, market performance measures of brand equity have been proposed in the literature. In addition to common measures such as profit, revenue, and market share, other measures include revenue premium (Ailawadi et al. 2003), price premium (e.g. Holbrook 1992; Randall, Ulrich, and Reibstein 1998; Sethuraman 2003), share of category requirements (e.g. Aaker 1996), and so on. In particular, Ailawadi et al. (2003) study a number of different possible indicators of a brand's market performance to make the case for revenue premium as an appropriate market outcome measure of brand equity. In their theoretical framework, they explain that a brand's sales are a function of its equity as well as its marketing mix and those of its competitors, and that brand equity is in turn a function of the brand's marketing mix, category characteristics, and firm strength. These market forces interact simultaneously, and market performance measures such as revenue and profit are achieved in competitive equilibrium. They also suggest that financial measures such as revenue or profit are better indicators of the brand's performance compared to measures like share or price premium because the former take into account both movements in price and volume. We thus model revenue premium as a market performance measure of firm-based brand equity. In addition, we propose an alternative measure of market performance in the form of a brand's profit premium, which is the incremental profit accruable to a product as a result of its brand name and is defined as the difference between the profit of the focal brand and that of a competing base brand. To complete the analysis, we also model the brand's profit and revenue in their absolute forms as possible measures of the brand's market performance.

4.3.1 Firm Competition in Pricing and Advertising

Extant research on firm competition has focused largely on firms' pricing behavior. Research on competitive advertising behavior, particularly in a supply and demand setting, has been relatively scarce. A notable exception is Vilcassim, Kadiyali, and Chintagunta (1999), who use a conjectural variation approach to study dynamic multi-firm interactions in pricing and advertising in a structural model of competition within a personal care product category and find that firms generally compete more aggressively on advertising than they do on price. The important role of advertising in creating and sustaining brand equity is well-documented (e.g. Aaker and Biel 1993). Within the context of brand

equity management, in addition to understanding strategic pricing behavior, it is also important to examine how a firm's strategic advertising actions may depend on its assessment of its consumer's perceptions and attitudes towards its brands (which we model through the demand function). We thus account for both the firm's pricing and advertising behavior in the model.

We assume that each firm chooses the optimal level of price and advertising expenditure that maximizes a particular market performance measure of firm-based brand equity, given that the other firms in the market are also doing the same. Since advertising decisions are usually more permanent relative to pricing decisions (i.e. less likely to be changed in the short run once implemented), we assume that firms act in two stages. In the first stage, firms simultaneously choose their levels of advertising expenditure, and in the second stage, they simultaneously choose prices. For each firm, the optimal level of advertising in the first stage is chosen in anticipation of its pricing decision in the second, and within the subgame in each stage, the firm's decision is made as a best response to its competitors' decisions. Such a two-stage model of firm competition has been used in the context of firms' pricing and product quality decisions (e.g. Andersen, Palma and Thisse 1992), and can be shown to result in a subgame perfect Nash equilibrium (Friedman 1990).

In deriving the optimal pricing and advertising decisions for each firm, we first solve for the firm's optimal pricing rule in the second stage, p^*, and use p^* in the derivation of the optimal advertising rule in the first stage. We illustrate the case for single-brand firms (the model can be modified to account for the case where multi-brand firms maximize their objective function across all their brands). We first show the derivation of the optimal pricing and advertising equations for the case where profit is used as the market performance measure of brand equity, and follow it up with the case where profit premium is used as the objective function. The derivations for the cases where revenue and revenue premium are used as the firms' market performance measure follow in a similar manner; only the final pricing and advertising equations for these cases are presented.

4.3.2 Profit as the Market Performance Measure of Brand Equity

The profit function for any brand *j* produced by a firm in period *t* is given by:

$$\Pi_{jt} = (p_{jt} - c_{jt}) s_{jt} M - A_{jt} \tag{10}$$

where c_{jt} is the marginal cost of production and *M* is the market size. The second-stage pricing first-order conditions for brand *j* satisfies the following equation under a Nash equilibrium:

$$\frac{\partial \Pi_{jt}}{\partial p_{jt}} = s_{jt} + (p_{jt} - c_{jt}) \frac{\partial s_{jt}}{\partial p_{jt}} = 0 \tag{11}$$

and can be shown to simplify to:

$$p_{jt}^{*} = c_{jt} + \frac{1}{\alpha(1 - s_{jt})} \tag{12}$$

The same Nash equilibrium assumptions are applied to the first-stage advertising first-order conditions for brand *j* and incorporates the brand's second-stage optimal pricing rule. The advertising first-order conditions are:

$$\frac{\partial \Pi_{jt}}{\partial A_{jt}} = s_{jt} M \frac{\partial p_{jt}^{*}}{\partial A_{jt}} + (p_{jt}^{*} - c_{jt}) \frac{\partial s_{jt}}{\partial A_{jt}} M - 1 = 0 \tag{13}$$

From brand *j*'s optimal pricing rule in (10), it can be shown that:

$$\frac{\partial p_{jt}^{*}}{\partial A_{jt}} = \frac{\mu s_{jt}}{\alpha A_{jt}(1 - s_{jt})} \tag{14}$$

It can also be shown from the logit share equation that:

$$\frac{\partial s_{jt}}{\partial A_{jt}} = \frac{\mu}{A_{jt}} s_{jt}(1 - s_{jt}) \text{ and } \frac{\partial s_{jt}}{\partial A_{kt}} = \frac{-\mu}{A_{kt}} s_{jt} s_{kt} \text{ for } j \neq k \tag{15}$$

Equation (14) represents the change in the firm's second-stage pricing decision for brand *j* as a result of its first-stage advertising decision. Using equations (14), (15) and the optimal second-stage pricing equation, p_{jt}^{*}, brand *j*'s optimal advertising equation is given by:

$$A_{jt}^{*} = \frac{\mu s_{jt} M}{\alpha(1 - s_{jt})} \tag{16}$$

The optimal pricing and advertising equations for brand *j* for the case where the brand's profit is used as the market outcome measure of brand equity are thus given by (12) and (16). We discuss the marginal cost specification, c_{jt}, in a later section.

4.3.3 Profit Premium as the Market Performance Measure of Brand Equity

We define brand *j*'s profit premium in period *t* as the difference between its profit and that of a competing base brand, *b*. Of the *H* firms competing in the market, we assume that *H-1* of these firms maximize each of their brand's profit premium with respect to a common base brand, *b*, produced by the *H*th firm. Depending on the nature of the industry, there could be different ways as to how the base brand is selected. For example, the base brand could be a generic brand or a private label, or it could be the least

dominant national brand, such as the brand with the smallest market share. In view of this, the firm producing the base brand is assumed to maximize its absolute profit instead of a premium measure. If multiple brands are produced by the firm producing the base brands, we represent them as a single brand, *b*, by using the sales-weighted average price and market share of these brands. The profit premium for brand *j* in period *t* is given by:

$$\Pi_{jt}^{prem} = (p_{jt} - c_{jt})s_{jt}M - A_{jt} - [(p_{bt} - c_{bt})s_{bt}M - A_{bt}] \tag{17}$$

where c_{jt} and c_{bt} are the marginal costs of producing the products for brands *j* and *b* respectively. Since the firm producing the base brand, *b*, is assumed to maximize its profits, its objective function is given by:

$$\Pi_{bt} = (p_{bt} - c_{bt})s_{bt}M - A_{bt} \tag{18}$$

and, the optimal pricing and advertising equations for brand *b* are given by:

$$p_{bt}^{*} = c_{bt} + \frac{1}{\alpha(1 - s_{bt})} \tag{19}$$

$$A_{bt}^{*} = \frac{\mu s_{bt} M}{\alpha(1 - s_{bt})} \tag{20}$$

The second-stage pricing first-order conditions for brand *j* under a Nash equilibrium satisfies the following equation:

$$\frac{\partial \Pi_{jt}^{prem}}{\partial p_{jt}} = s_{jt} + (p_{jt} - c_{jt})\frac{\partial s_{jt}}{\partial p_{jt}} - (p_{bt}^{*} - c_{bt})\frac{\partial s_{bt}}{\partial p_{jt}} = 0 \tag{21}$$

The optimal pricing rule for brand *j* thus becomes:

$$p_{jt}^{*} = c_{jt} + \frac{1 - 2s_{bt}}{\alpha(1 - s_{jt})(1 - s_{bt})} \tag{22}$$

As before, the first-stage advertising first-order conditions for brand *j* are derived under Nash equilibrium assumptions and incorporates its second-stage optimal pricing rule. The advertising first-order conditions for brand *j* are:

$$\frac{\partial \Pi_{jt}^{prem}}{\partial A_{jt}} = s_{jt}M\frac{\partial p_{jt}^{*}}{\partial A_{jt}} + (p_{jt}^{*} - c_{jt})M\frac{\partial s_{jt}}{\partial A_{jt}} - 1 - [(p_{bt}^{*} - c_{bt})M\frac{\partial s_{bt}}{\partial A_{jt}} + s_{bt}M\frac{\partial p_{bt}^{*}}{\partial A_{jt}}] = 0 \tag{23}$$

From brand *b*'s and brand *j*'s optimal pricing rules, it can be shown that:

$$\frac{\partial p_{bt}^*}{\partial A_{jt}} = \frac{\mu s_{bt} s_{jt}}{\alpha A_{jt}(1-s_{bt})^2} \tag{24}$$

$$\frac{\partial p_{jt}^*}{\partial A_{jt}} = \frac{\mu s_{jt}}{\alpha A_{jt}(1-s_{jt})} \tag{25}$$

Equation (24) represents the change in brand *b*'s second-stage pricing decision as a result of (its expectations of) brand *j*'s first-stage advertising decision, while equation (25) represents the relationship between the first-stage advertising and second-stage pricing decisions for brand *j* within the firm. Substituting these equations and both brands' optimal pricing rules into the advertising first-order conditions, the optimal advertising rule for brand *j* is given by:

$$A_{jt}^* = \frac{\mu s_{jt} M(1-2s_{bt}+s_{jt}s_{bt}^2)}{\alpha(1-s_{jt})(1-s_{bt})^2} \tag{26}$$

The optimal pricing and advertising equations for the case where profit premium is used as the market outcome measure of brand equity are thus given by (22) and (26) for brand *j*, and (19) and (20) for the base brand, *b*[5].

4.3.4 Revenue and Revenue Premium as Market Performance Measures of Brand Equity

The derivations of the optimal pricing and advertising equations for the case where revenue or revenue premium is used as the firm's objective function follow in a similar manner. The difference between these equations and those of the profit and profit premium cases is the absence of the cost specification in the pricing equation. For revenue, the equations are given by:

$$p_{jt}^* = \frac{1}{\alpha(1-s_{jt})} \tag{27}$$

$$A_{jt}^* = \frac{\mu s_{jt} M}{\alpha(1-s_{jt})} \tag{28}$$

and for revenue premium, they are given by:

$$p_{jt}^* = \frac{1-2s_{bt}}{\alpha(1-s_{jt})(1-s_{bt})} \tag{29}$$

$$A_{jt}^* = \frac{\mu s_{jt} M(1-2s_{bt}+s_{jt}s_{bt}^2)}{\alpha(1-s_{jt})(1-s_{bt})^2} \tag{30}$$

[5] Detailed derivations for these equations can be obtained from the authors.

4.3.5 Firm Cost

We model the cost of brand *j* as a log-linear function of cost shifters, w_{jt}, and a random cost error, η_{jt}:

$$\ln(c_{jt}) = \lambda w_{jt} + \eta_{jt} \tag{31}$$

The cost shifters, w_{jt}, may include the same factors that affect demand (such as physical product characteristics) or may include factors that affect only cost, such as economies of scale, measured as a function of the total production of a firm. We also include brand dummy variables in the cost function to capture any brand-specific effects associated with production costs. Like the brand dummies in the demand function, they can be specified at the level of the individual, parent, or corporate brand.

5. Empirical Application

We empirically test our model using publicly available firm market data and consumer survey data from the automobile industry. We first provide a description of the data, follow it up with a discussion of our analysis and estimation procedure, and then present our results.

5.1 Data

We obtain data on national automobile[6] sales, prices, physical characteristics, and manufacturers' worldwide production data (to be used as a cost-shifter measure of economies of scale in the cost function) for the years 1996-2003 from *Ward's Automotive Yearbook* and *Automotive News Market Data Book*. Automobile characteristics include size (length × width, in inches), horsepower, and fuel economy in miles per dollar (miles per gallon divided by the price of gas). These variables have also been used in previous studies on the automobile market such as Berry et al. (1995) and Sudhir (2001). In addition, we collect data on automobile manufacturers' advertising expenditure from Competitive Media Reporting's *AD$ Summary* publication, which provides annual advertising data for each automobile model.

5.1.1 Data on Consumer Mindset Measures of Brand Equity

We obtain data on consumer mindset measures of perceived quality and satisfaction using consumer ratings of car models available from *Consumer Reports* and J.D. Power and Associates' online Consumer Center. *Consumer Reports* provides annual data on consumer ratings of automobile reliability based on surveys of its subscribers' experiences with their cars, while J.D. Power and Associates provides annual

[6] We exclude non-car segments of the automobile industry such as SUVs, minivans, and trucks.

data on the initial, midterm, and long-term satisfaction ratings of various automobile models based on their consumer satisfaction surveys.

Perceived quality is one of the key components of consumer-based brand equity in the conceptual model first proposed by Aaker (1991). Although it is defined as an intangible, overall feeling of quality that a consumer has about a brand, it is usually "based on a number of underlying dimensions which include the characteristics of the product to which the brand is attached, such as reliability and performance." The reliability of a product has also been conceptualized as a key dimension of a product's overall quality by Garvin (1984), particularly for durable products such as automobiles. In addition, it has been proposed as a measure of customer-perceived brand performance in the brand equity pyramid conceptualized by Keller (2003). We thus use consumer ratings of automobile reliability taken from *Consumer Reports* as proxy measures for perceived quality. These ratings are measured on a 5-point scale and cover a total of 14 characteristics including the automobile's engine, transmission and ignition systems, suspension, power equipment, and body integrity and hardware.

In addition to perceived quality, Aaker (1996) also conceptualized customer satisfaction as a key component of consumer-based brand equity that is closely related to brand loyalty. This measure incorporates a variety of dimensions including the consumer's satisfaction with her usage experience and the degree to which she experienced problems while using the product. The automobile consumer satisfaction ratings given by J.D. Power are based on surveys of actual automobile owners and cover issues such as owner-reported problems with the vehicle and measures of a consumer's satisfaction with particular characteristics of the vehicle. The six characteristics measured include style, performance, comfort, mechanical quality, interior quality, and feature and accessory quality of the automobile, and are rated on a 4-point scale. We use these ratings as measures for consumer satisfaction.

The use of the above consumer automobile ratings as measures for perceived quality and satisfaction raises the potential problem of multicollinearity among the measures. Furthermore, the extant literature is quite divided as to the relationship between the two measures. While researchers such as Anderson et al. (1994) and Anderson and Sullivan (1993) have proposed that satisfaction is a function of perceived quality, Aaker (1991) suggests that satisfaction differs from perceived quality because the former is more a function of the customer's expectations of the product's performance rather than her quality perception of the product. To allay potential problems associated with these issues, particularly multicollinearity in the data, and to reduce the number of automobile characteristics to a smaller set of orthogonal factors, we combined the data from both *Consumer Reports* and J.D. Power and Associates and conducted a principal components factor analysis on all 20 characteristics. We retained all factors with eigenvalues greater than one and obtained four factors. As shown by the factor loadings in Table 1, factors 1 and 2 load more highly on the characteristics obtained from the *Consumer Reports*, and factors 3

and 4 load more highly on the characteristics obtained from J.D. Power and Associates. These results enabled us to come up with two composite indices representing perceived quality based on *Consumer Reports*' reliability ratings, and two indices representing satisfaction based on J.D. Power and Associates' satisfaction ratings. Based on the characteristics grouped under each factor, we label the variables for perceived quality as i) Engine and body, and ii) transmission and ignition, and label the variables for satisfaction as i) driving comfort, and ii) interior features.

Table 1: Factor Loadings from Principal Components Analysis of Automobile Characteristics

Source	Characteristic	Factor			
		1	2	3	4
Consumer Reports	1. Engine	0.71	0.34	0.040	0.14
	2. Cooling	0.71	0.41	-0.026	0.10
	3. Fuel	0.72	0.27	0.098	0.058
	4. Ignition	0.43	0.69	0.046	0.11
	5. Transmission	0.50	0.60	0.060	0.091
	6. Electrical	0.85	0.059	0.048	0.06
	7. Air Conditioning	0.72	0.42	-0.051	0.11
	8. Suspension	0.73	0.17	0.040	0.056
	9. Brakes	0.83	-0.024	0.16	0.064
	10. Exhaust	0.064	0.82	0.13	0.29
	11. Power Equipment	0.71	0.13	-0.15	0.23
	12. Paint	0.58	0.33	0.036	0.26
	13. Body Integrity	0.72	-0.060	-0.078	0.29
	14. Body Hardware	0.62	0.26	0.019	0.39
J.D. Power and Associates	15. Mechanical Quality	0.076	0.23	0.27	0.71
	16. Feature and Accessory Quality	0.18	0.15	0.16	0.73
	17. Body and Interior Quality	0.27	0.67	-0.13	0.71
	18. Performance	-0.018	0.091	0.81	0.26
	19. Comfort	0.074	0.013	0.83	0.21
	20. Style	0.033	0.036	0.82	-0.21

5.1.2 Selection of Automobile Brands

Ward's Automotive Yearbook classifies car models into four main segments: Small, Middle, Large, and Luxury. We exclude car models in the Luxury segment as they usually have small shares and idiosyncratic demand. For the time period under consideration, we select automobile brands from the seven largest firms (in terms of market share) to be included in the analysis. These firms are: GM, Chrysler[7], Ford, Toyota, Honda, Nissan, and Hyundai, the last of which is designated as the firm

[7] Chrysler Corp. merged with Daimler-Benz AG in 1998 to form DaimlerChrysler. Only DaimlerChrysler cars which are classified as non-luxury (all of which are sold under the Chrysler brand) are included in our analysis.

producing the base brand. Since we are considering the case of single-brand firms, we measure brand equities at the corporate brand level instead of at the level of the individual brands/models and henceforth refer to these firms as (corporate) 'brands'. We use Hyundai as the base brand in our model for a number of reasons. First, it is the smallest automobile firm in terms of production and sales, and is the brand with the lowest market share for most periods of our analysis. Second, it is the brand with the lowest average price across all segments and is the only non-Japanese and non-U.S. brand in the set. Finally, given that it is the latest entrant into the U.S. automobile market among the brands under study (Hyundai entered the U.S. market only in the mid 1980s), it seems reasonable to assume that it is the brand with the lowest equity, and hence the most suitable candidate for a base brand. This assumption is supported by the fact that Hyundai has the lowest average ratings of perceived quality and satisfaction among all the brands in our data set. Together, the seven brands account for about 71-78% of all non-luxury car sales in our period of analysis. Table 2 provides descriptive statistics of the data used in our empirical application.

Table 2: Descriptive Statistics for Automobile Brands[i]

Brand	Share[ii]	Price in $ '000	Advertising in $ '000	Size in '000 sq. inch	Horse-power	MPG	Perceived Quality[iii]	Satisfaction[iv]	No. of models
GM	0.0076	20.07	55,238	13.61	169.6	22.0	3.54	3.04	18.4
	(0.0051)	(1.68)	(46,240)	(1.40)	(40.4)	(4.6)	(0.70)	(0.40)	(1.6)
Ford	0.0093	20.45	36,332	13.79	168.4	21.1	3.52	2.96	9.3
	(0.0071)	(1.52)	(37,102)	(1.80)	(42.2)	(4.0)	(0.62)	(0.49)	(1,6)
Chrysler	0.0049	20.14	58,051	13.60	179.5	21.7	3.39	3.03	9.4
	(0.0027)	(1.79)	(40,726)	(1.43)	(42.3)	(3.7)	(0.71)	(0.51)	(1.9)
Toyota	0.0096	20.53	58,097	12.13	140.8	29.0	4.40	3.37	5.7
	(0.010)	(1.03)	(57,493)	(1.09)	(42.2)	(9.3)	(0.32)	(0.39)	(1.1)
Honda	0.014	20.64	75,698	12.24	157.1	26.1	4.38	3.47	3.7
	(0.012)	(3.72)	(62,543)	(0.66)	(30.1)	(3.7)	(0.31)	(0.43)	(0.5)
Nissan	0.0084	20.00	89,332	12.61	169.6	23.7	4.05	3.06	3
	(0.0023)	(1.18)	(54,547)	(0.77)	(45.8)	(2.7)	(0.45)	(0.53)	(0.0)
Hyundai	0.0034	13.78	32,346	11.89	129.9	23.7	3.46	2.42	6.0
	(0.0020)	(0.99)	(22,148)	(0.93)	(23.6)	(2.8)	(0.49)	(0.38)	(1.0)
Average	0.0076	19.15	53,598	13.16	163.0	23.1	3.67	3.02	7.9
	(0.0068)	(2.41)	(46,962)	(1.52)	(42.1)	(5.3)	(0.70)	(0.51)	(5.2)

[i] Figures shown are averages across all selected models and all years except for number of models, which is the average across all years. Standard deviation in the parentheses.
[ii] Shares are unconditional shares over the total market size per selected model
[iii] Measured on a 5-point scale
[iv] Measured on a 4-point scale

Since we are estimating brand equity at the level of the corporate brand (e.g. Toyota or GM) instead of the individual automobile model (e.g. Toyota Camry or Pontiac GrandAm), we model β_j in

the form of H-1 dummy variables. We do not estimate individual model-level brand equities for a number of reasons. First, we are more interested in studying the equities of these brands and the competition between them at the corporate level. Second, given that there are more than 70 different automobile models and only eight years of observations in our data set, we may not have enough data points to efficiently estimate model-level brand dummies. In addition, data for some models are not available near the end or at the beginning of the period of observation (i.e. some models are discontinued or introduced sometime during the period), making the estimation of model-level brand dummies more difficult. Third, even if we do obtain the model-level brand dummies for each firm, it would be difficult to determine the appropriate way of aggregating these product-level brand equities to the corporate level. To do so, one would have to consider various issues relating to the cross-brand and cross-segment effects across the different models within a firm, and such an analysis is beyond the scope of this paper.

To get data on the potential market size, we follow the approach in Sudhir (2001) and estimate the market size in any year t by multiplying the total number of households within the U.S. by the average number of cars per household, and dividing it by the average age of cars for the relevant time period (these figures are available from the American Automobile Manufacturers Association's *Motor Vehicle Facts and Figures* handbook).

5.2 Estimation

We estimate the model in two stages – demand in the first stage and supply in the second stage. Although such sequential estimation may reduce the efficiency of the estimates, it has its advantages (Venkataraman and Kadiyali 2004). First, the consistency of the demand estimates does not depend on the particular equilibrium or competitive interaction assumptions made on the supply side, and are hence applicable to a wider variety of firm competitive behavior. Second, we reduce computational burden by not having to solve the equilibrium pricing and advertising equations during demand model estimation. Finally, since one of our key objectives is to examine the impact of the consumer mindset measures of brand equity on the four different types of market outcome measures of brand equity, it is more logical to use the same demand estimates on all four market performance measures. Had we performed simultaneous supply-demand estimation on each of the four models, we would have obtained different demand parameter estimates for each market outcome measure used, which would not be reasonable because consumer preferences and choice behavior (as captured in the demand estimates) should not vary with firms' objective functions.

Since the demand parameters are estimated independently of supply, the equations to be estimated on the supply side, from which we obtain the firms' production cost estimates, are the pricing equations given by (12) for the case where profit is used as the market performance measure of brand

equity, and (19) and (22) for the case where profit premium is used. We do not estimate supply side equations for the cases where revenue or revenue premium is used as the firm's objective function, since they do not entail the estimation of any cost parameters. Though they are not empirically estimated, the expressions obtained for the optimal pricing and advertising equations for the revenue and revenue premium cases, as well as the advertising equations for the profit and profit premium cases, still serve as useful analytical expressions that describe how firms' optimal marketing mix decisions depend on demand and other characteristics of the market.

We estimate our demand model using the procedure outlined in Nevo (2000). We first approximate the integral in (9) by the following:

$$s_{jt} = \frac{1}{ns}\sum_{i=1}^{ns} \frac{\exp(\phi(x_{jt}, \xi_{jt}, \theta_1) + \sum_{k=1}^{K'} x_{jkt}\sigma_k v_{ik})}{1 + \sum_{m=1}^{J} \exp(\phi(x_{mt}, \xi_{mt}, \theta_1) + \sum_{k=1}^{K'} x_{mkt}\sigma_k v_{ik}} \tag{32}$$

where $(v_{i1},...,v_{iK'})$ for i = 1,…,*ns* are draws from $P(v)$, which is standard normal, *ns* is the number of simulated individuals, and *k* = 1,…,*K'* are the variables that have random coefficients. We follow it up with a similar Generalized Method of Moments (GMM) estimation procedure.

The estimation of the demand model requires the use of appropriate instrument variables. Our first set of instruments comes from the automobile characteristics Z_j, which we assume to be exogenous and orthogonal to ξ_{jt}. This assumption is reasonable given that automobile manufacturers are not likely to change physical specifications like size or horsepower in the short term, unlike prices, advertising expenditure, or market shares, which may be endogenous. Our next set of instruments comes from the constant term, the brand dummy variables and the consumer mindset measures of perceived quality and satisfaction, X_{jt-1}. Since our measures of perceived quality and satisfaction are those of the previous period, we can assume that they are exogenous to the structural error term in the present period. Additionally, we generate additional instruments based on approaches used by Bresnahan, Stern, and Trajtenberg (1997) and Sudhir (2001) as follows. For each automobile model in a year, we generate two similarity subsets: a within-firm average of automobile attributes, and a without-firm average of the same attributes. In calculating the within-firm average for a particular model, we calculate two average values of each automobile attribute for all the other models produced within the same firm (i.e. with the same corporate brand): one for automobiles belonging to the same segment and with the same country of origin as the focal model, and the other for automobiles belonging to the same segment and with the same regular/specialty classification as the focal model. In calculating the without-firm average, we again calculate the same two averages for each automobile attribute, but this time using automobile models that are not manufactured by the focal model's firm. This gives four instruments for each automobile attribute.

We also calculate a within-firm and without-firm average for the constant term to reflect the number of competitors for each model to use as additional instruments.

5.3 Demand Estimates

The estimates of our demand model, presented in Table 3, provide empirical support for our proposed model specification. Looking at the coefficients of the four variables capturing consumer-based brand equity, we see that higher levels of perceived quality and satisfaction are generally associated with higher levels of consumer utility, though only two of the variables, perceived quality (transmission and ignition), and satisfaction (interior features) are significant. In addition, there is no significant heterogeneity associated with consumer preferences for these measures, suggesting that most, if not all consumers, derive greater utility from higher levels of perceived quality and satisfaction. These results suggest that consumer-mindset measures of brand equity are positively linked to higher market shares and thus higher levels of firm-based, market outcome measures of brand equity and provide evidence for the existence of a strong structural link between consumer-based brand equity and market performance.

Table 3: Estimates of Demand Parameters

	Parameter Estimate (β)	t-statistic (β)	Variance Estimate (σ)	t-statistic (σ)
Constant	-11.301*	-12.14	1.342	1.64
Perceived Quality (Engine and Body)	0.0623	1.17	0.0092	1.23
Perceived Quality (Transmission and Ignition)	0.215*	4.87	0.0966	1.42
Satisfaction (Driving Comfort)	0.0141	0.97	0.00653	1.17
Satisfaction (Interior Features)	0.147*	3.13	0.0724	1.53
Size	0.179*	2.56	0.106*	2.36
Horsepower	0.467*	2.88	0.0821*	3.12
Miles Per Dollar	0.00975	1.87	0.00165	1.07
Price, -α	0.134*	3.72	0.082*	2.39
Log (Advertising)	0.876*	5.87	0.194*	3.94
GM	0.526*	2.35		
Ford	0.951*	4.77		
Chrysler	0.142*	2.06		
Toyota	0.503*	2.26		
Honda	0.684*	3.11		
Nissan	0.247*	2.43		

*Significant at the 0.05 level

The coefficients on the marketing mix variables of price and advertising are positive and significant, suggesting that the average consumer derives greater utility from lower prices and more advertising. However, it is interesting to note that there is considerable heterogeneity in consumer

preferences for price and advertising (as indicated by the significant variance estimates for these variables), suggesting that there may be consumers who prefer less advertising and more expensive cars. In terms of the variables describing the physical characteristics of the automobiles, we see that consumers in general prefer bigger cars and cars with higher horsepower. Again, there is significant heterogeneity in preferences for these automobile characteristics, indicating that some consumers may prefer smaller and less powerful cars.

Looking at the coefficients on the dummy variables, we find that consumers in general have a higher intrinsic preference for U.S. and Japanese automobile brands relative to Hyundai. Coefficients on some U.S. brands like Ford and GM appear to be quite high relative to the Japanese brands, which at first appears counter-intuitive, given the Japanese's reputation for building high quality and reliable cars. These estimates of β_j appear more reasonable when we recognize the fact that they represent only the static, non-varying component of consumer-based brand equity that stays constant across the period of observation (i.e. they represent residual brand equity after accounting for the dynamic component of brand equity captured by the consumer-mindset measures of perceived quality and satisfaction in each period). The total consumer-based brand equity for each brand in each period, β_{jt}, is given by equation (4). We report the average values of β_{jt} and the dynamic component of β_{jt} across the period of observation in Table 4, and illustrate how β_{jt} changes over time in Figure 2.

Table 4: Dynamic and Total Brand Equity Estimates*

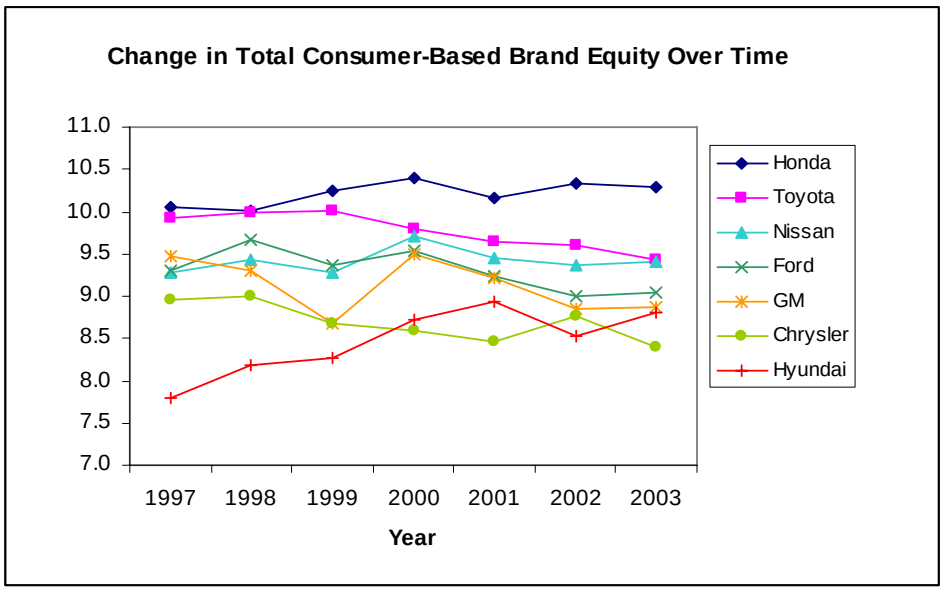
	Dynamic Component of Brand Equity	Total Brand Equity
GM	8.60	9.12
Ford	8.35	9.31
Chrysler	8.55	8.69
Toyota	9.26	9.77
Honda	9.53	10.21
Nissan	9.17	9.42
Hyundai	8.47	8.47

* Average value across period of observation

Analysis of the dynamic and total brand equity estimates provides a clearer and more intuitive picture of the relative equities across brands than that provided by the static brand equity estimates. When the dynamic consumer-mindset measures of perceived quality and satisfaction are taken into account, Honda generally has the highest equity, followed by Toyota and Nissan, the three U.S. brands, and Hyundai. We also note that the dynamic component of brand equity is much higher in terms of magnitude relative to the static component represented by the brand dummy coefficients, further illustrating the

important role of consumer mindset measures of brand equity in affecting consumer utility and choice, and hence, brand market share and performance.

Figure 2: Change in Total Consumer-Based Brand Equity Over Time



5.4 Supply Estimates

The cost estimates obtained from the pricing equations in our supply model are presented in Table 5. For both the cases where firms maximize either profit or profit premium, we see that higher economies of scale are associated with lower production costs and that bigger and more powerful cars are associated with higher costs. It also costs less to produce cars with higher fuel efficiency. With regard to the coefficients on the brand dummies for firm costs, all U.S. and Japanese brands appear to have higher production costs relative to Hyundai, with Toyota and Honda having the highest relative costs and Chrysler and Nissan having the lowest relative costs.

In general, the parameter estimates for both the cases where profit and profit premium are used as the firms' objective function are quite similar. This is not surprising, given that we have included the outside good as a choice alternative in our demand model so that the (unconditional) market shares used in estimating the demand and supply equations for both cases are fairly small. The consistency in estimates between the two different models also provides support for profit premium as a viable, alternative market performance measure of firm-based brand equity.

Table 5: Estimates of Supply (Cost) Parameters

Variable	Firm Market Outcome Measure of Brand Equity			
	Profit		Profit Premium	
	Estimate	t-statistic	Estimate	t-statistic
Constant	15.868*	4.54	14.487*	4.56
Log (Production)	-0.590*	-2.35	-0.473*	-2.09
Size	0.079*	5.32	0.069*	5.18
Horsepower	0.623*	10.64	0.583*	11.05
MPG	-0.0199*	-2.85	-0.0192*	-3.15
GM	1.0142*	3.29	0.851*	3.12
Ford	0.684*	2.92	0.562*	2.73
Chrysler	0.246*	3.03	0.227*	3.26
Toyota	1.220*	4.44	1.031*	4.24
Honda	0.800*	6.20	0.703*	6.34
Nissan	0.454*	3.96	0.395*	4.02

*Significant at the 0.05 level

5.5 Share Elasticities of Consumer-Based Brand Equity Measures

We can get a better idea of how the consumer-based brand equity measures of perceived quality and satisfaction affect market performance through their impact on demand by looking at the elasticities of share with respect to these measures. As an illustration, we calculate the elasticities for the two measures of perceived quality and satisfaction whose coefficients are significant, and report these in Tables 6 and 7.

Table 6: Own- and Cross- Elasticities of Share for Perceived Quality (Engine and Body)

Brand	GM	Ford	Chrysler	Toyota	Honda	Nissan	Hyundai
GM	1.166	-0.00919	0.00823	-0.00816	-0.00901	-0.00765	-0.00603
Ford	-0.00912	1.130	-0.00912	-0.00912	-0.00698	-0.00651	-0.00642
Chrysler	-0.00846	-0.00931	1.039	-0.00726	-0.00798	-0.00809	-0.00748
Toyota	-0.00718	-0.00907	-0.00529	1.117	-0.00943	-0.00921	-0.00543
Honda	-0.00604	-0.00587	-0.00761	-0.00934	1.062	-0.00913	-0.00641
Nissan	-0.00767	-0.00713	-0.00688	-0.00901	-0.0106	1.202	-0.00561
Hyundai	-0.00816	-0.00735	-0.00688	-0.00844	-0.00922	-0.00864	0.854

Table 7: Own- and Cross- Elasticities of Share for Satisfaction (Interior Features)

Brand	GM	Ford	Chrysler	Toyota	Honda	Nissan	Hyundai
GM	0.443	-0.00843	-0.008030	-0.00901	-0.00723	-0.00687	-0.00753
Ford	-0.00944	0.419	-0.008460	-0.00741	-0.00718	-0.00812	-0.00647
Chrysler	-0.00835	-0.00917	0.408	-0.00574	-0.00943	-0.00711	-0.00634
Toyota	-0.00824	-0.00654	-0.00539	0.496	-0.00916	-0.00896	-0.00498
Honda	-0.00712	-0.00597	-0.00667	-0.00909	0.473	-0.00814	-0.00564
Nissan	-0.00614	-0.00711	-0.00601	-0.01020	-0.00924	0.43959	-0.00594
Hyundai	-0.00774	-0.00749	-0.00712	-0.00782	-0.00932	-0.00815	0.250

The elasticities suggest that, for every percentage increase in consumers' perceived quality of a brand, its share may increase by between 0.85 to 1.20 percent, and the same potential share increase stands at between 0.25 to 0.50 percent for every percentage increase in consumer satisfaction. The cross elasticities give an indication of the potential percentage decrease in competing brands' shares for every percentage increase in a focal brand's consumer-based brand equity. They differ across brands because they are determined in part by similarities in characteristics among different brands and individual consumer tastes for these characteristics – brands that have more similar characteristics will have cross-elasticities that are closer to those of the focal brand. Using these elasticities, the effect of changes in consumer mindset measures of brand equity (of a focal brand as well as those of its competitors) on financial measures of the brand's market performance can be calculated.

5.6 Competitive Clout and Vulnerability

In addition to examining the share elasticities for the two consumer-based measures of brand equity, it would also be managerially useful to use these elasticities to examine the competitive clout and vulnerability of each brand[8] with respect to these measures as follows:

$$\text{Competitive Clout}_i = \sum_{j \neq i} \eta_{ji}^2 \tag{33}$$

$$\text{Vulnerability}_i = \sum_{j \neq i} \eta_{ij}^2 \tag{34}$$

where η_{ij} is the cross-elasticity of share of brand *i* with respect to competitor *j*. Changes in brand equity for a brand with considerable clout will have a large impact on the shares of its competitors, while the share of a brand with high vulnerability will change substantially as a result of brand equity changes of its competitors. As Figure 3 indicates, in terms of perceived quality, Hyundai has the least clout and the highest vulnerability. In line with their reputation for quality, the Japanese brands, especially Honda and Toyota, have higher clouts and generally lower vulnerabilities relative to the other brands. Among the U.S. brands, Chrysler, the smallest brand in terms of share, has the least clout and the largest vulnerability. Ford has the highest clout, while GM has a fairly high level of vulnerability that is comparable to Chrysler's.

The plot of vulnerability and clout for the satisfaction measure is given in Figure 4. Again, the Japanese brands generally score high in terms of competitive clout and low in terms of vulnerability, with Honda and Toyota respectively leading the group on both fronts. As in the case for perceived quality,

[8] The reader is referred to Kamakura and Russell (1989) for a discussion of these measures.

Hyundai appears to be the brand with the least clout and the highest vulnerability. Among the U.S. brands, GM has the highest clout, followed by Ford and Chrysler, and in terms of vulnerability, they are positioned fairly close to one another. These findings are generally in line with our expectations, and can provide managers with a tool to better understand their brands' equity positioning among competing brands in the market.

Figure 3: Plot of Clout and Vulnerability for Perceived Quality (Engine and Body)

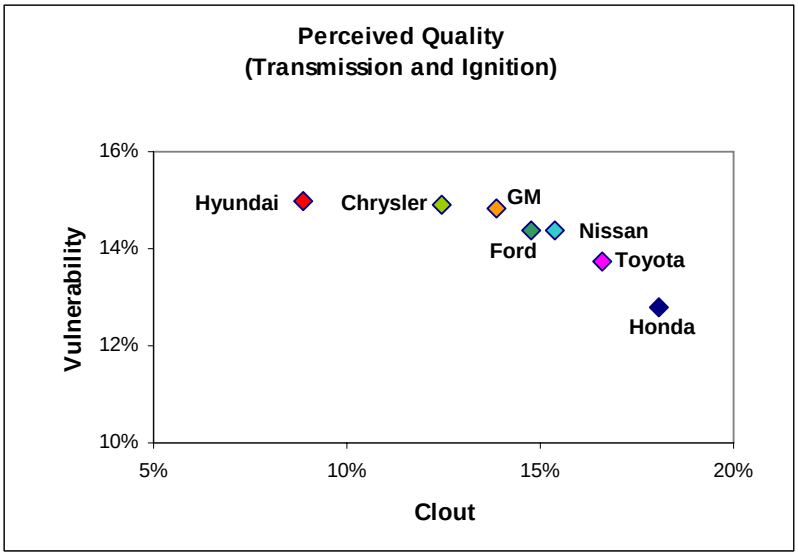
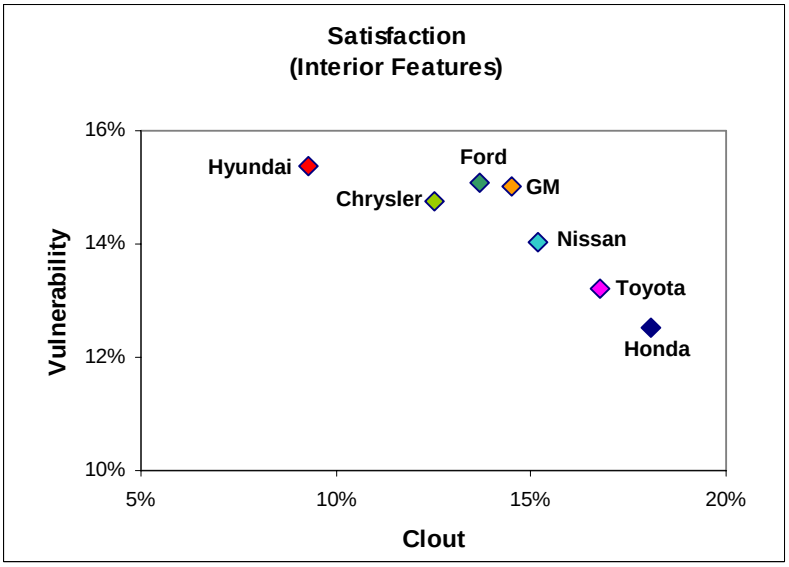


Figure 4: Plot of Clout and Vulnerability for Satisfaction (Interior Features)



5.7 Role of Consumer-Based Brand Equity Measures in Predicting Market Performance

In addition to understanding the structural link between consumer-based brand equity and the brand's market performance, one of our research objectives was to examine the value of the former in predicting or explaining changes in the latter. We did this by comparing the predictive validity of our proposed model vis-à-vis an alternative model which does not account for the measures of perceived quality and satisfaction in the demand function. To do this, we re-estimated the model using data from 1996-2002 and used these parameter estimates and the data for 2003 to obtain predicted values of the share and the four market outcome measures of brand equity for each firm. For profit and profit premium, we assume that actual costs are the same as our estimated costs.

We first computed the correlations between the observed and predicted values for market share as well as the four market outcome measures of brand equity for our proposed model as well as for the alternative model without consumer-based brand equity measures. As shown in Table 8, predicted shares obtained from the proposed model are more highly correlated with observed values than predicted shares obtained from the alternative model. We find the same results for the predicted values of each measure of market performance.

Table 8: Correlations* of Observed and Predicted Values between the Proposed Model and an Alternative Model without Consumer-Based Brand Equity (CBE) measures

Correlation between observed and predicted values of:	Proposed model	Model without CBE measures
Share	0.896*	0.818*
Profit	0.846*	0.776*
Profit Premium	0.809*	0.745*
Revenue	0.875*	0.825*
Revenue Premium	0.861*	0.805*

*Significant at the 0.05 level

We also assessed the usefulness of including the consumer-based brand equity measures in the model by looking at the incremental value that these measures provide in explaining changes in the brand's market share and market performance. For each of these performance variables[9], we first regressed the predicted value of the variable obtained from the proposed model, $\hat{y}_j^{CBE}$, against the

[9] We used a log transformation to stabilize the variance of the variables for the market outcome measures of brand equity. For share, we used the following monotonic transformation $y_{j,share}^{Obs} = \log(\frac{s_j}{1-s_j})$ so as not to restrict its values to be between 0 and 1.

predicted value of the variable obtained from the alternative model without consumer-based brand equity measures, $\hat{y}_j^{No\ CBE}$:

$$\hat{y}_j^{CBE} = \alpha_0 + \alpha_1 \hat{y}_j^{No\ CBE} + \varepsilon_j \tag{35}$$

The residuals from this regression, $\hat{\varepsilon}_j$, contain information which explain changes in $\hat{y}_j^{CBE}$ that are not captured by $\hat{y}_j^{No\ CBE}$, i.e. information contained in the consumer-based brand equity measures. We then regress the observed values of the variable, y_j^{Obs} on both $\hat{y}_j^{No\ CBE}$ and the residual, $\hat{\varepsilon}_j$:

$$y_j^{Obs} = \beta_0 + \beta_1 \hat{y}_j^{No\ CBE} + \rho \hat{\varepsilon}_j + \eta_j \tag{36}$$

If the consumer-based brand equity measures of perceived quality and satisfaction can significantly help in explaining changes in market share and the firm's market performance, we expect the coefficient on the predicted residual, ρ, to be positive and significant. The results of the regression, given in Table 9, indicate this to be true for market share as well as the four market performance measures of brand equity, suggesting that these measures of consumer-based brand equity do contain information that can help to account for changes in the brand's market performance which cannot be explained by the other predictor variables in the model. This result also further strengthens the finding that a strong structural link does exist between the two forms of brand metrics.

Table 9: Incremental Value of Consumer-Based Brand Equity Measures in Explaining Changes in Share and Market Performance

Variable	Intercept	t-statistic	Coefficient on $\hat{y}_j^{No\ CBE}$	t-statistic	Coefficient on $\hat{\varepsilon}_j$ (ρ)	t-statistic
Share	0.00187	3.41	0.628*	11.93	0.00203*	5.38
Profit	7.216	5.38	0.643*	9.72	0.270*	4.46
Profit Premium	5.493	2.76	1.230*	3.45	0.372*	2.40
Revenue	6.288	4.88	0.703*	11.59	0.291*	4.85
Revenue Premium	11.158	5.35	0.469*	4.78	0.316*	3.10

*Significant at the 0.05 level

6. Conclusions

We summarize our key findings and contributions in this section and discuss some managerial implications of our results. We also discuss the limitations of our model and provide suggestions for future research.

6.1 Summary and Managerial Implications

We have developed a conceptual model of brand equity management that illustrates the structural link between consumer-based brand equity and the brand's market performance and accounts for strategic marketing actions on the part of the firm and its competitors. We parameterized this conceptual model into a mathematical model using extant methodological approaches in structural modeling and illustrated its implementation using publicly available data from the automobile industry. Our results are generally in line with expectations and provide empirical support for our proposed model specification. More importantly, they show the existence of a strong structural link between consumer-based brand equity (as represented by our measures of perceived quality and satisfaction) and product market performance measures of brand equity (in the form of the brand's profit, revenue, profit premium, and revenue premium), and suggest that any changes in these consumer-based brand equity measures may significantly affect the brand's resulting market performance. In view of these results, it may be useful for managers to keep track of changes in consumer-based brand equity (by conducting periodic consumer satisfaction surveys, for example) in addition to monitoring financial-based measures of their brand's market performance.

Second, we have illustrated how the demand and resulting market performance for any brand may be affected by changes in the brand equity of competing brands by examining the elasticities and competitive clouts and vulnerabilities of the brands concerned. By looking at these elasticities and plots of clout and vulnerability, managers would be able to get a better understanding of their brands' equity positioning among rival brands and respond accordingly, using the derived optimal pricing and advertising equations as a guide in setting their optimal pricing and advertising levels.

Finally, we have also shown the usefulness of including consumer mindset measures of brand equity measures in a model of brand equity management in predicting and explaining changes in share and market performance vis-à-vis excluding such measures. Our results suggest that the proposed model predicts a brand's market performance better than an alternative model which does not account for these consumer-mindset measures, suggesting that such information do provide incremental value in explaining changes in a brand's market performance. The results are consistent across all four market performance measures which we considered.

In terms of substantive contributions to the brand equity literature, we provide a formal approach to modeling the structural link between consumer- and firm-based brand equity and have given additional insights on the relationship between the two kinds of measures beyond the findings already reported in extant research, which have mostly been based on reduced-form approaches. We have also provided an increased understanding of how a firm's optimal marketing activities may depend on the firm's expectations of how consumer brand attitudes and perceptions. Finally, we have examined a new product

market outcome measure of firm-based brand equity in the form of a profit premium, and demonstrated its viability as an alternative measure of a brand's market performance.

6.2 Limitations and Future Research

A number of limitations in our proposed model provide avenues for future research. Our theoretical model assumes that the only marketing mix variables that can affect consumer mindset measures of brand equity are pricing and advertising. This assumption may not be realistic, as many other market forces (such as product distribution) can also affect a consumer's decision to buy a product. If data are available, these variables could certainly be included in the model. In addition, our supply-side model assumes only one form of game-theoretic interaction among firms. As with all game-theoretic papers that have assumed specific forms of competitive behavior among firms, one may question the validity of the particular form of competition assumed. Future research could explore other possible forms of game-theoretic behavior (e.g. Stackelberg games in one or both of the advertising and pricing subgames) to describe the interaction between the firms involved.

Our model also has limitations in terms of the data we have. As with many extant papers on the automobile industry, the prices we have used are published prices, and not actual transaction prices, which would have been more appropriate. In addition, our model is strongly limited in terms of the consumer-mindset measures of brand equity which we have available to us. While the publicly-available measures that we have obtained from *Consumer Reports* and J.D. Power and Associates have proven to be useful, they may not completely capture a consumer's perceived quality or satisfaction with a brand. In addition, there are many other dimensions and measures of consumer-based brand equity (such as awareness, loyalty, perceived risk, and associations, to name but a few) which we have not looked at and which may be more appropriate for the industry which we have studied. To the extent that the data are available, researchers should take these measures into account in future research on brand equity measurement and management.

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