Brand Equity and Vertical Product Line Extent

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Abstract

This paper addresses the question of how the vertical structure of a product line relates to brand equity. Does the presence of "premium" or high-quality products in a product line enhance brand equity? Conversely, does the presence of "economy" or low-quality products in a product line diminish brand equity? Economists and marketing researchers refer to variation in quality levels of products within a category as "vertical" differentiation, whereas variation in the function or "category" of the products is referred to as "horizontal" differentiation. Much of the existing research on the relationship between product line structure and brand equity has focused on the horizontal structure of the product line and has been primarily concerned with *brand extensions*—what happens when the product line of a brand is extended horizontally into new categories? Researchers have been concerned primarily with how the extension fares, but the effect of the extension on the *core* products is also important. There is an analogous question of what happens when the product line of a brand is extended vertically, either "up market" or "down market." This question of vertical extensions is part of the more general issue of how the vertical structure of a product line relates to brand equity.

The specific research questions addressed in this paper are: (1) do "premium" or high-quality products enhance the brand equity associated with the other products in the line? (2) Conversely, do "economy" or low-quality products diminish the brand equity associated with the other products in the line? These research questions are relevant to three managerial issues in product-line strategy. First, what are the costs and benefits of including "down market" products within a brand? Second, what are the implications of including high-end models within a brand? Third, when should high-end and low-end products be offered under an existing brand umbrella and when should these products be offered under separate brands?

We address these research questions empirically through an analysis of the models and brands within the U.S. mountain bicycle industry. We use price premium above that which can be explained by the physical characteristics of the bicycle as a metric for brand equity. We then test several hypotheses related to the relationship between extension of the product line upward and downward and the price premium commanded by the brand. We further support this analysis with a simple laboratory experiment. The analysis reveals that price premium, in the lower quality segments of the market, is significantly positively correlated with the quality of the lowest-quality model in the brand's product line; and, that for the upper quality segments of the market, price premium is also significantly positively correlated with the quality of the highest-quality model in the brand's product line. The results of the analysis are supported by the outcome of an experiment in which 63 percent of the subjects preferred a product offered by a high-end brand to the equivalent product offered by a low-end competitor. These results imply that managers wishing only to maximize the equity of their brands would offer only high-quality products and avoid offering low-quality products. However, this result must be moderated by the overall objective of maximizing profits. Maximizing profits is likely to involve a tradeoff between preserving high brand equity (and therefore high margins) and pursuing the volume typically located in the lower end of the market. One of the most significant implications of this research is that product line managers need to be mindful not just of the incremental cannibalization or stimulation of sales of products that are immediate neighbors of an extension to the product line, but also the effect of such an extension on the brand equity in other, possibly quite different, parts of the product line.

(*Brand Equity*; *Price Premium*; *Product Line Extent*; *Product Line Breadth*; *Product Variety*; *Brand Strategy*; *Bicycle Industry*)

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1. Introduction

This paper addresses the question of how the vertical structure of a product line relates to brand equity. Economists and marketing researchers refer to variation in quality[1] levels of products within a category as "vertical" differentiation, whereas variation in the function or "category" of the products is referred to as "horizontal" differentiation. For example, there are dozens of variants of soap offered under the *Ivory* brand, yet this variety is mostly horizontal, representing different formulations, sizes, package types, and target applications (e.g., bar soap, liquid hand soap, soap flakes, dish soap). There is no real sense in which there are economy or premium products within the Ivory product line. Contrast this situation to that of most consumer durables, where in addition to horizontal differentiation, vertical differentiation (i.e., "good, better, best") within a brand is common. For example, Nikon offers cameras differentiated horizontally (e.g., point-and-shoot, digital, 35mm SLR, underwater, etc.); but within the 35mm SLR category, the Nikon offerings include the N50, N70, and N90. These cameras are all intended for essentially the same application, but differ in quality level.

Research on brand equity has flourished over the past decade. (See, for example, Aaker 1991, Farquhar 1989, and Keller 1993.) Much of the existing research on the relationship between product line structure and brand equity has focused on the horizontal structure of the product line and has been primarily concerned with *brand extensions*—what happens when the product line of a brand is extended horizontally into new categories? Researchers have been concerned primarily with how the extension fares, but the effect of the extension on the *core* products is also important. An example of such an extension would be the extension of the Ivory brand from soap to shampoo, or of Nikon's extension from cameras to scanners. There is an analogous question of what happens when the product line of a brand is extended vertically, either "up market" or "down market." This question of vertical extensions is part of the more general issue of how the vertical structure of a product line relates to brand equity.

[1]By *quality* we mean primarily *performance quality* (Garvin 1988), but some of the arguments apply to *conformance quality* as well.

The specific research questions addressed in this paper are: do "premium" or high-quality products enhance the brand equity associated with the other products in the line? Conversely, do "economy" or low-quality products diminish the brand equity associated with the other products in the line? Consider these questions in the context of one of the most significant recent brand events in the auto industry—the decision by Toyota to launch the Lexus brand (*Automotive News* 1988). Would the brand equity of Toyota have been enhanced if the Lexus models had been offered as part of the Toyota product line (e.g., a "Toyota LS400")? Conversely, would the equity associated with the Lexus brand be diminished if the Lexus product line included economy cars (e.g., a "Lexus Corolla")?

These research questions are relevant to three managerial issues in product-line strategy. First, what are the costs and benefits of including "down market" products within a brand? This assessment is important because product strategists often wish to exploit the equity of premium brands in the lower-priced parts of the market, where there is typically more product volume. The key issue is the implications of such a strategy for the equity the brand may enjoy with its high-end customers. Second, what are the implications of including high-end models within a brand? Even if these products are not profitable when viewed in isolation, can they be justified when viewed in the context of their positive impact on overall brand equity? Third, when should high-end and low-end products be offered under an existing brand umbrella and when should these products be offered under separate brands? That is, when are the costs of managing a new brand outweighed by the benefits? Potential benefits include the equity a separate high-end brand could develop, and the damage avoided to the equity of a premium brand when a set of economy products is offered under a distinct brand.

We address these research questions empirically through an analysis of the models and brands within the U.S. mountain bicycle industry. We use price premium as a metric for brand equity. We then test several hypotheses related to the relationship between vertical product line extent and price premium. We further support this analysis with a simple laboratory experiment.

In the balance of the introduction, we outline the theory and results of previous research, and formally pose our hypotheses. In § 2, we provide an overview of the bicycle industry and of our data sources. The analytical research methods are detailed in § 3, with the results in § 4. Section 5 presents the results of an experiment designed to supplement the statistical analysis. Section 6 is a discussion of the results. The final section comprises concluding remarks.

Theory

A brand is an identifier for a set of products offered for sale by the same organizational entity (Kotler 1997). Keller (1993) writes that "a brand is said to have positive (negative) customer-based brand equity if consumers react more (less) favorably to the product, price, promotion, or distribution of the brand than they do to the same marketing mix element when it is attributed to a fictitiously named or unnamed version of the product or service." Brand equity may be manifest in at least three forms: price premium, increased market share, and reduced costs of introducing new products (Aaker 1991, Simon and Sullivan 1993).

Figure 1 is a conceptual model of the role of brands in the consumer buying process. When evaluating a product in his or her consideration set, the consumer takes into account the *directly observable attributes* of the product (e.g., features, style, color, etc.) and the value of the brand, among other factors. There are at least three underlying causes of brand value: (1) brand associations regarding difficult-to-observe attributes, (2) brand prestige, and (3) brand image. We first explain these three factors and then link them to the structure of the product line.

Some attributes of a product are important to consumers, yet are difficult to observe. An example of such an attribute is reliability. Consumers must estimate the values of these attributes if they are to avoid the cost of trying to actually observe them. Brands may be associated in the minds of consumers with performance with respect to these difficult-to-observe product attributes (e.g., Maytag and reliability). If a brand's products offer consistency with respect to attributes that are difficult to observe before purchase, then consumers can use the brand label as a surrogate for performance with respect to these attributes (Farquhar 1989, Kotler 1997). Therefore, brand association is a powerful mechanism used by consumers to evaluate products. Because of its role in reducing the effort required to evaluate products, a brand may be of direct value to consumers, and therefore may affect the perceived utility of a branded product.

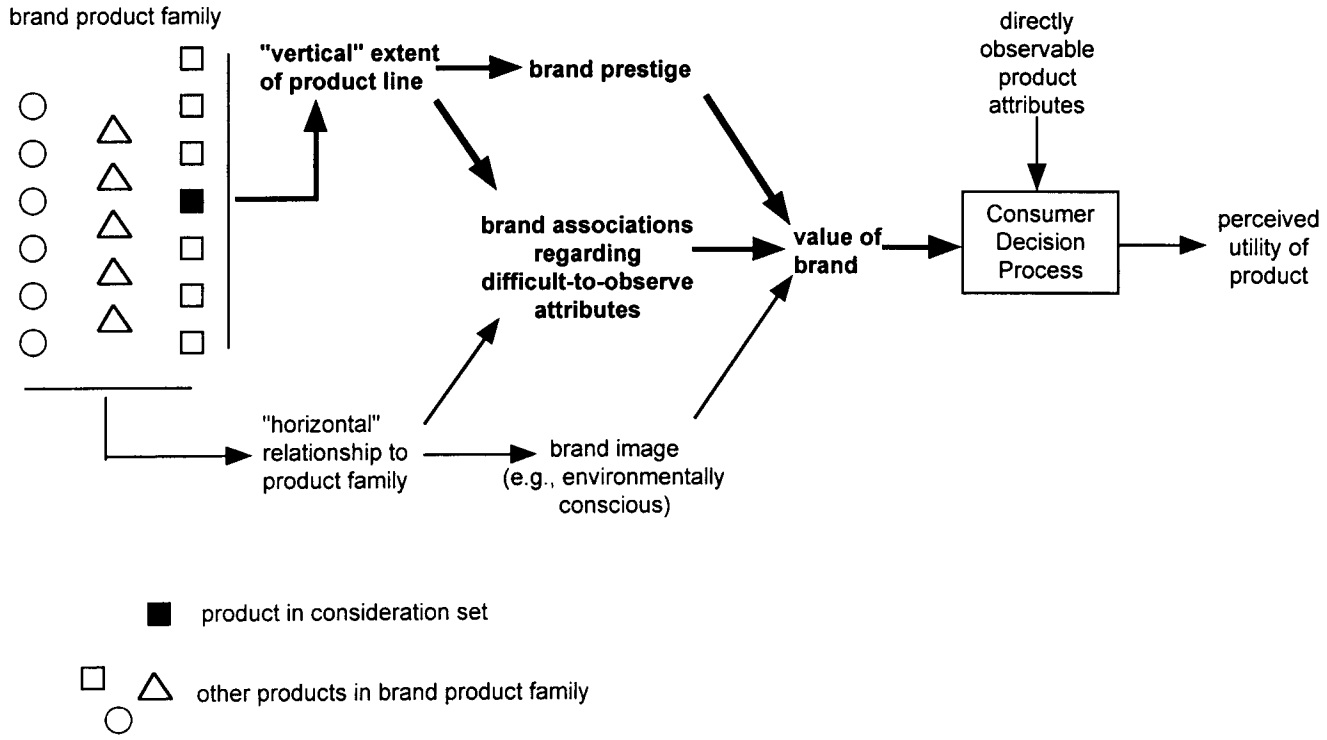
The consumer may also derive direct benefits from the product's brand. One possible benefit derived from a brand is the *prestige* it confers on the user or owner of the product. For example, Armani (apparel), Rolex (watches), and Mercedes (automobiles) are currently all prestige brands, so consumers who value prestige may respond more positively to products offered by these brands.

Prestige is a special instance of a particular *brand image*. However, there are many other possible brand images that may offer symbolic benefits to consumers (Solomon 1983). For example, Nike has effectively associated its brand with exuberant athletic self-expression ("Just Do It"). Consumers who identify with this value may respond more positively to the Nike brand than they would to another brand without this image.

We argue that both the horizontal and vertical structure of the product line may influence the consumer's perceptions of brand value. For conceptual clarity, assume that the brand product family consists of three categories of products (shown as circles, triangles, and squares in Figure 1), with each containing products differentiated vertically (i.e., by quality level). We represent vertical extent with two poles: the degree to which the product line includes premium models, and the degree to which the product line includes economy models. (We intend "premium," "high-end," and "high-quality" to be synonymous; as we do "economy," "low-end," and "low-quality.")

Influence of the Horizontal Structure of the Product Line on Brand Associations and Image. There is rich literature on brand extensions and their relationship to brand association. (See, for example, Aaker and Keller 1990, Loken and Roedder John 1993, and Boush and Loken 1991). This literature has focused primarily on horizontal extensions. While our primary interest is the vertical structure of the product line, there are important parallels to the research on horizontal extensions. The question often addressed in the existing literature is how brand associations facilitate extensions

Figure 1 **Conceptual Model of the Influences of the Structure of the Brand Product Family on the Consumer Decision Process**



into other categories (e.g., speed entry, increase penetration, or allow for a higher price). The basic result from this literature is that when a brand attempts to extend its offerings into *similar* categories, brand associations carry over to the extension, but that when the extension is into a very different category, brand associations do not carry over to the extension. (See, for example, Rangaswamy, Burke, and Oliva 1993, Reddy, Holak, and Bhat 1994, Broniarczyk and Alba 1994, and Park, Jaworski, and MacInnis 1986.) In one of the prior research efforts, Aaker and Keller studied horizontal extensions experimentally. The dissimilar extensions included Heineken popcorn, Crest chewing gum, and McDonalds photo processing (Aaker and Keller 1990). They found that extensions are likely to be rated poorly if (1) there is a lack of perceived fit of the product with the original product classes, (2) the extension is perceived as too easy to make (e.g., labeling a commodity with a brand), or (3) the original brand carries damaging attribute characteristics to the extension (e.g., a perception that Crest chewing gum will taste like toothpaste). Others find that if consumers perceive that a product is offered by a brand with very different siblings in very different product categories, this product is unlikely to inherit positive brand associations. However, if the product is similar to its siblings, then a brand's association with, say, high reliability, may extend to this product. Note that this research has focused primarily on brand *extensions*. That is, the research issue is what is the outcome of a horizontal *change* in the product line. This research has also focused primarily on the success of the extension, and *not on the reciprocal effect on the original core set of products*. Little if any of this research on brand extensions has addressed how vertical product line extent relates to brand associations, although this issue has been identified as an important area for future research (Aaker and Keller 1990).

Influence of the Vertical Structure of the Product Line on Brand Prestige and Associations. Figure 1 illustrates the vertical extent of the product line relative to the product under consideration. This vertical

structure may influence both brand prestige and brand associations. The presence of high-end models in a product line may contribute to an image of prestige and exclusivity. For example, Mercedes is perceived as a prestigious brand in the United States primarily because of the high-end models in its product line. This prestige persists to some degree even for the middle-market models offered under the Mercedes brand. Just as high-end models may enhance the prestige of a brand, low-end models may diminish this prestige. Practicing managers and the business press often refer to the possibility that a low-end model within a product line may tarnish the image of the parent brand. For example, many believe that the introduction of the Cadillac Cimarron (a "low-end" Cadillac) diminished Cadillac's overall brand equity (Yovovich 1988). Maintaining a brand image of prestige and exclusivity while simultaneously offering products in the low-end of the market under the same brand may be difficult or impossible.

We hypothesize that brand *associations* may also be derived from cues taken from the vertical extent of the product line. The presence of high-end models may create a consumer belief that the brand possesses strong design and production capabilities. The consumer may further believe that such capabilities are likely to result in high product performance relative to difficult-to-observe product attributes, even for the non-premium models in the product line. This influence could be viewed as a belief in a "trickle-down" of quality from the high-end models to the low-end models. In economic terms, a high-end model can be thought of as a signal of the quality of the product line (Hertzendorf 1993). For example, in the United States, Mercedes-Benz offers primarily high-end automobiles which consumers have come to associate with durability and safety (among other more directly observable attributes like driving performance and comfort). When Mercedes offers a middle-market automobile such as the C-Class sedan, consumers may believe that this product inherits the durability and safety attributes of its higher-quality siblings. This is not necessarily an irrational belief. There may be genuine economies of scope and scale that allow higher-quality components and systems to be applied to the lower-end products in the line. Conversely, the presence of low-end models may raise in the mind of the consumer the possibility that some of the lesser-quality materials, components, and processes used in the low-end products are also used in the high-end products; that perhaps the brand "cuts corners" in its high-end models. Again, these beliefs would apply primarily to difficult-to-observe attributes of the products.

There is only a small amount of existing research on the relationship between the vertical structure of the product line and brand equity. In experimental studies, Loken and Roedder John (1993) find some support for the notion that consumers perceive a brand's quality to be diminished if a low-quality product is added to the product line. Sullivan has shown that problems with one model in a line may influence the sales of another model. She showed that the perceived "sudden acceleration" problem of the Audi 5000 reduced sales of the Audi 4000 (Sullivan 1990). While in this case, a nominally high-end model had a negative influence on the brand, the underlying inheritance mechanism is similar to that proposed for the influence of low-quality models on brand equity.

Where is the Effect of Quality Extent Likely to be Manifest? Brand equity is ultimately manifest as an increase in the perceived value of a branded product by a consumer. This brand equity may manifest itself differently across the brand's products. For example, a brand's products may command a price premium at the high end of the market, but not at the low end.

Assume a consumer is considering a set of high-end products offered by different brands. All of the products in the consumer's consideration set are high-end products and are therefore, by definition, offered by brands with high-end products in their product lines. These brands are not differentiated from one another in this respect. Therefore, brand equity should not be manifest in the high end of the market as a result of the brand's including high-end products in its line. However, these brands could be differentiated by the extent to which they include low-end models in their lines and so the presence of low-end models in a product line could be associated with the equity enjoyed by a brand at the high end of the market.

Conversely, assume a consumer is considering a set of low-end products offered by different brands. All of

the products in the consumer's consideration set are therefore, by definition, offered by brands with low-end products in their product lines. These brands are not differentiated from one another in this respect. Therefore, a lack of brand equity should not be manifest at the low end of the market as a result of the brand's including low-end products in its line. However, these brands could be differentiated by the extent to which they include high-end models in their lines and so the presence of high-end models in a product line could be associated with the equity enjoyed by a brand at the low end of the market.

Hypotheses

The model of consumer decision making developed here gives rise to hypotheses about the relationship between the vertical extent of the product line and brand equity. In these hypotheses we use the highest and lowest quality levels in the product line to represent the vertical structure of the line. We therefore have two hypotheses, one relating to the association between the highest-quality product in the line and brand equity, and the other relating to the association between the lowest-quality product in the line and brand equity.

H1. *Brand equity for the lower-quality products in the market is increasing in the quality level of the highest-quality model in the brand's product line.*

H2. *Brand equity for the higher-quality products in the market is increasing in the quality level of the lowest-quality model in the brand's product line* (*i.e., the higher the quality level of the lowest-quality model, the higher the brand equity*).

These hypotheses reflect an equilibrium condition in which the structure of a product line is established and consumers' perceptions have been formed. Most of the existing research on product line structure and brand equity has related to brand *extensions*—to *changes* in the structure of the product line. An important question is the degree to which changes in the quality extent of a product line can lead to changes in brand associations and brand image, and therefore in overall brand equity. We believe that an equilibrium hypothesis implies a change hypothesis. That is, if the equilibrium condition holds, then changes in one variable will result in changes in the other variables. We would expect, however, that responses to change occur with a substantial time lag and so one must be careful in drawing inferences about the effects of changes to the product line, even if the relationships in Figure 1 hold in equilibrium.

Approaches to Estimating Brand Equity

The literature suggests several methods for measuring brand equity. (See Park and Srinivasan 1994, and Simon and Sullivan 1993 for reviews of methods.) Methods such as conjoint analysis (Green and Wind 1975, Green and Srinivasan 1978) directly elicit a consumers' utility for a brand by asking consumers to make tradeoffs between brand and other relevant product characteristics such as price or quality. Other direct approaches to measuring brand equity use surveys to elicit consumer brand preferences (Aaker 1996). Under these methods, higher brand equity manifests itself in the form of higher consumer utility. While these methods are useful in making relative comparisons of brands, it is not easy to translate preference measures into financial measures for use in cost-benefit analyses. Simon and Sullivan (1993) estimate the market value associated with a firm's portfolio of brands by extracting the equity of the brand portfolio owned by a firm from the market value of a firm's intangible assets. This method captures several important elements of brand value, including the price premium associated with a portfolio of brands, the expected future profits of the brand portfolio, and the ability of the brand portfolio to reduce the marketing costs associated with current and future products. However, the aggregate nature of the measurement procedure complicates the measurement of the value of a brand in a multi-brand environment.

We measure brand equity using the price premium elicited by each product sold under a unique brand name (Holbrook 1992, Bello and Holbrook 1995). We recognize several theoretical weaknesses in this methodology. First, this method only partially measures brand equity. Price premiums do not capture a brand's ability to reduce the marketing costs of current and future products. Thus, the premium of brands that do not command a price premium, but have the ability to reduce the marketing costs of current and future products, will be understated. Second, pricing strategies can confound price premiums. For example, a firm may

choose to take the benefits of brand equity in the form of greater market share. However, unlike the market value estimation method, the estimation of price premiums associated with each product allows us to measure brand premium on a product-by-product basis and does not require a capital market valuation of each brand. This flexibility is important since most of the brands in our sample belong to private companies. Given our measure of brand equity, the reader should carefully note that when we refer to brand equity in the context of the empirical study, the underlying measure is price premium.

2. The Bicycle Industry

The United States bicycle market consists of approximately 10 percent of the world market, with sales of approximately 12 million units per year. Total unit sales have been fairly constant over the past decade, but recent trends in mountain biking have increased that segment's portion of total unit sales from 12 percent in 1985 to 66 percent in 1995. Approximately, 75 percent of all bicycles in the U.S. are sold through the mass merchandising channel in stores such as Toys R Us, Wal-Mart, and Kmart. Bicycles sold through the mass merchandising channel are typically children's bicycles and adult bicycles priced below $200. The remaining 25 percent of U.S. bicycle sales occur through independent bicycle dealers (IBDs). Ninety-five percent of all bicycles priced above $200 are sold through IBDs. As of 1995, there were approximately 6,000 IBDs in the U.S. with 1,500 of them accounting for 60 percent of all unit sales.

Our analysis focuses on the "over-$200" mountain bike segment.[2] We focus here for several reasons. The number of manufacturers in the below-$200 category is limited to a few large-volume producers. The limited number of competitors in the low end of the market limits the number of product line strategies that can be observed. In the over-$200 category, 75 different brands can be observed with an average of 10 models per brand. The competition in the over-$200 category allows for more natural variation in product line strategies, which provides a richer research environment. A focus on the bicycle industry also allows us to substantially isolate differences in the vertical extent of the product line from differences in horizontal extent. With minor exceptions, all of the brands in this industry are focused exclusively on the bicycling category. There have been almost no brand extensions into other categories nor have established brands entered from other categories.[3]

Data Sources

We obtained information on most 1995 adult bicycle models offered for sale in the United States. This information was supplied to us by *Bicycling Magazine,* whose technical editor gathered these data from the manufacturers for inclusion in the magazine's annual buying guide. We believe that the database contains at least 95 percent of the models offered for sale in the United States in 1995. The descriptions of each model include the full list of components (spokes, rims, pedals, brakes, hubs, etc.), the weight, the suggested retail price, and the sizes and colors in which the bicycle is offered.

We supplemented this database with information from trade and consumer publications and with interviews with manufacturers and retailers in the industry. The details of this supplemental data gathering are given in the Methods section of this paper.

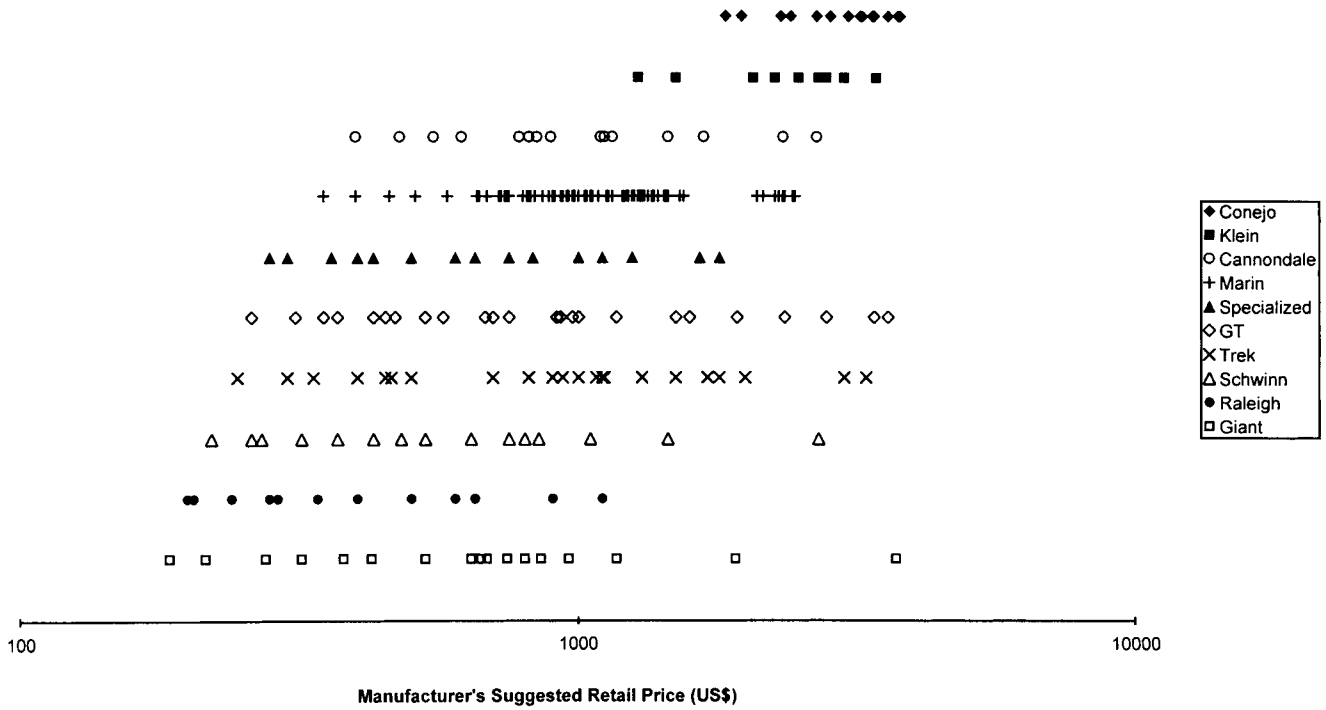
Overview of Product Lines

Figure 2 is a plot of the models in the product lines of 10 selected brands. Several observations can be made from these data. First, there is intense competition at all price points. Even looking at only 10 of 75 brands, there are many models in every price interval. Second, firms pursue widely divergent product line extent strategies. Conejo offers products only at the high end. Raleigh offers products only at the low end. Giant offers products at every price point. Third, the density of models within a brand differs widely. Marin and Cannondale compete in roughly the same price interval, yet Marin offers 84 models and Cannondale offers 15.

[2]Despite the label, a few manufacturers in this segment offer bicycles through the IBDs at prices slightly below $200.

[3]We note several exceptions: Cannondale, Trek, and Specialized extended into bicycle accessories and clothing. Swiss Army, a popular and established brand of knives, was the only company extending into bikes. However, we noted that in the season following our analysis many automobile companies entered the bicycle category with line extensions. Examples include Jeep, BMW, and Mercedes.

Figure 2 **Product Lines of Ten Representative Mountain Bike Brands.** Each mark represents a model. The brands are organized vertically in order of the price of the lowest priced model in the product line.



3. Methods

The primary method for testing our hypotheses is a statistical analysis, using multiple regression, of the relationship between the vertical extent of a product line and brand equity, as reflected by price premium. We also conducted a simple laboratory experiment. This section and the following describe the statistical analysis. Section 5 describes the experiment.

Approach

Our basic approach is to test the relationship between price premium and the extent of a brand's product line. We employ the method of hedonic regression, which assumes that product prices are a function of the imputed prices customers assign to the attributes in a product (Waugh 1928, Griliches 1961, Ohta and Griliches 1986, Holbrook 1992, Bello and Holbrook 1995). To increase our confidence in our results, we do this analysis two different ways:

1. **One-stage analysis.** In the one-stage analysis, we regress the price of each bicycle against tangible product attributes (e.g., frame material, components) along with variables describing the vertical extent of the product line of the brand offering the bicycle. This approach directly tests the hypotheses that the extent of the product line is associated with price premium.

2. **Two-stage analysis.** In a first stage, we regress the price of each bicycle against tangible product attributes along with dummy variables for the different brands. We use the resulting estimated coefficients of the brand dummies as estimates of the price premium for each brand. Then, in a second-stage analysis, we regress these estimates of brand price premium against the vertical extent of the brand's product line and other brand-level control variables. This second-stage analysis tests the hypothesis that the extent of the product line is associated with a brand's price premium.

In this section, we describe the one-stage analysis in detail, and then we describe the two-stage analysis by outlining the ways in which it differs from the one-stage approach.

Variable Definition

Manufacturer's Suggested Retail Price. Manufacturer's suggested retail price (MSRP) serves as the dependent variable and as a proxy for the transaction price of each bicycle. Prior studies using hedonic models use the transaction price of a product to impute the price of product attributes. However, for the mountain bike category, true transaction prices are not readily available. The use of MSRP rather than transaction price poses two potential problems for our study. First, if prices of particular brands are systematically discounted (inflated) at the time of purchase, a model using MSRP will overstate (understate) premiums for a systematically discounted (inflated) brand. Second, if prices within a particular quality range (e.g., high end or low end) are systematically discounted (inflated) at the time of purchase, a model using MSRP will overstate (understate) the premium of brands with a higher concentration of models within the affected quality range.

Because of these concerns we carefully explored the extent to which MSRP reflects transaction prices in the over-$200 mountain bike category. We do not believe that systematic brand discounting or inflation is common in practice for four reasons. First, we observe that bicycle retailing is not intensely price competitive, unlike categories such as consumer electronics. IBDs rarely advertise via mass media and rarely advertise the price of specific models, which makes consumer price comparison difficult. Furthermore, consumers in this category typically purchase bicycles from local shops. Shops generally try to stock brands different from those of other shops in the area. For example, in Philadelphia, three bicycle shops operating within one mile of each other carry 14 different brands of mountain bikes. Only one brand is carried by two of the three stores. This type of retail strategy, supported by both the manufacturers and the retailers, mitigates price competition between stores for the same brand.[4] Second, manufacturers structure stringent contracts with IBDs (e.g., "uniform minimum advertised price" or "UMAP" policies) to discourage price deviation from MSRP. Third, each manufacturer lists its products, including MSRP, in the annual consumer buyer's guide published by *Bicycling* magazine. The buyer's guide is widely used, especially by consumers in the middle and upper segments of the market, and so a manufacturer's position in the guide is competitively important. A product is listed by price and product attributes side-by-side with competitive offerings of similar price. Under these circumstances, deviant pricing is transparent to consumers and IBDs. Inflated MSRPs would make a brand's bicycles appear to be poor values relative to the immediately neighboring competitive offerings. Deflated MSRPs would lead to price mark-ups with respect to MSRP at the retailer, a tactic likely to lead to consumer dissatisfaction. Fourth, we conducted a telephone survey of 40 IBDs to discuss discounting and other issues. Respondents indicated that when they discount, they do so on a product-by-product and customer-by-customer basis, not on a brand-by-band basis.

Product-Specific Attributes. We model MSRP as a function of brand-level variables and of eight product attributes: frame material, component group, front suspension, rear suspension, high performance components, colors per model, sizes per model, and whether or not the bicycle was assembled in the United States. Figure 3 illustrates some of these attributes on a typical mountain bike. Dummy variables represent the different quality levels for the frame material, component group, and front suspension characteristics.

Figure 3 A Mountain Bicycle with Front Suspension.

Courtesy of Lifespeed Titanium Components, Inc.

[4]These properties of bicycle retailing are in flux and we believe it is possible that the retail landscape will change dramatically over the next few years.

Dummy variables also represent the rear suspension, high performance component, and "assembled in U.S.A." attributes. We use the presence of clipless pedals as proxy for high-performance components such as bar ends and titanium saddles. Discussions with industry personnel revealed a prevailing belief that consumers place additional value on bicycles produced in the United States.

Table 1 provides descriptive statistics for each product attribute and its respective levels. For product attributes where dummy variables represent quality levels, we report the number of models in the data set possessing a given quality level. For colors and sizes, we report typical summary statistics. Note that a few manufacturers supply the majority of the components and front suspensions to the industry. In the case of components, Shimano supplies 94 percent of all models. In the case of front suspension, Rock Shox and Manitou supply 74 percent of all models with front suspension. In fact, with the exception of Cannondale, the brand associated with components and forks is independent of the bicycle brand. While not described in Table 1, frame materials are sourced from several large tube suppliers including Reynolds, Alcoa, and Tange. The presence of dominant independent suppliers allows us to predict price using the presence of a particular component as a proxy for the performance or quality of an attribute. For example, in the case of front suspension, we use the presence of, for example, Rock Shox Judy or Manitou Comp as a proxy for suspension quality rather than directly measuring the performance specifications of front suspensions such as amount of travel or weight. This treatment is consistent with the way consumers evaluate product offerings. A consumer will typically identify a model as, for example, a Trek bicycle with Shimano XTR components and a Rock Shox Judy SL front suspension.

Brand-Level Attributes. ADVERTISING. Advertising may enhance brand premium by reinforcing a brand's association with a level of quality or with a particular image (Kirmani and Wright 1989, Nelson 1974). Klein, for example, currently advertises its brand with the slogan, "Gorgeous, ultra-light, and as

Table 1 Summary Statistics of Bicycle Attributes (727 Models in the Data Set)

Frame Materials	*N*	Component Groups	*N*	Front Suspension	*N*		*N*
Low Quality Steel	94	Shimano Acera	55	Unsuspended	293	Rear Suspension	117
Chromoly Steel	90	Shimano Alivio	65	Custom	16		
Butted Chromoly Steel	131	Shimano Altus	33	SR Duo Track	12	High Perf. Components	134
Elite Steel	32	Shimano Deore LX	113	Cannondale Headshock	8		
Butted Elite Steel	17	Shimano Deore XT	140	Manitou 4	32	Assembled in U.S.A.	234
Aluminum/Steel	5	Shimano Deore XT/LX	49	Manitou Comp	33		
Aluminum	129	Shimano Deore STX	104	Manitou EFC	10		
Butted Aluminum	128	Shimano Deore STX-RC	53	Manitou Magna	22		
Oversize Aluminum	21	Shimano Tourney	37	Marzocchi	29		
Aluminum/Carbon	4	Shimano XTR	37	Rock Shox Judy SL	36		
Carbon Fiber	20	Unspecified	31	Rock Shox Judy SXC	61		
Titanium	45	Other	10	Rock Shox Magna	47		
Metal Matrix Composite	6			Rock Shox Quadra	51		
Monocoque Composite	5			RST	27		
				Other	50		

	Mean	Std	Maximum	Minimum
Price	1200	912	159	5400
Colors	1.64	1.17	10	1
Sizes	4.60	1.34	10	1

N = number of models having a given product attribute.

you'd expect . . . very expensive" (*Bicycling* 1996). We expect higher premiums to be associated with higher levels of advertising. Advertisements in bicycling magazines represent the bulk of the advertising expenditures in the industry. In our model, we represent advertising level by the number of advertising pages purchased by a brand in the major bicycling magazines during 1995.

LnMKTSHARE. This variable is the natural logarithm of percent market share from 1994, a year earlier than the rest of the data. We use the lagged value to help address a potential simultaneity bias, which we discuss in the section on methodological issues. We include the variable LnMKTSHARE as a control variable for several reasons. First, firms with high market share may benefit from economies of scale, allowing them to price lower than firms without equivalent market share. Second, firms may sacrifice price premium in the short run for higher market share. Third, in the mainstream market, a brand that is more common may achieve higher awareness, which may give rise to brand equity (and increased price) among mainstream consumers. However, market share could adversely affect brand equity at the high end of the market. If a brand's models are too common, the brand could lose its image of exclusivity and prestige. Taken independently, some of these mechanisms would cause market share to be negatively correlated with brand premium, while others would cause market share to be positively correlated with brand premium.

#MODELS. Reibstein et al. (1975) suggest that customers will pay more in order to have a choice of products, implying that brands offering more models within a given range of products will have higher premiums. Baumol (1957) also suggests consumers value variety, but that the marginal benefit of variety decreases in the number of products offered. We use the number of models (#MODELS) offered by a brand in a given segment as a measure of product variety.

HIGH and **LOW.** These variables are the independent variables describing the vertical extent of the product line, and associated with our tests of hypotheses. These variables correspond to the maximum (HIGH) and minimum (LOW) priced bicycles in the brand's product line. The values of HIGH and LOW are not manufacturer's suggested retail prices (MSRP). Rather, we estimate a "predicted price" for the highest- and lowest-quality models in the product line using the hedonic regression model absent brand-level variables. Predicted prices assign the same dollar value to each non-brand-related product attribute across all brands creating a brand-neutral "quality index." The following example illustrates why we use predicted prices as our proxy for quality levels rather than MSRP. Consider a market with two brands, A and B, offering three products with identical attributes, except for the brand name they carry. However, for some reason brand A commands a ten-percent premium over brand B. Consider the variable HIGH. Because the difference in the value of HIGH between the two brands is exactly equal to brand premium, the hypotheses that premium is related to HIGH becomes tautological. This problem is alleviated if predicted prices are used, in which case there would be no difference in the value of HIGH between the two brands. We delete the highest- and lowest-predicted-price bicycle from each brand from our data set to avoid an obvious correlation between HIGH/LOW and LnMSRP for those bicycles.

Table 2 shows the Pearson correlation coefficients between pairs of brand-level variables. While many of the variables exhibit significant correlation, several relations merit specific attention. First, LOW and HIGH are significantly and positively correlated ($r = 0.41$, p

Table 2 **Correlations Between Independent Brand Variables (62 Brands)**

	LOW	HIGH	ADVERTISING	LnMKTSHARE	#MODEL
LOW	1.00				
HIGH	0.41***	1.00			
ADVERTISING	−0.34***	0.10	1.00		
LnMKTSHARE	−0.33***	0.01	0.73***	1.00	
#MODELS	−0.40***	0.11	0.40***	0.27**	1.00

*** = $p < 0.01$, ** = $p < 0.05$.

LOW = Lowest predicted price of the models of brand j.

HIGH = Highest predicted price of the models of brand j.

ADVERTISING = Number of advertising pages in national bicycling magazines in 1995.

LnMKTSHARE = Natural logarithm of 1994 market share.

#MODELS = number of models per brand.

< 0.01) indicating that brands entering the market with higher-quality low-end products also tend to offer higher-quality high-end products. Second, LnMKTSHARE and ADVERTISING exhibit a strong positive correlation ($r = 0.73$ $p < 0.01$). Larger firms advertise more than smaller firms. Third, LOW and LnMKTSHARE show a significant negative relation ($r = -0.32$, $p < 0.01$) consistent with the fact that most of the volume is sold at the low-end of the market and brands offering low-end bicycles have higher market share. Finally, #MODELs and LnMKTSHARE exhibit a significant positive correlation ($r = 0.27$, $p < 0.05$) indicating brands offering more bicycles have higher share.

Data Set Exclusions. We exclude two brands, Terry and Swiss Army, because the brands contain product attributes that are difficult to model. Terry is a producer of women's bicycles while all other bicycles in the data set are unisex. Swiss Army produces one bicycle sold as a promotional item with a major automobile company. This bicycle is not available to the mass market. We also exclude bicycles offered in custom sizes and colors. Finally, we exclude four brands, Maxcycles, Oryx, Timberlin, and Signature, because country of manufacture information was not available for these brands.[5] After these exclusions, the data set consists of 727 bicycles (products or models) from 64 different brands.

Functional Form. Consistent with hedonic pricing literature (Griliches 1961), we model bicycle price as a function of product attributes by taking the natural logarithm of MSRP. We use a semi-log model for two reasons. First, examination of a family of Box-Cox transformations indicated a logarithmic transformation provides the best functional form. Second, we believe that the price differences associated with product- and brand-level variables are best represented as percentage differences rather than constant differences. After logarithmic transformation of MSRP, the estimated model takes the following form

$$\begin{aligned}\text{LnMSRP}_i = {} & \beta_0 + \bar{\beta}_1\textbf{FRAME-MATERIAL}_i \\ & + \bar{\beta}_2\textbf{FRONT-SUSPENSION}_i \\ & + \bar{\beta}_3\textbf{COMPONENT-GROUP}_i \\ & + \beta_4\text{REAR-SUSPENSION}_i \\ & + \beta_5\text{HIGH-PERFORMANCE-COMPONENTS}_i \\ & + \beta_6\text{COLORS-PER-MODEL}_i \\ & + \beta_7\text{SIZES-PER-MODEL}_i \\ & + \beta_8\text{ASSEMBLED-IN-USA}_i \\ & + \beta_9\text{ADVERTISING}_i \\ & + \beta_{10}\text{LnMKTSHARE}_i \\ & + \beta_{11}\#\text{MODELS}_i \\ & + \beta_{12}\text{HIGH}_i + \beta_{13}\text{LOW}_i + \varepsilon_1\end{aligned}$$

where LnMSRP_i is the natural logarithm of MSRP of the ith bicycle; β_0 is a constant; β_j are regression coefficients (or vectors of coefficients when denoted as $\bar{\beta}_j$); **FRAME-MATERIAL, FRONT-SUSPENSION,** and **COMPONENT-GROUP** represent vectors of dummy variables for frame materials, front suspension, and component groups; ADVERTISING, LnMKTSHARE, #MODELS, HIGH and LOW represent levels of these variables for the brand associated with each bicycle model; and ε_i is an error term.

Methodological Issues

Segmenting the Bicycles. We perform the analysis for five separate price segments: below \$500, \$350 to \$750, \$500 to \$1000, \$750 to \$1500, and above \$1000.[6] We perform the analysis separately for each price segment for two reasons. First, we do not expect consumers to place the same value on product attributes from segment to segment. Segmentation allows the coefficients on performance attributes and brand-level attributes to vary across segments. Second, we believe that margins in the industry increase as price increases. If true, consumers pay more for any given attribute at higher price levels than lower price levels. This could bias the tests in favor of accepting our hypotheses. For this reason, we only compare the differential pricing of bicycles within the market segment where margins

[5]It is our observation that up to 8 brands enter or exit the market each year. After numerous attempts, we were unable to locate these firms and thus assumed they had ceased operations.

[6]These segments are created using predicted prices without brand variables (as discussed in our explanation of the variables HIGH and LOW) so as to compare bicycles of approximately the same brand-neutral quality level.

should be relatively constant. Discussions with industry experts and bicycle retailers indicated that the natural price segments in the market are the below $500, $500 to $1000 and above $1000 segments, with the below $500 segment considered "lower-quality" and the above $1000 segment considered "higher-quality."[7] We use these quality designations for the purposes of testing our hypotheses. The $350 to $750 and $750 to $1500 segments are included to test the sensitivity of our results to segment cutoffs.

Weighting Observations. We observe that brands differ greatly in the number of bicycles they offer to the market. For example, Marin offers 84 bicycles while AMP offers 3. (See Figure 2 for an indication of the differences in the number of models across product lines.) Because of these differences, in an unweighted analysis, firms with large numbers of bicycles exert a disproportionate influence on the estimates of the coefficients on brand-level variables. We do not believe that this influence is justified, but rather feel that each brand should be weighed equally. To account for this factor, we perform our analysis using a weighted least squares regression model, with each bicycle model weighted by the inverse of the number of models offered by its brand. Despite this logic, note that results from models using this weighting scheme do not differ from unweighted models except as noted in the results section.

Simultaneity. There is a potential simultaneity bias in the model as price and volume may be determined jointly. This is because on the demand side an increase in price implies a decrease in volume, yet on the supply side an increase in price implies an increase in volume. (See Greene 1990, Chapter 19, for a discussion of precisely this type of simultaneity.) We can replace the potentially endogenous variable, market share, with an *instrumental variable*—a variable that is highly correlated with market share, but exogenous—which will mitigate the problem of simultaneity bias (Kennedy 1998). We use lagged market share (from 1994) as such an instrumental variable, because it is highly correlated with market share, but is largely exogenous to the simultaneous supply-demand system for the year in which the analysis is performed (1995). We recognize that lagged market share has two potential weaknesses as an instrument. First, there will be serial correlation between market share from year to year. Second, we believe that the price-volume decision is made on a model-by-model basis, and we have market share data only at the brand level.

Two-Stage Analysis

There are several potential weaknesses in the one-stage analysis described here, including the issue of whether and how to weigh observations according to the number of models in a brand's product line. To build our confidence in the robustness of our results, we separately perform a two-stage regression analysis. In the first stage, we estimate the price premium associated with each brand, and then in the second stage, we estimate the effect of brand-level variables on this estimated price premium. To estimate price premiums associated with each brand, we perform a regression analysis with LnMSRP as the dependent variable. As independent variables we include (1) the tangible product attributes such as component group and frame material, accounting for the quality of the bikes and (2) dummy variables for each brand. The coefficients associated with the brand dummy variables become our estimates of brand premium. Then, in a separate regression (stage 2), we estimate the effect of the brand-level variables, including HIGH and LOW, on these estimates of brand premium. Using this technique, each brand receives equal weight in the second-stage model. As in the one-stage analysis, we perform both stages for each of five price segments.

4. Results

Table 3, Panel A presents summary results of the one-stage weighted hedonic pricing model for each segment. (Panel B, discussed later, shows the results for the subset of firms that outsource production.) Coefficients for the individual product-level characteristics are not shown in Table 3, although the full results for one of the price segments are provided in Appendix A. The adjusted R^2 for the models ranges from 0.81 in

[7] "Lower quality" is, of course, a relative concept. A salesman from Klein, a high end brand, indicated that their internal analysis shows that consumers perceived a bike to be "low-end" if it were priced between $800 and $1000. Klein's lowest price model is around $1200.

Table 3 **One-Stage Analysis.** Dependent variable is LnMSRP of each bicycle. Coefficients for tangible product attributes (e.g., frame material, component group) are not shown. T-statistics are shown in brackets.

	Panel A: All bicycles offered by all firms					**Panel B:** Bicycles by firms outsourcing production				
	Below $500	$350 to $750	$500 to $1000	$750 to $1500	over $1000	Below $500	$350 to $750	$500 to $1000	$750 to $1500	over $1000
HIGH	0.005***	0.007***	0.005***	0.007**	0.003	0.004***	0.006***	0.006***	0.009**	0.0001
	[3.53]	[4.88]	[2.93]	[2.45]	[1.01]	[2.65]	[4.34]	[3.29]	[2.55]	[0.36]
LOW	0.01	0.02	0.03***	0.03***	0.02***	0.02	0.01	0.03***	0.03*	0.02***
	[0.34]	[1.09]	[2.71]	[3.60]	[3.75]	[0.76]	[0.51]	[3.03]	[1.97]	[3.36]
# MODELS	−0.93	−0.95**	−0.03	−0.02	0.15	−0.45	−1.13**	0.01	−0.07	0.07
	[−1.21]	[−2.14]	[−0.15]	[−0.15]	[0.75]	[−0.57]	[−2.31]	[0.04]	[−0.43]	[0.32]
ADVERTISING	−0.02	0.04	0.09*	0.05	−0.004	−0.008	0.07	0.03	0.05	0.09
	[−0.39]	[0.78]	[1.84]	[0.65]	[−0.05]	[−0.15]	[1.24]	[0.67]	[0.61]	[0.99]
LnMKTSHARE	1.40	0.25	−0.84	−3.53*	−0.05	0.14	0.12	0.49	−2.82	−2.43
	[1.21]	[0.23]	[−0.72]	[−1.77]	[−0.03]	[0.11]	[0.10]	[0.39]	[−1.18]	[−0.91]
Adj R^2	0.81	0.81	0.76	0.63	0.77	0.82	0.81	0.79	0.71	0.65
	27.10***	25.79***	17.73***	10.22***	20.26***	26.75***	24.87***	19.49***	11.80***	9.69***
N (models)	132	191	206	221	259	125	182	183	176	180

***, **, * = significant at $p < 0.01$, $p < 0.05$ and $p < 0.10$ levels respectively, two tailed tests.

HIGH = highest predicted price of the models offered by the bicycle's brand.

LOW = lowest predicted price of the models offered by the bicycle's brand.

#MODELS = number of models offered in the price segment by the bicycle's brand.

ADVERTISING = number of advertising pages in major bicycling magazines in 1995.

LnMKTSHARE = logarithm of lagged (1994) market share.

the less-than-$500 segment to 0.62 in the $750-to-$1500 segment. The models are significant at the $p < 0.01$ level. Diagnostic tests revealed no problems with heteroskedasticity or multi-collinearity.

The coefficient for HIGH is positive and significant in all segments below the above-$1000 segment. These results support Hypothesis 1, which predicts an association between HIGH and brand equity in the lower-quality segments of the market. The coefficient for LOW is positive and significant in all of the price segments above $500. This result is consistent with Hypothesis 2, which predicts an association between LOW and brand equity in the higher-quality segments of the market.

The #MODELS is negative and significant in the $350-to-$750 segment. ADVERTISING is positive and significant in the $500-to-$1000 segment and insignificant in all other segments. To control for the potential lagged effects of advertising, we ran models using advertising pages from 1994. There were no significant differences in the results. LnMKTSHARE is negative and significant in the $750-to-$1500 segment.

We examined influential observations using guidelines suggested by Belsley, Kuh, and Welsch (1980) and Myers (1990) and found the results to be robust to outliers. Several differences resulted when using unweighted regression models. First, in the $500-to-$1000 segment, LOW is not significant. Second, in the $750-to-$1500 segment HIGH is only marginally significant ($p < .11$) and LnMKTSHARE loses significance. Finally, LnMKTSHARE is positive and significant in the below $500 segment. Note that in some of these segments, two brands account for about one third of the models in the segment. As a result, the un-weighted analysis is strongly influenced by the values of the brand-level variables for these heavily-represented brands.

Table 4, Panel A reports the results of the two-stage regression analysis described in § 3. These results are largely consistent with the single stage results in Table

Table 4 **Results of Two-Stage Analysis.** Results shown are for the second-stage analysis. The dependent variable is the estimated price premium for each brand. T-statistics are shown in brackets.

	Panel A: All bicycles offered by all firms					**Panel B:** Bicycles by firms outsourcing production				
	Below $500	$350 to $750	$500 to $1000	$750 to $1500	over $1000	Below $500	$350 to $750	$500 to $1000	$750 to $1500	over $1000
Intercept	26.98	−7.07	−53.03***	−53.05*	−41.47	17.39	0.55	−35.24**	−43.10**	−53.47*
	[1.48]	[−0.52]	[−2.82]	[−1.87]	[−1.64]	[0.87]	[0.04]	[−2.14]	[−2.11]	[−1.83]
HIGH	0.005***	0.008***	0.01***	0.005	−0.008*	0.004**	0.008***	0.009***	0.007*	−0.004
	[2.75]	[3.29]	[3.54]	[0.95]	[−1.91]	[2.39]	[3.62]	[2.84]	[1.81]	[−0.70]
LOW	−0.02	0.01	0.05***	0.06***	0.02***	−0.01	0.03	0.04***	0.03*	0.01
	[−0.75]	[0.51]	[3.99]	[4.46]	[3.42]	[−0.32]	[1.32]	[2.98]	[1.90]	[1.10]
# MODELS	−2.13*	−0.99	−0.26	−0.14	−0.003	−1.89	−1.32	0.19	0.07	0.02
	[−1.75]	[−1.19]	[−0.48]	[−0.30]	[−0.01]	[−1.49]	[−1.60]	[0.41]	[0.24]	[0.04]
ADVERTISING	−0.06	0.005	0.07	0.04	0.26*	−0.05	−0.02	0.09	0.01	0.31*
	[−0.95]	[0.06]	[0.53]	[0.26]	[1.68]	[−0.83]	[−0.27]	[0.87]	[0.14]	[1.84]
LnMKTSHARE	4.01*	1.31	−0.03	−6.21	−8.94*	2.83	3.44	1.33	−4.83	−9.58*
	[1.92]	[0.57]	[−0.01]	[−1.26]	[−1.98]	[1.23]	[1.45]	[0.41]	[−1.28]	[−1.76]
Adj R^2	0.17	0.20	0.49	0.43	0.21	0.11	0.29	0.37	0.20	0.02
F	2.49*	2.86**	8.56***	7.04***	3.78***	1.83	3.72***	4.91***	2.54*	1.13
M (brands)	37	38	40	41	53	35	35	35	31	33

***, **, * = significant $p < 0.01$, $p < 0.05$ and $p < 0.10$ levels respectively, two tailed tests.

HIGH = highest predicted price of the models offered by the bicycle's brand.

LOW = lowest predicted price of the models offered by the bicycle's brand.

#MODELS = number of models offered in the price segment by the bicycle's brand.

ADVERTISING = number of advertising pages in major bicycling magazines in 1995.

LnMKTSHARE = logarithm of lagged (1994) market share.

3. We note two exceptions. First, HIGH is not significant in the $750-to-$1500 segment and is negative and significant in the over $1000 segment. These exceptions are the result of outliers. The removal of these observations results in a positive and significant HIGH coefficient in the $750-to-$1500 segment and an insignificant coefficient in the over-$1000 segment. Second, we find the result of control variables #MODELS, ADVERTISING and LnMKTSHARE, to be different in the two stage model than in the one stage model. For example, in the over $1000 segment of Table 4, both ADVERTISING and LnMKTSHARE are significant, where as they are not in Table 3.

Competing Hypotheses

The statistical evidence is strongly consistent with both Hypothesis 1 and Hypothesis 2. However, there are several competing hypotheses. Here we consider three competing hypotheses and the factors, which we believe, minimize their plausibility.

Omitted Product Attributes. High-end brands may offer products with tangible attributes that are both valuable to consumers and not captured by our hedonic price model. The presence of such attributes would bias our estimate of brand premium in favor of accepting Hypotheses 1 and 2. We know that some such attributes exist. For example, the IBIS brand offers bicycles featuring brake cable supports die cast in the form of a human fore arm and clenched fist. Our pricing model does not include this attribute. Therefore, if consumers value this brake-support feature, its value will be included within our estimate of IBIS's brand premium, when it should be attributed to a tangible physical attribute. We attended the primary industry trade show (Interbike) for two years and visited many

bicycle retailers. We observe very few unmodeled attributes. The unmodeled attributes we do observe are: differences in graphic design and color schemes of paint, differences in details of cable routing and component supports, and differences in rear suspension schemes for full-suspension models. We consider the paint schemes and mounting details to be relatively minor features, which we do not believe could account for very much of the variation in prices left unexplained by the price model. The suspension designs are more highly varied, and may account for substantial variation in prices for fully suspended models. However, in 1995, relatively few models offered full suspension and there was no consensus as to which suspension design was best. Therefore, we do not view our lack of a more complex model of rear suspension types as a serious threat to the results.

We also note that some tangible features of products are closely related to the concept of brand. For example, the IBIS fist is much like a hood ornament for a car. While it is a tangible attribute, it is also a brand identifier. Many of the unmodeled attributes that we observed at the trade shows fall into this category.

Finally, we note that many different brands source bicycles from the same smaller set of manufacturers. For example, A-Pro and Giant are two large Taiwanese manufacturers who produce bicycles for Barracuda, Fuji, Gary Fisher, Giant, Haro, Marin, Raleigh, Scott, Specialized, Trek, and Univega. As evidenced in Table 1, these bicycles are produced with the same materials and components. Furthermore, these bicycles are produced with approximately the same frame fabrication and finishing technology. In effect, these bicycles differ only in brand and in the features we have modeled. As a result, for many brands we are certain that there are no significant differences among bicycles not captured by the pricing model. While we do know of a few isolated instances of unmodeled attributes, such as the IBIS fist, our observations of the bicycles themselves and our knowledge of the brand-manufacturer relations lead us to conclude that unmodeled attributes are not an overwhelming threat to the validity of our results.

Systematic Differences Among Firms in Elasticity of Supply. High-end firms may have inelastic supply curves due to capacity constraints. When faced with increased demand for their products, these firms would charge price premia rather than increase production volume. These firms would appear to have more brand equity than firms with equal equity that increased production volume instead of raising prices. To explore this competing hypothesis, we performed our analysis on bikes from the subset of firms (n = 53) that outsource frame production. Note that these 53 firms outsource to about a dozen, mostly far-eastern suppliers (e.g., Giant, A-Pro), with many of these firms contracting with the same supplier. Discussions with industry experts revealed that bicycle suppliers experienced excess capacity during 1995, implying that firms that outsource frame production should have had similar, relatively elastic supply curves. These results are presented in Tables 3 and 4, Panels B. The results are similar to those for the entire set of firms reported in the Panels A with the exception of Table 4 where no results are found in the over $1000 segment.

Systematic Manufacturing Cost Bias. High-end brands may have higher manufacturing costs than low-end brands, even for products of equal quality. This situation could arise because there is greater sales volume at the low end of the market, giving low-end brands greater scale economies. In such a competitive situation, it would be rational for the high-end brands to set their prices higher than the low-end brands. True cost data are not available for the brands in our data set. Consistent with the literature on economies of scale, we would expect costs to decline with volume, and would expect diminishing returns to scale. We have attempted, therefore, to control for any cost-driven pricing decisions by including in the brand model the variable LnMKTSHARE. To the extent that this variable does not adequately reflect the cost structures of the brands, our estimate of price premium may include cost-driven pricing decisions, and could bias our results in favor of accepting Hypotheses 1 and 2.

We believe that volume should capture cost differences among the brands. However, we note again that the vast majority of brands source their products from a smaller set of manufacturers. As a result, we expect that differences in direct manufacturing costs will arise primarily from differences in bargaining power among

brands, with the larger brands wielding greater power in negotiating prices than the smaller brands. However, the bicycle manufacturing industry is intensely competitive, and so we do not expect dramatic differences in direct manufacturing costs among the brands. We would expect more substantial differences in indirect costs, including the costs associated with selling, administration, inventory, distribution, and technical support. Differences in these costs, however, should be largely captured by differences in sales volume.

Perhaps the strongest mitigation of the threat of a bias due to differences in manufacturing costs is the analysis of the subset of firms that outsource production. These firms are likely to have very similar cost structures (as noted in point 2 above). The results of this analysis are shown in the Panels B of Tables 3 and 4, and are largely consistent with those for the entire data set.

5. Experimental Evidence

In our conceptual model of the influence of the structure of the product family on the consumer decision process (Figure 1), we assert that the vertical extent of the line will influence the value of the brand both by enhancing the prestige of the brand and by creating associations regarding difficult-to-observe attributes. While the statistical analysis is strongly supportive of the hypotheses, several weaknesses in measurement, data availability, and methodology threaten the internal validity of the study. Furthermore, the statistical evidence provides little insight into how consumers process cues from the vertical extent of the line. These problems can never be eliminated entirely, and so we would like to triangulate on the results using some other evidence. To bolster our findings, we conducted an experiment measuring the preference of consumers for an identical bicycle offered by two brands with differing vertical product line extent. While the experiment offers little external validity, it does support the findings of our statistical analysis and offers insight into the consumer behavior that gives rise to differences in brand equity.[8]

[8]The authors are grateful to Richard Staelin and an associate editor for recommending the use of this experiment to bolster the study results.

Eighty-four subjects from a convenience sample (two classes at The Wharton School) were presented with "catalogs" of two fictitious mountain bike brands: a high-end brand and a low-end brand. (Fortunately, students are likely targets for mountain bikes.) The catalogs each displayed photographs of six different bicycles with their associated specifications and were reproduced in color on 11 inch by 17 inch sheets. The bicycles in each catalog were a mix chosen from the product lines of Giant, Trek, and ProFlex (chosen because they used very similar photographs in their brochures), but the photographs were retouched to remove brand identifiers. Bicycles in the high-end brand ranged in price from \$759 to \$2,799. Bicycles in the low-end brand ranged in price from \$199 to \$959. To control for presentation, we randomized the brand names ("Timber" and "Frontier") and the catalog graphic design ("A" and "B"). For half of the subjects, Frontier was the high-end brand with catalog design A, and for the other half, Timber was the high-end brand with catalog design B.

On a written response form, respondents were asked for their impressions of each brand and then asked the following question:[9]

> "Timber and Frontier each plan to introduce a new model of mountain bike (not shown) priced at about \$800. Both models will have the same basic features: frame made from Cro-Moly double-butted steel tubing, Shimano Deore LX components (e.g., hubs, derailleurs, cranks, etc.), and Manitou 4 front suspension fork. If you had to choose between the bike offered by Timber and that offered by Frontier, which would you choose, assuming that the prices of the two new bikes were the same?"

They were then asked how much extra they would be willing to pay for their choice (<\$5, \$5–10, \$11–20, \$21–50, >\$50) and why they made the choice they did. We also gauged the respondents' interest in bicycles as a consumer category by asking if they owned a mountain bicycle and if they were planning on purchasing a mountain bicycle within the next five years.

Note that in order to manage the scope of the experiment, the survey design combines tests of Hypotheses 1 and 2. In other words, if a respondent prefers the high-end brand, we cannot determine if the choice

[9]A copy of the catalogs and survey is available from the authors.

is due to a higher quality low-end model or a higher quality high-end model.

Sixty-three percent of the respondents selected the high-end brand. At 63 percent, we reject the null hypotheses that respondents prefer the brands equally ($Z = 2.40$, $p = 0.016$). Twenty-seven percent of the respondents indicated that they owned mountain bicycles. Of those that owned mountain bicycles, 70 percent preferred the high-end brand ($Z = 1.88$, $p = 0.060$).

We coded a respondent as perceiving a quality difference between product lines if he or she observed that a brand was "high end, high priced, high tech, high performance, high quality, low end, low tech, low quality, or low priced." Eight-four percent of the respondents mentioned these phrases when recording impressions of the brands. Among those that perceived a quality difference between brands, 67 percent chose the high-end brand ($Z = 2.77$, $p = 0.006$).

Those that chose the high-end brand were willing to pay \$21–50 (median category) more for their choice, while those that chose the low-end brand were willing to pay \$11–20 (median category) more. This corresponds to about a five percent price premium for those choosing the high-end brand.

We noted two dominant reasons for preferring either the high-end or low-end brand: quality and value (i.e., quality per dollar). Of those choosing the high-end brand, 75 percent chose the brand because they perceived the quality of the brand to be superior. In fact, several respondents literally wrote that the quality of high-end products would probably "trickle down" to the lower end of the product line. Interestingly, of those choosing the low-end brand, 52 percent felt the low-end brand offered more value, even after we specified that the bikes had the "same basic features" and were "the same price." Only 16 percent felt the low-end brand was of higher quality. It appears that for a substantial segment of the market, the presence of high-end models makes consumers somewhat suspicious that they are being "ripped off" when they buy the low-end models. Other reasons for choosing a particular brand included preference for the image portrayed by the brand ("it's just me") or preference for some attribute of the catalog design.

While we cannot independently distinguish between the effect of low-end and high-end models, the results of the experiment corroborate the general hypothesis that brand equity is affected by the vertical extent of the product line and that the influence is consistent with Hypotheses 1 and 2. Furthermore, we find support for the underlying theory that the perceived quality of higher-end models will affect how other models in the product line are perceived. However, we were intrigued to learn that some consumers seem to be somewhat suspicious of brands. We speculate that for some consumers (i.e., "value shoppers") and perhaps for some product categories, attempting to elevate brand equity with high-end models in the product line may be ineffectual, or even counterproductive.

6. Discussion and Implications

We hypothesized that, for the lower-quality products in the market, brand equity increases with the quality of the lowest-quality model in the brand's product line. We also hypothesized that, for the higher-quality products in the market, brand equity increases with the quality of the highest-quality model in the product line. The statistical evidence from the mountain bike industry strongly supports an association between the quality extent of the product line and brand price premium. Firms with low-quality products in their lines tend to have lower brand premiums. We see this effect principally for the above-\$500 products. Firms with high-quality products in their lines tend to have higher brand premiums. We see this effect principally in the segments below-\$1000. The experimental results also support these hypotheses, although our experimental design did not attempt to distinguish between the role of high-quality products and low-quality products.

These results also have substantial face validity. We presented the findings of the research to a group of approximately 30 bicycle industry executives at the Interbike trade show in the Fall of 1996, including marketing managers, general managers, and chief executives of a dozen of the leading bicycle brands. There was widespread agreement with our general findings, with several managers commenting that our results were consistent with their experiences. In one case, a manager from a brand with "top-ten" market share

showed us how his booth at the Interbike trade show was used in a fashion consistent with our results. The booth showcased an extremely expensive model, mounted on a rotating platform, and illuminated with spot lights. When asked how many of these models he sells, the manager responded, "we don't sell any of these—maybe a few hundred a year—we sell those over there," pointing to a set of low- and mid-quality models off in the corner of the booth. He asserted that the high-end model is justified by its ability to enhance the brand's overall equity. We received similar comments from managers of other brands.

Considering the statistical evidence, the experimental evidence, and the face validity, there is support for the equilibrium hypotheses associating brand equity (reflected in price premium) with vertical product line extent. These equilibrium hypotheses imply change hypotheses with causal implications (i.e., a change in the vertical extent of a product line will result in a change in brand equity, or perhaps that a change in brand equity will result in a change in the product line). However, the change hypotheses raise five issues: (1) does product line extent cause brand equity, or does equity cause product line extent? (2) is product line quality determined only by the lowest- and highest-quality products? (3) what constitutes a product offering? (4) time dynamics and path dependence, and (5) trading off costs and benefits.

Does Product Line Extent Cause Brand Equity, or Does Brand Equity Cause Product Line Extent?

Assume that the statistical evidence is valid: brands with high-end models and without low-end models tend to have high brand equity. Can we conclude that the vertical structure of the product line *causes* the brand equity? Or, could it be that firms with strong brand equity offer high-end products and avoid low-end products. For our results to be derived by this reverse causality, it would require that firms with high brand equity would be less likely to extend downward than firms with low brand equity. We believe that this behavior is still consistent with our theory. Such behavior raises the question of why a firm with high brand equity would avoid the low end of the market. If there were no risk that a lower-quality product offering would result in diminished brand equity, and given downward sloping demand curves, we believe firms with high brand equity would offer low-end products at least as often as high-end products. For example, if Mont Blanc would not lose brand equity by going down market, offering an inexpensive pen would be highly desirable. If, on the other hand, firms with high brand equity do not offer low-end products because this action would dilute brand equity, then this behavior is consistent with our theory. That is, we do not intend to make a strong distinction between (a) avoiding the low end of the market in order to avoid diminishing brand equity and (b) avoiding the low end of the market in order to create brand equity. We acknowledge that it is possible that managers act according to our theory because they believe it, but that in fact the theory is false. However, we believe that this possibility is somewhat remote because in a competitive market, systematic irrational behavior is not likely to persist.

Is Product Line Quality Determined Only by the Lowest- and Highest-quality Products?

The theory of brand equity that we outline in the introduction argues that the impression of the vertical extent of the product line has an impact on a consumer's beliefs about a brand. We argued that the highest- and lowest-quality products are key determinants of the vertical structure of the product line. However, other properties of the product line may be important in creating an impression of a brand. For example, consider two brands, each with 10 models and each with the same lowest- and highest-quality level. The brand with the remaining 8 products concentrated near the upper quality level should have greater brand equity than the brand with the remaining 8 products concentrated near the lower quality level. The mean or median quality level of the product line might capture such differences in the distribution of the models. We do not take the strong position that the only features of a product line that contribute to the brand equity effect are the highest- and lowest-quality model. Rather, we note that any few metrics of the structure of the product line will fail to capture some relevant characteristics. HIGH and LOW appear to be useful metrics and seem to be consistent with a theory of how consumers develop impressions of

brands, but other characteristics of the structure of the product line may be important.

What Constitutes a Product Offering?

Our results support the hypothesis that the presence of high- or low-quality models in a product line is associated with brand equity, but what exactly is required to achieve this effect? Does merely listing a single high-end product in a catalog create an association with brand equity, or does a larger set of activities associated with offering high- or low-quality models give rise to the association?

Because brand equity is ultimately expressed in the marketplace, we posit that the marketplace—dealers and/or consumers—must be aware of the structure of the product line for the effect to be active. This awareness probably requires more than a catalog entry alone, but probably does not require that sales of the models at the high and low extremes of the product line be large. Catalogs, brochures, advertising, displays of the brand's models at trade shows, and direct communication from the sales force create dealer awareness of the extent of product line. Consumer awareness of the extent of product line is created by the presence of products in the use environment (e.g., seeing bikes on the trail), advertising, media coverage, and retail displays. If the marketplace is not aware of the extent of the product line, then this extent is unlikely to be associated with brand equity. We expect that the brand's activities to communicate the extent of its line to the marketplace will modulate the effect of this extent on brand equity.

Brand equity may also be influenced by the market's perception of where the brand focuses its marketing efforts. For a given product line, we might expect that a firm that chooses high-end distribution channels and that advertises in media targeting the high end would garner more brand equity in the middle of the market than a firm focusing its marketing resources on mass channels and mass media. That is, part of the exclusiveness and prestige of the brand may be associated with its marketing emphasis at the high end. However, a dilemma presents itself in this situation. While the impression of a focus on the high end requires a commitment of marketing resources to the high end of the market, the value of this impression accrues in the middle of the market. So a firm may have to simultaneously create the impression of focusing on the high end, while communicating this impression strongly to the middle of the market.

Time Dynamics and Path Dependence

We do not believe that brand equity increases or decreases instantaneously in response to changes in the structure of the product line. We would expect that firms that have enjoyed consistently high brand equity and who concentrate their models at the higher end of the market could reap this equity over some time period after they begin offering lower-quality products. Conversely, we would expect that low-end brands would not garner enhanced brand equity for some time after they extend their product lines up market.

For example, our analysis indicates that Klein, a high-end brand, is an outlier in the brand-level models, commanding more premium than the HIGH and LOW for Klein would indicate. Further investigation reveals that Klein introduced two new models in 1995 at price points of $1200 and $1400, approximately $1000 less than the least expensive model in 1994. Our estimates of Klein's premium are consistent with the product line extent of the previous year. There are at least two possible interpretations of this observation. First, brand equity may decrease gradually with time, and Klein is "spending" the equity it had accrued previously. Second, Klein may have made pricing errors in 1995, adopting prices that were consistent with 1994 brand equity, but which were too high, given the structure of the product line in 1995.

We also suspect that brands moving their product lines down market may enjoy higher brand equity than brands moving their product lines up market, even if both brands ultimately arrive at product lines with the same extent. If this is true, then brand equity is path dependent, which implies that managers may wish to launch new brands "higher" than they ultimately expect to settle, rather than "lower." Of course, competitive dynamics may also be important. As a brand extends its line, this may precipitate a competitive response (Day and Reibstein 1997). Both the extension of the line and the competitive offerings would have an impact on the originating brand's equity.

Trading Off Costs and Benefits

Firms add products to existing lines under the premise that the new items' profit contribution outweighs the cannibalized sales of other products in the product line and the fixed costs of launching the new items. Cannibalization is generally considered to be highest the closer the new item is positioned to other products in the product line. The findings of this study imply that the costs or benefits of adding a new item may also include an impact on brand equity. Unlike the cannibalization effect, where the greatest impact is on the nearest neighbors, the brand-equity effect can impact the entire product line. Furthermore, the equity impact can have both a positive and negative effect on the entire product line.

According to the strong interpretation of our results, a firm would choose to offer only high-quality products under a brand if its objective were to maximize brand equity. However, maximizing brand equity is rarely the sole objective. Brand equity is a means to achieving higher profitability, which may arise from higher margins, higher market share, or decreased costs of launching new products. In most markets, there is a downward sloping demand curve, so the industry sales volume is much higher in the lower-quality segments than in the higher-quality segments. This is why high-end brands extend their product lines down market (e.g., Klein in bicycles, Mercedes in automobiles). This type of market structure gives rise to a cost-benefit trade-off. For a brand considering extending its product line up market, the trade-off is between the investment and support costs associated with the new models and the increase in profits that may arise from enhanced brand equity across the rest of the product line (in addition to any profits that may actually be generated by selling the premium models). For a brand considering extending its product line down market, the trade-off is between the increased profit contribution from the presumably large new sales volume in the lower-quality segment and the lost profits due to diminished brand equity across the rest of the product line (in addition to any investment costs required to introduce the new models).

The trade-off between costs and benefits of a product line extension in this context can be expressed analytically as follows. Let Q_0, p_0, and c_0 be the sales quantity, average unit price, and average unit cost of the old product line. Let Q_0', p_0', and c_0', be the corresponding values for the old products after an extension. Let Q_n, p_n, and c_n be the corresponding values for the new product. Let F_n be the fixed costs of performing the extension. The old profits can be expressed as

$$Q_0(p_0 - c_0).$$

The new profits can be expressed as

$$Q_n(p_n - c_n) + Q_0'(p_0' - c_0') - F_n.$$

The condition for a profitable line extension can therefore be expressed as

$$Q_n(p_n - c_n) + Q_0'(p_0' - c_0') - F_n > Q_0(p_0 - c_0).$$

If we accept the strong interpretation of the findings of our research, then when extending a product line up market, we expect Q_0' to be greater than Q_0 and p_0' to be greater than p_0 increasing the profitability of existing models. However, the line extension will require investment, F_n and the profit contribution from the new models, $Q_n(p_n - c_n)$, may even be negative if Q_n is very small, because unit costs are likely to be high for these models.

When extending a product line down market, we expect Q_0' to be less than Q_0 and p_0' to be less than p_0, and the line extension will require investment, F_n. However, the profit contribution from the new models, $Q_n(p_n - c_n)$, may be large enough to justify this action.

The cost-benefit analysis is further complicated by the option of using a new brand to introduce models at the high end or low end of the market. This practice is common in other industries, and has begun to be adopted in the bicycle industry. A firm wishing to enhance its total brand equity may choose to both extend the models of its existing brand(s) up market, while also introducing a new brand offering only high-end models. This is the strategy we observe with Trek (Frothingham 1995). Trek has acquired and invested substantially in several premium brands—Gary Fisher, LeMond, Bontrager, and Klein—but has carefully managed their identities; it is not generally known in the marketplace that Trek owns these brands. We also observe Diamondback pursuing this strategy. In a recent article in *Bicycle Retailer and Industry News*, a senior executive of Diamondback discussed a new brand

strategy in which it will introduce a new high-end brand, *DBR*. Noting that the Diamondback name will be absent from the DBR bikes, he commented, "it will be like Camry and Lexus" (Frothingham 1997).

An alternative to extending an existing brand down market is to preserve the structure of the existing product line, while using a new brand for the low-end models, perhaps with its own premium models to enhance its brand equity. This strategy was first adopted in the bicycle industry in 1996. Specialized introduced a new brand, Full Force, aimed at the low-quality segment of the market and intended to be sold through mass merchandisers. However, Specialized's initial strategy of labeling the brand "Full Force by Specialized" backfired due to an extreme negative reaction from dealers concerned that this action would tarnish the equity of the Specialized product sold through the traditional bicycle retail channel. The company responded by downplaying the relationship between the two brands (Frothingham 1996).

The wisdom of the strategy of using a new brand to offer products at the low or high end hinges on the trade-off between the costs of launching an entirely new brand and the benefits that accrue from preserving the separate identities of the new brand and the existing brands. In the Future Work subsection of the paper we discuss decision support tools for evaluating such strategies.

7. Concluding Remarks

Generalizing the Results

Our analysis is of a single product category in a single industry. An important question is the degree to which our results apply to other situations. Our theory suggests that these results apply in categories where vertical product line extent is present, where there are difficult-to-observe attributes (e.g., wine and bicycles), and when the product category is associated with prestige (e.g., cars and watches).

The mountain bike category is relatively young, having emerged within the last 10–15 years. To date, there has been little segmentation within the category other than by performance quality, and therefore by price. Because of our focus on the role of the vertical extent of the product line, we would expect our results to generalize primarily to categories in which a clear ordering of products by quality is possible. Packaged goods, for example, are rarely differentiated vertically within a brand, but durables are often arranged within a brand according to good-better-best logic.

The experimental results also suggest that our findings may not apply in markets or segments of markets were consumers are extremely value conscious. In such markets, consumers may be suspicious of brands, fearing that high-end brands may be overcharging for their low-end products.

Future Work

There are several opportunities for future work. First, the dynamics and path dependence issues raised in the discussion need to be tested empirically. The key research questions would be: What are typical delays in gaining and losing brand equity in response to managerial action? Does a high-end brand moving down market achieve higher brand equity than a low-end brand moving up market (assuming the same eventual product line extent)?

Second, the basic trade-offs raised in the discussion need to be explored analytically. This analysis may give rise to some conceptual insights, but would also form the basis of a decision support tool. This tool would allow a brand strategist to compare the expected profits of different product line strategies, including the use of multiple brands by the same firm.

Third, practical application of such a decision support tool requires at least two types of information, in addition to the influence of product line extent on brand equity: (1) the sales volume that could be expected for a given product portfolio, and (2) the cost of introducing new models and brands. Further research to gather detailed sales volume and cost information is necessary to determine the value of such a decision support tool.

Summary

• This paper addresses the question of how vertical product line extent is associated with brand equity. Does the presence of "premium" or high-quality products in a product line enhance brand equity? Conversely, does the presence of "economy" or low-quality products in a product line diminish brand equity?

• We address the research questions empirically through an analysis of the U.S. mountain bicycle industry. We use an estimate of price premium as a metric for brand equity. We then test several hypotheses related to the influence of product line extent on brand equity.

• The analysis reveals that brand price premium is significantly positively correlated with the quality of the lowest-quality model in the product line for the lower quality segments of the market; and that for the upper quality segments of the market, brand price premium is also significantly positively correlated with the quality of the highest-quality model in the product line.

• The results of the analysis are supported by the results of an experiment in which 63 percent of the subjects preferred a product offered by a high-end brand to the equivalent product offered by a low-end competitor.

• These results imply that managers wishing only to maximize the equity of their brands would offer only high-quality products and avoid offering low-quality products. However, this result must be moderated by the overall objective of maximizing profits. Maximizing profits is likely to involve a tradeoff between preserving high brand equity (and therefore high margins) and pursuing the volume typically located in the lower end of the market.

• One of the most significant implications of this research is that product line managers need to be mindful not just of the incremental cannibalization or stimulation of sales of products that are immediate neighbors of an extension to the product line, but also the effect of such an extension on the brand equity in

Appendix A Relation Between and Bicycle Attributes for the Below-$500 Price Segment (Dependent Variable Is LnMSRP)

		Coefficient	T-Statistic
Intercept		5.59***	45.92
Frame Materials	Chromoly Steel	0.05*	1.68
	Butted Chromoly Steel	0.18***	4.69
	Aluminum	0.30***	6.24
Front Suspension	Other	0.09*	1.77
	Rock Shox Quadra	0.10**	2.45
	SR Duo Track	0.21***	4.73
	RST	0.35***	3.68
Component Groups	Shimano Altus	0.22***	5.57
	Shimano Acera	0.33***	7.94
	Shimano Alivio	0.44***	9.93
	Shimano Deore STX	0.58***	10.66
	Shimano Deore STX-RC	0.98***	5.89
	Unspecified	0.09	1.35
High Performance Accessories		−0.18	−1.39
Colors		0.01	0.36
Sizes		−0.03***	−3.69
Assembled in U.S.A.		−0.01	−0.24
HIGH		0.00005***	3.53
LOW		0.00008	0.34
#MODELS	−0.009	−1.21	
ADVERTISING		−0.0002	−0.39
LnMKTSHARE		0.014	1.21
Adj R^2		0.81	
F		27.07***	
N (bicycles)		132	

*** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.10$, two-tailed tests.

other, possibly quite different, parts of the product line.[10]

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