MARKETING SCIENCE
Vol. 23, No. 1, Winter 2004, pp. 134–145
ISSN 0732-2399 | EISSN 1526-548X | 04 | 2301 | 0134

DOI 10.1287/mksc.1030.0044
© 2004 INFORMS

Consumer Learning, Brand Loyalty, and Competition

J. Miguel Villas-Boas
Haas School of Business, University of California at Berkeley, Berkeley, California 94720-1900, villas@haas.berkeley.edu

In several markets, consumers can gain further information regarding how well a product fits their preferences only by experiencing it after purchase. This could then generate loyalty for the products tried first. This paper considers a model in which consumers learn in the first period about the product they buy and then make choices in the second period about the competing products, given what they learned in the first period. The paper finds that if the distribution of valuations for each product is negatively (positively) skewed, a firm benefits (is hurt) in the future from having a greater market share today—the brand loyalty characteristic. With negative skewness, two effects are identified: On one hand, marginal forward-looking consumers are less price sensitive than myopic consumers, and this is a force toward higher prices. On the other hand, forward-looking firms realize that they gain in the future from having a higher market share in the current period and compete more aggressively in prices. For similar discount factors for consumers and firms, the latter effect dominates. The paper also characterizes the importance of consumer learning effects on the market outcome.

Key words: consumer learning; brand loyalty; dynamic competition; experience goods; lifetime value of customers; forward-looking consumers; forward-looking firms
History: This paper was received December 31, 2001, and was with the author 8 months for 3 revisions; processed by Sridhar Moorthy.

1. Introduction

Firms in the dot-com industry justified their aggressive pricing under the theory that profits would be obtained later because of potential gains in market share through consumer learning about the Web sites they tried. One piece of conventional wisdom was that firms were "investing money, not 'losing' money" ("Jungle Fever on the Web," *Time*, Dec. 7, 1998, p. 63). In the end, investors were not convinced, either because the competition for the future profits turned out to be too aggressive or because they believed that the experiences the Web sites were providing did not create enough positive effects in the future. Observations on free product trial or cheap introductory offers for new products can also be seen as examples of the same type of forces at work. In several markets, consumers can gain further information regarding how well a product fits their preferences only by experiencing it after purchase. For example, a consumer might learn how much he appreciates a restaurant only after trying it, or how long a piece of clothing lasts after wearing it for some time. Similarly, a consumer might learn how much a certain bank meets his needs only after going through several transactions at that bank.[1] Furthermore, in several of these markets an important part of the different valuations for the different products is idiosyncratic to each consumer; that is, consumers have different relative valuations (after experiencing them) of the available products. In addition, firms may not have any significant private information regarding which consumers value their own product more or less.[2]

In such markets, consumers—when purchasing a product—learn about its valuation to them. Then, in future periods, there is an informational advantage in the sense that a consumer knows more about the products the consumer has tried than about the

[1] Demonstration activities by the firm (Heiman and Muller 1996) might not be enough to reduce this uncertainty about the product fit. Similarly, in some markets consumer search, or prepurchase inspection, may be costly (e.g., Kuksov 2003), and not be enough to evaluate product fit.

[2] Other possible important dimensions not explored here are that there may be some common effects across consumers on how they value different brands, and some possible private information of the firms regarding these common effects, which may lead to signaling activities (see, for example, Moorthy and Srinivasan 1995, Desai 2000) or other strategic behavior (see, for example, Kalra et al. 1998).

products he has not tried. It is then argued that this informational advantage may benefit the products that were bought first; that is, consumers exhibit brand loyalty. The idea is that after trying a product and understanding its valuation, a consumer may prefer the product whose valuation he knows better, rather than the product whose valuation remains mostly uncertain. In this sense, firms may compete fiercely for consumers to try their products first. Similarly, Bain (1956) argued that this informational advantage may work as a barrier to entry because consumers tend to be loyal to the pioneering brands. As noted in Wernerfelt (1991): "You know the quality of your current brand, so why take a risk on changing?"

In numerous studies since Guadagni and Little (1983),[3] researchers have found that consumers in panel data seem to show stochastic loyalty to the products they purchased most recently. It is often argued that this effect is a result of the consumers having less uncertainty about the value of the products they bought most recently. Danaher et al. (2003) argue that this stochastic loyalty seems to be stronger for online purchases. Note also that these studies do not consider the firms' strategic behavior, in particular the role of brand loyalty on the dynamic optimal pricing by the firms. This paper looks at those firms' strategic decision-making problem with a well-developed explanation for brand loyalty.

This paper can then be seen as formalizing the process by which this information about the products previously bought enters into the consumers' choices and as examining the competitive effects of these informational advantages on firm decision making. This involves a careful consideration of forward-looking behavior of both consumers and firms and the interaction among all these forward-looking market players, establishing an explanation for how firms create and exploit brand loyalty.

When one consumer tries a product, he may also find it to have a poor valuation, and therefore may choose to buy a competitor's product, even though its valuation may be more uncertain. In fact, whether a firm ends up being better or worse off from having greater initial demand turns out to depend on the skewness of the prior distribution over valuations, as shown below. A firm is in a better (worse) position in the future for having a greater initial demand, greater brand loyalty, if the distribution of valuations for each product is negatively (positively) skewed; that is, if there is a greater mass of valuations above (below) the mean. The intuition for this result is that with a greater mass of valuations above the mean when trying a product, there is a greater probability that that product's valuation is above the mean valuation than below. That is, consumers are concerned about trying another product when their expected outcome of the new product is lower than what they already have, which happens if very poor draws are possible.

With a negatively skewed distribution of valuations, One can then show that firms compete more aggressively in the first period than in the second period. Several interesting effects are uncovered. The revelation of different valuations in the first period alters the differentiation in the market and generates softer competition in the second period. In the first period, two conflicting effects are present with respect to the distribution skewness: On one hand, marginal forward-looking consumers realize that by purchasing a product in the first period they will be charged a higher expected price in the second period, which results in reduced price sensitivity and higher market prices in the first period (in comparison to the case with no dynamic effects). On the other hand, forward-looking firms realize that they gain in the second period from having a higher market share in the first period, and compete more aggressively in prices. The former effect increases with consumer patience, while the latter increases with firm patience. With similar discount factors for consumers and firms, the latter effect dominates because the second-period profits depend in large part on the first-period market shares. Comparative *statics* with respect to the importance of consumer learning and to the skewness of the distribution of valuations are also obtained.

The markets that one should think of as examples for the results in this paper are those in which there is a sufficiently large amount of preference heterogeneity among consumers regarding the product attributes about which they learn through consumption. That is, consumers can determine how much they value a product only through consumption, and these valuations are sufficiently heterogeneous across the population (horizontal differentiation is important). For example, consumers know how much they value a restaurant only by trying it, and different consumers value differently various restaurants. Another example is that consumers realize how much they appreciate a certain automobile after using it for a few months, but different consumers will have different valuations for the same automobile. Other examples where this fit between the product and the consumer can be relatively important regarding attributes that are learned only through consumption are banking services, newspaper or magazine subscriptions, and

[3] See also, for example, Lattin (1987), Vilcassim and Jain (1991), Bucklin and Lattin (1991), Krishnamurthi and Raj (1991), Pedrick and Zufryden (1991), Papatla and Krishnamurthi (1992), Fader and Lattin (1993), Roy et al. (1996), and Seetharaman et al. (1999).

groceries. An alternative interpretation of the results in this paper is that the learned attribute is like quality, with quality production being stochastic so that different consumers experience different quality levels.

The results above suggest that a firm operating in such a market should price more aggressively (lower prices) to attract more consumers who are likely to stay with the firm in the future. The benefit of cutting prices is greater if the differentiation induced by learning is greater and if the distribution of valuations is more negatively skewed. However, the firm managers also have to be aware that in such a market consumers are less sensitive to price cuts. This is both because the consumers understand that they are likely to buy this product in the future, and therefore they will care more about the search attribute, and because the marginal consumers foresee higher prices from shifting demand. In such a market, a firm with a large market share in the previous period may want to raise its price and take advantage of the large proportion of consumers who have tried its product. The results can also be seen as presenting factors influencing the lifetime value of customers in these markets. The lifetime value of a marginal customer increases in both the negative skewness of the distribution of valuations and the differentiation induced by consumption. That is, attracting a new consumer is more valuable in markets with greater negative skewness and where the attributes being learned through trial are more important. It could be, for example, that firms in the dot-com industry believed in this negative skewness and/or importance of the learned attributes, but in the end these features were not very significant in the market.

Related to this paper is a literature on consumer learning affecting the market structure. Following Bain (1956), it has been argued that informational differentiation is a barrier to potential entrants (which is translated in this paper to a potential advantage of having a greater initial market share).[4] Without assuming that competing firms have any private information, Bergemann and Välimäki (1996) look at the case of homogeneous consumers where all firms are able to observe the results of the consumers' experiences and focus on the consumer experimentation problem. In contrast, in this paper I look at heterogeneous consumers (also without private information by the firms) but do not consider the consumer experimentation issues by looking at a two-period model. The intuitions discussed here are also present in extensions to a multiperiod model. Other effects may also be uncovered in such extensions.

This paper is also quite related to the literature on competition with brand loyalty or with switching costs, where firms gain in the future from having a higher market share today because consumers have a greater preference for the products they buy first (Wernerfelt 1991, Beggs and Klemperer 1992). In fact, this paper can be seen as endogenizing one central explanation for brand loyalty or switching costs, "the uncertainty about the quality of untested brands" (Klemperer 1995). Endogenizing this explanation is important for several reasons. First, it is not clear what is measured by the brand loyalty or switching-cost parameter in a market with consumer learning. Is that parameter measuring the skewness of the distribution of valuations, the importance of the attributes that are learned, or how forward looking consumers are, or is it a nonobvious combination of these three effects? Second, by having the model fully specified, one is able to completely determine the role played by each of the primitive parameters in the consumer learning framework. For example, one can show that the skewness of the prior distribution of valuations plays a crucial role in whether the market behaves as if there is brand loyalty or switching costs. Also interestingly, the consumers gaining more information about the products they try changes the level of differentiation between the products in the market, which does not have a direct equivalent in a brand loyalty or switching-costs model. The consumers who have a bad impression of the product they try first always go on to try the competitor's product, also unlike a brand loyalty or switching-costs model. Forward-looking consumers also realize that their purchases today may influence the prices in the future and become less price sensitive. Another way to endogenize the switching costs is to consider firms' actions that directly create those switching costs. As an example of this, Caminal and Matutes (1990) and Kim et al. (2001) consider the case where switching costs arise endogenously through the actions of the firms, in particular through loyalty programs.

The rest of the paper is organized as follows. The next section presents the model. Section 3 obtains the result that the direction of the dynamic effects depends on the skewness of the prior distribution of valuations. Section 4 derives the main results, and §5 concludes. Proofs are presented in the appendix.

[4] See also Schmalensee (1982). Golder and Tellis (1993) and Kalyanaram and Urban (1992) discuss several studies that provide some empirical support to this argument. Neelamiegham and Jain (1999) empirically investigate the case of choice and postchoice behavior in the movie industry as an example of an experience good. Mehta et al. (2003) present evidence that good consumption experiences with one product may lead consumers to put that product in their consideration set, which may lead to more likely future purchases. See also, for example, Akcura et al. (2003) on consumer learning through product consumption.

2. The Model

Two firms, A and B, produce (at zero marginal cost) nondurable goods A and B, respectively, in each of two periods. There is a continuum of consumers with mass normalized to one. In each period, each consumer can use one unit of product A, or one unit of product B, or neither. No consumer has any additional gain from using more than one unit from either brand in each period. Each consumer's preferences are characterized by the triple (μ_A, μ_B, x), which is fixed through time. The three elements of the triple are independent in the population. The elements μ_A and μ_B measure the experience-related wealth-equivalent gross benefits received from products A and B, respectively. The consumer only learns μ_i for product i after trying (and buying) product i. The marginal prior cumulative distribution function for μ_i is $F(\mu_i)$ for $i = A, B$ for all consumers, and the density is represented by $f(\mu_i)$.[5] The support of μ_i is $[\underline{\mu}, \bar{\mu}]$. The function $F(\mu_i)$ is smooth and continuous for $\mu_i \in (\underline{\mu}, \bar{\mu})$.

The element x is known by each consumer before purchasing any product and represents a preference between products A and B. This is related to the characteristics of a product that can be inspected before purchase. The distribution of x is uniform on [0, 1], where x can represent the distance from product A and $1 - x$ the distance from product B. The wealth-equivalent net benefit of buying product A in one period is defined by $U(\mu_A, x) = \mu_A - \tau x - p^A$. The net benefit of buying product B is defined by $U(\mu_B, x) = \mu_B - \tau(1 - x) - p^B$. The parameter τ can be seen as representing a per-unit cost of "traveling" to the product being purchased. The variables p^A and p^B are the prices charged by Firms A and B, respectively.

The relative size of $\bar{\mu} - \underline{\mu}$ with respect to τ helps to determine the relative importance of consumer learning of the product in the total consumer valuation in relation to the product characteristics that can be inspected before purchase. If τ is small in comparison to $\bar{\mu} - \underline{\mu}$, the most important part of the consumer valuation of a product has to do with what is learned when trying it. Throughout the paper, it is assumed that τ is sufficiently small (or $\underline{\mu}$ small and $\bar{\mu}$ large) so that for all x, if a consumer has a very poor experience with a product, he chooses to try the other product. Similarly, if a consumer has a very good experience with a product, he chooses to purchase that product in the next period. The consumers are assumed to be risk neutral with respect to their wealth-equivalent net benefit of buying either brand. The expected value of the gross benefit of either product, μ_A or μ_B, is assumed to be high enough that in the market outcome all consumers purchase one of the products in each period.

Because this paper considers only two periods (this could also be seen as consumers completely changing tastes after two periods), there is no role for experimentation—that is, for trying different products to choose in the future the product that provides the best fit. However, the current structure still captures several important aspects of markets with experience goods. First, after experiencing a good fit, consumers find it too costly to experiment further. Second, because tastes and products being offered change through time, any possible gains from experimentation can be greatly diminished.[6] The lifetime net benefit of a consumer is the discounted sum of the net benefits with discount factor δ_C, with $0 \leq \delta_C < 1$.

In the second period, and after having tried product A in the previous period (having tried product B is the symmetric case), the consumer compares the net benefit of purchasing product A, $\mu_A - \tau x - p^A$, with the expected net benefit of purchasing product B, which is $E\mu_B - \tau(1 - x) - p^B$, where E is the expected value operator. Learning μ_i of the product being purchased in the previous period generates another dimension of differentiation between products. Indifferent consumers are characterized by $\mu_A = E\mu_B - \tau(1 - 2x) + p^A - p^B$, as can be seen in Figure 1. Having pairs (μ_A, x) above the line yields choosing product A in the second period, while having pairs below the line yields choosing product B. One result used in the figure is that if one consumer of type x chose product A in his first period in the market, then any consumer of type $\hat{x} < x$ also chose product A in that period. This is because in the first period consumers are identical in all aspects except in location, and they care more about their first-period net utility than that of the second period.[7] In each period t, firms simultaneously choose the prices to be charged, p_t^A and p_t^B. Firms want to maximize the expected discounted value of their profits, using a discount factor δ_F, with $0 \leq \delta_F < 1$. The discount factors δ_C and δ_F are considered distinct in order to be able to study the role of each of them in the market outcome. The case of $\delta_C = \delta_F$ is immediate from the results below.

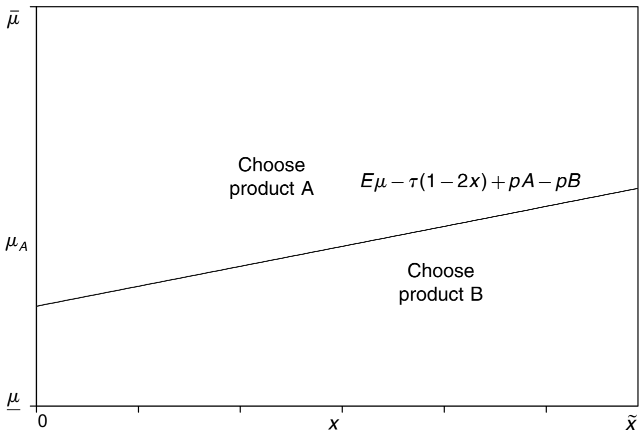
For possible benchmarks, consider the case where products (or tastes) change completely from period to period and the case where consumers are fully

[5] The assumption of common priors for all consumers is taken for simplicity but may not hold in several markets. In fact, in this model it generates a greater differentiation between the products after rather than prior to the consumption of one of the products. The idea that the degree of differentiation changes with consumer learning is robust; the idea that differentiation increases with consumer learning depends critically on the common-priors assumption.

[6] See Iyer and Soberman (2000) for the case, without experimentation, where product attributes change through time.

[7] This result is shown in the appendix.

Figure 1 **Choice in Second Period for Consumers Having Bought Product A in First Period**



informed about the benefits of the competing products. When products change completely from period to period, the expected benefits $E\mu_i$ cancel out, and the market outcome becomes exactly as in the traditional Hotelling case, with prices equal to τ and profit for each firm equal to $\tau/2$. This can also be seen as the case in which consumer learning does not play any role; there is no differentiation based on consumer learning. When consumers are fully informed about the benefits of the competing products, demand for each firm as function of the prices is less straightforward because one has to account for all possible combinations (μ_A, μ_B, x) that choose either firm. Define $\alpha \equiv 1 - \lim_{\mu\to\bar{\mu}^-} F(\mu)$, the size of the possible mass point at the top of the support. For a symmetric equilibrium we can obtain the full information prices to be characterized by

$$p^i = \tau \cdot \left\{4\tau \int_0^{1/2}\int_{\underline{\mu}}^{\bar{\mu}-\tau(1-2x)} f(\mu) f(\mu+\tau(1-2x))\, d\mu\, dx + \alpha^2 + F(\underline{\mu})^2\right\}^{-1}, \quad \text{for } i = A, B$$

(the proof is in the appendix).

Given that $\bar{\mu}-\underline{\mu}$ is assumed to be sufficiently larger than τ, it can be seen that the market price under full information is higher than the market price when the products change completely from period to period, τ, if $f(\,)$ is sufficiently flat. This can be seen as intuitive in the sense that more information about the products creates more product differentiation in this setting. As expected, the market prices are increasing in the differentiation measures, $1/f(\mu)$ and τ. When α or $F(\underline{\mu})$ increases, the market prices decrease because there is a greater mass of consumers that values the firms equally (on the attribute that is being learned).

3. Dynamic Effects of Consumer Learning

In this section, I investigate the impact of the first-period market shares on the firms' second-period profits and market behavior. Suppose that the market share of Firm A in the first period was $\tilde{x}$. We know from above that the consumers who chose product A are the ones with type $x < \tilde{x}$. Because of the assumption that the market is covered, the market share of Firm B was $1-\tilde{x}$. The profit of Firm A as a function of the prices being charged, p^A and p^B, is then

$$\pi_2^A = p^A\left\{\int_0^{\tilde{x}} [1 - F(E\mu + p^A - p^B - \tau(1-2x))]\, dx + \int_{\tilde{x}}^1 F(E\mu + p^B - p^A - \tau(2x-1))\, dx\right\},$$

where the first term in the demand comes from the consumers who chose product A in the first period and found a good fit (high μ_A), and the second term comes from the consumers who chose product B in the first period and found a poor fit (low μ_B). To find the equilibrium effect of the previous-period market shares on this period's profit, we can use the envelope theorem to see that

$$\frac{d\pi_2^A}{d\tilde{x}} = \frac{\partial \pi_2^A}{\partial \tilde{x}} + \frac{\partial \pi_2^A}{\partial p^B}\frac{dp^B}{d\tilde{x}}.$$

The first term represents the direct effect of $\tilde{x}$ on profits. The second term represents the strategic effect through the price of the competitor. Let us focus first on the direct effect.

Lemma 1. *Suppose that $|p^A - p^B - \tau(1-2\tilde{x})| < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$. If $1 - F(E\mu - z) - F(E\mu + z) > 0$ for $0 \le z < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$, then the direct effect of the previous-period market share on this period's profit is positive. Similarly, if $1 - F(E\mu - z) - F(E\mu + z) < 0$ for $0 \le z < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$, then the direct effect of the previous-period market share on this period's profit is negative.*

The condition that $|p^A - p^B - \tau(1-2\tilde{x})| < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$ states that at the equilibrium prices, there is always a positive mass of consumers with a sufficiently high μ_i such that they remain with product i, and a positive mass of consumers with a sufficiently low μ_i such that they purchase the other product. If there is a symmetric equilibrium, $\tilde{x} = 1/2$ and $p^A = p^B$, and the condition is trivially satisfied.

The condition that $1 - F(E\mu - z) - F(E\mu + z) > 0$ for $0 \le z < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$ implies that the Fisher skewness, defined by $E[(\mu - E\mu)^3]/\{E[(\mu - E\mu)^2]\}^{3/2}$, is negative. In addition, note that if $\tilde{x} = 1/2$ generates a market outcome $p^A = p^B$ (that is, the symmetric equilibrium case, in both the first and the second period), the only condition that is required is that $F(E\mu) < 1/2$, which is equivalent to the condition that the mean of μ be smaller than the median, m, with $F(m) = 1/2$. Note also that the Pearson Median Skewness is defined by $(E\mu - m)/\{E[(\mu - E\mu)^2]\}^{1/2}$. In what follows, let us use the term negative skewness to mean $E\mu < m$; i.e., $F(E\mu) < 1/2$. The result that the direct effect is in the direction of the firms benefiting from having had a high market share in the previous period (the loyalty effect) if the distribution exhibits negative skewness can be seen as quite intuitive. This is because negative skewness means that more likely than not, the draw valuation obtained by one consumer is above the mean valuation of trying another product, which is a force towards the consumer staying with the product chosen in the previous period.[8]

To evaluate the total effect of the market share on profit, one still has to consider the strategic effect. In order to see this, one has to consider the impact of an increase in the market share on the pricing of that firm in the second period. Suppose that $\tilde{x}$ consumers bought product A in the first product. As stated above, these are then the consumers with type $x < \tilde{x}$. The first-order condition for Firm A in the second period (see the proof of Proposition 1 below) can be obtained to be

$$\begin{aligned}
&\int_0^{\tilde{x}} \left[1 - F\left(E\mu + p_2^A - p_2^B - \tau(1-2x)\right)\right] dx \\
&\quad + \int_{\tilde{x}}^1 F\left(E\mu + p_2^B - p_2^A - \tau(2x-1)\right) dx \\
&\quad + p_2^A \Bigg[- \int_0^{\tilde{x}} f\left(E\mu + p_2^A - p_2^B - \tau(1-2x)\right) dx \\
&\qquad\quad - \int_{\tilde{x}}^1 f\left(E\mu + p_2^B - p_2^A - \tau(2x-1)\right) dx \Bigg] = 0,
\end{aligned}$$

and one can obtain a similar condition for Firm B.

For a symmetric equilibrium, $\tilde{x} = 1/2$, one can obtain the market prices to be $p_2^i = \tau/\{2[F(E\mu) - F(E\mu - \tau)]\}$, for $i = A, B$. The market second-period prices are decreasing in the density of valuations close to the mean valuation. A lower density can be interpreted as greater level of differentiation because fewer consumers switch brands given a certain price change. For the remainder of the paper, let us use the term informational differentiation to denote $\tau/(F(E\mu) - F(E\mu - \tau))$. This is the differentiation that results from the consumers having different experiences in the first period; i.e., it represents the importance of the experience of the product. Note also that the equilibrium is unique because the best response function of each firm has slope less than one. The following proposition states the result for the strategic and total effect.

Proposition 1. *Starting from a position of equal market shares in the first period, then* (i) *an increase in either firm's market share increases* (*decreases*) *its second-period price and decreases* (*increases*) *its competitor's*, (ii) *the strategic effect of the firm's market share on its profit is negative* (*positive*), *and* (iii) *the total effect of increasing a firm's market share on its profit is positive* (*negative*) *if and only if the Pearson median skewness is negative* (*positive*).

The first result points out the intuitive idea that in a market with consumer learning, whether a firm with a greater market share chooses a higher price depends critically on whether the distribution of valuations is negatively skewed. At $\tilde{x} = 1/2$, the price for each firm is increasing in the firm's market share if and only if the distribution of valuations is negatively skewed as

$$\frac{dp_2^A}{d\tilde{x}} = \frac{\tau[1 - 2F(E\mu)]}{3[F(E\mu) - F(E\mu - \tau)]}.$$

Note also that, for τ sufficiently small compared to $\bar{\mu} - \underline{\mu}$, $F(E\mu) - F(E\mu - \tau) < 1/2$ and the market prices would be greater than τ. This is because there is now greater differentiation in the market. Note also that the lifetime value of the marginal customer for a firm in this model (at the market outcome) can be computed as $d\pi_2^A/d\tilde{x}$, which can be computed (from the proof of Proposition 1) as

$$\frac{\tau[1 - 2F(E\mu)]}{3[F(E\mu) - F(E\mu - \tau)]}.$$

The lifetime value of the customer is then increasing in both the negative skewness of the distribution of the experience valuations and the product differentiation induced by the experience with the product.

From (i) one can immediately get point (ii) on the direction of the strategic effect of the market share on the profit of the firm. That is, the direct and strategic effects are in opposite directions. Finally, point (iii) shows that the direct effect dominates when we are close to a symmetric equilibrium. This result then shows that if the distribution of valuations is negatively skewed, firms gain in the second period from having a large market share in the previous period, and therefore may compete more aggressively in the first period.

4. The Market Outcome

4.1. Consumer Behavior in the First Period

When making the decision of which product to buy in the first period, consumers are able to foresee the

[8] If μ represents a utility of the physical fit of the product, then it can be shown (see Appendix) that greater risk aversion over the physical fit (i.e., greater concavity of a function μ of the physical fit) decreases the skewness of $F(\mu)$. Furthermore, for infinitely large risk aversion over the physical fit, any skewness measure is at its lowest level, which is negative.

second-period prices, and how these should affect the consumer decisions. By choosing product A in the first period, a consumer of type x has an expected net benefit of $E\mu - p_1^A - \tau x$ in the first period. In the second period, if $\mu_A > E\mu + p_2^A - p_2^B - \tau(1-2x)$, the consumer also buys product A in the second period and gets an expected net benefit of $E[\mu_A \mid \mu_A > E\mu + p_2^A - p_2^B - \tau(1-2x)] - \tau x - p_2^A$. If, on the other hand, $\mu_A < E\mu + p_2^A - p_2^B - \tau(1-2x)$, the consumer buys product B in the second period and gets an expected net benefit of $E\mu - \tau(1-x) - p_2^B$. The discounted value of the expected net benefits if the consumer chooses product A is then

$$
\begin{aligned}
&E\mu - p_1^A - \tau x \\
&\quad + \delta_C \int_{E\mu + p_2^A - p_2^B - \tau(1-2x)}^{\bar{\mu}} (\mu_A - p_2^A - \tau x) \cdot f(\mu_A)\, d\mu_A \\
&\quad + \delta_C F\big(E\mu + p_2^A - p_2^B - \tau(1-2x)\big) \cdot \big(E\mu - p_2^B - \tau(1-x)\big).
\end{aligned}
$$

One can similarly obtain the discounted value of the expected net benefits if the consumer chooses product B.

To obtain the marginal consumer with type $\tilde{x}$ who is indifferent between buying product A or product B in the first period, we can make the discounted value of expected benefits of purchasing A equal the discounted value of expected benefits of purchasing B to obtain

$$
\begin{aligned}
&p_1^A - p_1^B - \tau(1-2\tilde{x}) \\
&\quad + \delta_C \int_{E\mu - p_2^A + p_2^B + \tau(1-2\tilde{x})}^{\bar{\mu}} \big(\mu - p_2^B - \tau(1-\tilde{x})\big) f(\mu)\, d\mu \\
&\quad + \delta_C F\big(E\mu - p_2^A + p_2^B + \tau(1-2\tilde{x})\big)\big(E\mu - p_2^A - \tau\tilde{x}\big) \\
&\quad - \delta_C \int_{E\mu + p_2^A - p_2^B - \tau(1-2\tilde{x})}^{\bar{\mu}} (\mu - p_2^A - \tau\tilde{x}) f(\mu)\, d\mu \\
&\quad - \delta_C F\big(E\mu + p_2^A - p_2^B - \tau(1-2\tilde{x})\big) \\
&\quad \cdot \big(E\mu - p_2^B - \tau(1-\tilde{x})\big) = 0,
\end{aligned}
$$

where p_2^A and p_2^B are functions of $\tilde{x}$. Remember that, as already noted, the demand in the first period for product A is $D_1^A = \tilde{x}$ and demand for product B is $D_1^B = 1 - \tilde{x}$. Totally differentiating the equation above with respect to $\tilde{x}$ and p_1^A at $\tilde{x} = 1/2$, one can obtain the price sensitivity of demand at the symmetric equilibrium to be

$$
\frac{d\tilde{x}}{dp_1^A} = -\left\{2\tau + 2\tau\delta_C\left[1 + \frac{1 - 2F(E\mu)}{3[F(E\mu) - F(E\mu - \tau)]}\right] \cdot [1 - 2F(E\mu)]\right\}^{-1};
$$

Direct differentiation of this equation yields the following result.

Proposition 2. *Suppose that the distribution of valuations is negatively skewed. In the first period, at $\tilde{x} = 1/2$ demand is less sensitive to the firm's price the greater are τ, $1 - 2F(E\mu)$, δ_C, and the informational differentiation (where the comparative statics with respect to each of these variables is done while keeping the other variables constant).*[9]

When the consumers are myopic, $\delta_C = 0$, the demand in the first period is exactly as in the traditional Hotelling case. Now consider the role of the informational differentiation (i.e., $\tau/(F(E\mu) - F(E\mu - \tau)))$, $1 - 2F(E\mu)$, and δ_C on one firm's own price sensitivity. First note that because there are higher prices in the second period, the consumers could potentially demand lower prices in the first period. This is, however, not applicable in this model because the market is fully covered, and the first-period marginal consumer is marginal in choosing between the two firms, not marginal in deciding to buy or not to buy the product. Second, note that the consumers foresee that they are likely to stick with the product that they choose in the first period, which makes the search attribute become more important. That is, this effect is in the direction of the consumers becoming less price sensitive in the first period. In order to see this effect, note that totally differentiating the consumer indifference equation above with respect to $\tilde{x}$ and p_1^A at $\tilde{x} = 1/2$, keeping constant the second-period prices, one obtains

$$
\frac{d\tilde{x}}{dp_1^A} = -\frac{1}{2\tau + 2\tau\delta_C[1 - 2F(E\mu)]} > -\frac{1}{2\tau}.
$$

Third, note that in the first period the marginal consumers foresee that by choosing one product they get a higher expected price in the next period because they are more likely to buy the product they bought first (given $1 - 2F(E\mu) > 0$), and that firm is going to charge a higher price in the second period. Therefore, this effect is also in the direction of the consumers becoming less price sensitive in the first period. These latter two effects disappear if consumers are myopic ($\delta_C = 0$) or if firms do not gain in the second period from having a greater first-period market share (i.e., if the distribution of valuations is not negatively skewed, $1 - 2F(E\mu) = 0$). Both effects are greater the more consumers value the future, higher δ_C, and the more the firms gain from having a greater first-period market share, greater $1 - 2F(E\mu)$. The third effect is also greater the larger the increase in the

[9] For example, when doing the comparative statics on τ, one changes $F(E\mu - \tau)$ such that $\tau/(F(E\mu) - F(E\mu - \tau))$ remains constant. Note that τ measures the degree of differentiation in the search attribute and $\tau/(F(E\mu) - F(E\mu - \tau))$ measures the degree of differentiation due to consumer learning.

second-period price as a result of an increase in the firm's market share, greater informational differentiation. Both of these latter effects constitute a force toward higher prices in the first period, and this force increases with consumer patience.

If the distribution of valuations is positively skewed, $2F(E\mu)-1>0$, and if $|2F(E\mu)-1|$ is sufficiently small, then demand is more sensitive to the firm's price the greater are the informational differentiation and δ_C. In particular, demand is more sensitive to price if the distribution of valuations is positively skewed instead of negatively skewed.

4.2. Firms' Decisions in the First Period

Each firm i in the first period chooses the price to maximize $p_1^i D_1^i + \delta_F \pi_2^i$. Consider a negatively skewed distribution of valuations, $2F(E\mu)-1<0$. From the first-order conditions, one can obtain the symmetric equilibrium prices of the two-period model. These market prices in the first period are

$$p_1^i = \tau + \delta_C \tau[1-2F(E\mu)]\left(1+\frac{1-2F(E\mu)}{3[F(E\mu)-F(E\mu-\tau)]}\right) - \delta_F \tau \frac{1-2F(E\mu)}{3[F(E\mu)-F(E\mu-\tau)]}.$$

One can obtain the market prices in the second period as

$$p_2^i = \frac{\tau}{2[F(E\mu)-F(E\mu-\tau)]}.$$

The equilibrium net present value of profits for each firm is $(1/2)(p_1^i+\delta_F p_2^i)$.

The first-period prices are increasing in the observable differentiation parameter, τ (while keeping the informational differentiation constant), and in how much consumers value the future, δ_C, and decreasing in how much the firms value the future, δ_F. Prices are increasing in δ_C because consumers become less price sensitive, as discussed in the subsection above. Note that, therefore, profits are increasing in the consumers being more forward looking. Prices are decreasing in δ_F because firms compete more for market share for the gains in the next period. The first-period prices can be either higher or lower than the case where the products' characteristics changed from period to period, which is equivalent to the traditional Hotelling case (with price equal to τ). For example, the first-period prices are higher if $\delta_F=0$, $\delta_C>0$, and $1-2F(E\mu)>0$. Note also that both the first- and second-period prices are below the full information prices if $f(\,)$ is sufficiently flat. The effects of the distribution skewness measure, $2F(E\mu)-1$, and of the informational differentiation, $\tau/(F(E\mu)-F(E\mu-\tau))$, are presented in the next proposition.

Proposition 3. *Suppose that the distribution of valuations is negatively skewed. Then:*

(i) *The first-period market prices are decreasing in the informational differentiation (while keeping τ constant) if and only if $\delta_F - \delta_C[1-2F(E\mu)]>0$, which is satisfied for δ_C close to δ_F;*

(ii) *the discounted value of profits is increasing in the informational differentiation; and*

(iii) *both the first-period market prices and the discounted value of profits are decreasing in $1-2F(E\mu)$ if and only if*

$$\delta_F - 2[1-2F(E\mu)]\delta_C - 3\delta_C[F(E\mu)-F(E\mu-\tau)]>0,$$

which is satisfied for δ_C close to δ_F, $1-2F(E\mu)$ not too large, and τ sufficiently small.

The effect of the informational differentiation is composed of two parts. On one hand, if the marginal consumers value the future, they understand that by choosing one product, they are more likely to have to pay a higher price in the second period, and this effect is greater the greater the informational differentiation is. Therefore, as discussed above, consumers become less price sensitive to the first-period prices, which is a force towards higher prices. This force is greater the more consumers value the future, greater δ_C, and the greater the likelihood of getting a higher price in the next period, which is affected by $1-2F(E\mu)$, the skewness of the distribution of valuations.

On the other hand, a greater informational differentiation, greater $\tau/(F(E\mu)-F(E\mu-\tau))$, means that the gain in the second period of a firm having a higher first-period market share is greater. Then, firms are more aggressive in the first period competing for market share, which is a force towards lower first-period prices. This force is greater the more the firms value the future, greater δ_F. For δ_C close to δ_F, the second force dominates, and first-period prices decrease in the informational differentiation.

However, the effect of the informational differentiation on the discounted value of profits is unambiguous: Firms always benefit from consumers putting a greater importance on the attributes over which there is consumer learning. This is because in the second period, firms always benefit from a greater informational differentiation and the competition for market share in the first period is never sufficiently aggressive to overcome this second-period effect.

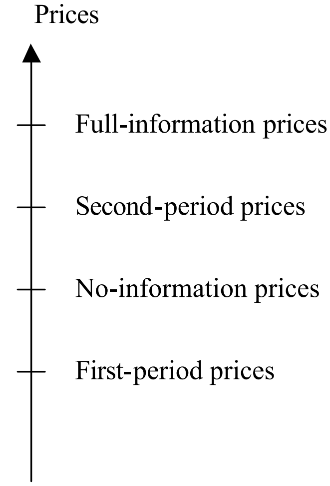
Similarly, the effect of the distribution skewness measure, $2F(E\mu)-1$, is composed of two parts. On one hand, the marginal consumers, by choosing one product, are more likely to have to pay a higher price in the second period, corresponding to higher $1-2F(E\mu)$. Then, and as above, consumers become less price sensitive to the first-period prices, which is a force towards higher prices. This force is greater

(i) the more consumers value the future, greater δ_C; (ii) the greater the likelihood of getting a higher price in the next period, which is affected by $1-2F(E\mu)$, the skewness of the distribution of valuations; (iii) the greater the informational differentiation because it results in higher future prices; and (iv) the greater the importance of the observable characteristics of the products (greater τ while keeping the informational differentiation constant) because they are more likely to affect the net benefit in the second period also.

On the other hand, a more negatively skewed distribution of valuations, a greater $1-2F(E\mu)$, means that the gain in the second period of a firm having a higher first-period market share is greater. Then, firms are more aggressive about competing for market share in the first period, which is a force toward lower first-period prices. This force is greater the more the firms value the future, greater δ_F, and the greater the informational differentiation, $\tau/(F(E\mu)-F(E\mu-\tau))$. For δ_C close to δ_F, $1-2F(E\mu)$ not too large, and the experience being more important than the observable characteristics of the products (τ small compared to the informational differentiation), the second force dominates, and first-period prices decrease in $1-2F(E\mu)$. This is because the second-period profits depend in large part on the first-period market shares.

Because in the market outcome the market shares and second-period prices are not affected by $1-2F(E\mu)$ (while keeping $F(E\mu)-F(E\mu-\tau)$ constant), the impact of $1-2F(E\mu)$ on the discounted value of profits is subject to exactly the same forces as the first-period prices. If consumer learning is important and the discount factors are close enough, firms' profits are hurt when the distribution of valuations is more negatively skewed. Finally, it can be easily checked that the first-period prices are lower than the second-period prices, and that the first-period prices are lower than the no-information prices, τ, when δ_C is close to δ_F. Because under full information there is more information for greater differentiation between the two products, prices under full information are even higher than the second-period prices (for $1-2F(E\mu)$ small and $f(\,)$ sufficiently flat). See Figure 2 for an illustration of the comparison of the equilibrium prices for the different conditions and periods.

Figure 2 Illustration of Comparison of Equilibrium Prices for τ Small, δ_C Close to δ_F, 1-2F(Eμ) Small, and f( ) Sufficiently Flat



5. Conclusion

This paper considers the competitive effects of the potential informational advantages of a product that has been tried by a consumer. The paper argues that whether a firm ends up being better or worse off by having greater initial demand turns out to depend on the skewness of the prior distribution over valuations. A firm is better (worse) off in the future of having a greater initial demand if the distribution of valuations for each product is negatively (positively) skewed, that is, if there is a greater mass of valuations above (below) the mean. Note that the set of distribution of valuations with zero skewness has measure zero in the set of all distributions.

The results above point toward a firm operating in such a market to price more aggressively (lower prices) to attract more consumers who are likely to be loyal to the firm in the future. The benefit of cutting prices is greater if consumer learning results in greater differentiation between the firms and if there is a probability of very bad experiences. However, a firm also has to be aware that in such a market consumers are less sensitive to price cuts.

The analysis above considers a symmetric market. One can show that when firms are asymmetric, with one firm offering in expectation a better fit than the competitor, the main messages of the results above continue to hold. In addition, we would then have that the demand of a firm is now greater if the firm is more likely to offer a good fit. Some of the results above can be empirically tested. One important idea presented above is that we should be more likely to observe consumer learning effects when the distribution of valuations is more negatively skewed. In particular, one can test for the skewness of the distribution of valuations. In the same way, one could test whether the consumer learning/loyalty effects are greater in markets where the skewness of the distribution of experience valuations is greater.

Acknowledgments

The author thanks the editor, area editor, two anonymous reviewers, Dmitri Kuksov, and seminar participants at Harvard University, Hong Kong University of Science and Technology, New York University, Northwestern University, Universidad Torcuato Di Tella, University of Toronto, and the Marketing Science Conference in Wiesbaden, Germany, for helpful suggestions on an earlier version of this paper. Financial support from the Center of Marketing and Technology at the University of California, Berkeley, and research assistance from Liang Guo are gratefully acknowledged.

Appendix

Proof that all Consumers Choosing Product A in the First Period Have Their Location to the Left of Some Threshold. To see this result, consider the decisions by the consumers in their first period in the market; suppose it is period t. A consumer with type x has expected value of lifetime net benefits of buying product A of

$$E\mu_A - \tau x - p_t^A + \delta_C E\{\max[\mu_A - p_{t+1}^A - \tau x, E\mu_B - p_{t+1}^B - \tau(1-x)]\},$$

where p_t^i represents the price charged by firm i in period t. Similarly, the expected value of lifetime net benefits of buying product B is

$$E\mu_B - \tau(1-x) - p_t^B + \delta_C E\{\max[\mu_B - p_{t+1}^B - \tau(1-x), E\mu_A - p_{t+1}^A - \tau x]\}.$$

Subtracting the latter from the former, one obtains

$$\begin{aligned} &p_t^B - p_t^A - \tau(2x-1) + \delta_C F(E\mu - \tau(1-2x) + p_{t+1}^A - p_{t+1}^B) \\ &\quad \cdot [E\mu - p_{t+1}^B - \tau(1-x)] \\ &\quad + \delta_C \int_{E\mu-\tau(1-2x)+p_{t+1}^A-p_{t+1}^B}^{\bar{\mu}} f(\mu)[\mu - p_{t+1}^A - \tau x]\, d\mu \\ &\quad - \delta_C F(E\mu - \tau(2x-1) + p_{t+1}^B - p_{t+1}^A)[E\mu - p_{t+1}^A - \tau x] \\ &\quad - \delta_C \int_{E\mu-\tau(2x-1)+p_{t+1}^B-p_{t+1}^A}^{\bar{\mu}} f(\mu)[\mu - p_{t+1}^B - \tau(1-x)]\, d\mu. \end{aligned}$$

Differentiating with respect to x, one obtains

$$\begin{aligned} &-2\tau + \delta_C \tau [2F(E\mu - \tau(1-2x) + p_{t+1}^A - p_{t+1}^B) \\ &\qquad + 2F(E\mu - \tau(2x-1) + p_{t+1}^B - p_{t+1}^A) - 2], \end{aligned}$$

which is negative. Therefore, if a consumer with type x in his first period in the market chooses to purchase product A, then any other consumer with type $\hat{x} < x$ also chooses to purchase product A.

Proof of the Full Information Prices. Under full information, demand for Firm A is composed of all consumer types (μ_A, μ_B, x) satisfying $\mu_A - \tau x - p^A > \mu_B - \tau(1-x) - p^B$. For x satisfying $p^A - p^B > \tau(1-2x)$, which is equivalent to $x > (\tau + p^B - p^A)/(2\tau)$, demand for Firm A is

$$\int_{\underline{\mu}}^{\bar{\mu}-p^A+p^B+\tau(1-2x)} f(\mu_B) \int_{\mu_B+p^A-p^B-\tau(1-2x)}^{\bar{\mu}} f(\mu_A)\, d\mu_A\, d\mu_B.$$

For $p^A - p^B < \tau(1-2x)$, which is equivalent to $x < (\tau + p^B - p^A)/(2\tau)$, demand for Firm A is

$$1 - \int_{\underline{\mu}}^{\bar{\mu}+p^A-p^B-\tau(1-2x)} f(\mu_A) \int_{\mu_A-p^A+p^B+\tau(1-2x)}^{\bar{\mu}} f(\mu_B)\, d\mu_B\, d\mu_A.$$

Integrating over x, one obtains the total demand for Firm A, D^A, as

$$\begin{aligned} D^A = &\int_{(\tau+p^B-p^A)/(2\tau)}^{1} \int_{\underline{\mu}}^{\bar{\mu}-p^A+p^B+\tau(1-2x)} f(\mu_B) \\ &\cdot \int_{\mu_B+p^A-p^B-\tau(1-2x)}^{\bar{\mu}} f(\mu_A)\, d\mu_A\, d\mu_B\, dx \\ &+ \int_0^{(\tau+p^B-p^A)/(2\tau)} \bigg[1 - \int_{\underline{\mu}}^{\bar{\mu}+p^A-p^B-\tau(1-2x)} f(\mu_A) \\ &\cdot \int_{\mu_A-p^A+p^B+\tau(1-2x)}^{\bar{\mu}} f(\mu_B)\, d\mu_B\, d\mu_A \bigg] dx. \end{aligned} \qquad \text{(i)}$$

Firm A then maximizes its profit, $\max_{p^A} p^A D^A$. Using the first-order condition of this maximization and the symmetry $p^A = p^B$ one obtains the market price presented in the text.

Proof of Lemma 1. Direct differentiation gets

$$\begin{aligned} \frac{\partial \pi_2^A}{\partial \tilde{x}} = p^A[&1 - F(E\mu + p^A - p^B - \tau(1-2\tilde{x})) \\ &- F(E\mu + p^B - p^A - \tau(2\tilde{x}-1))]. \end{aligned}$$

If $1 - F(E\mu - z) - F(E\mu + z) > (<) 0$, for $0 \le z < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$ this derivative is positive (negative) given that $|p^A - p^B - \tau(1-2\tilde{x})| < \min[E\mu - \underline{\mu}, \bar{\mu} - E\mu]$.

Proof of Proposition 1. The first-order condition for Firm A is

$$\begin{aligned} &\int_0^{\tilde{x}} [1 - F(E\mu + p^A - p^B - \tau(1-2x))]\, dx \\ &\quad + \int_{\tilde{x}}^1 F(E\mu + p^B - p^A - \tau(2x-1))\, dx \\ &\quad + p^A \bigg[-\int_0^{\tilde{x}} f(E\mu + p^A - p^B - \tau(1-2x))\, dx \\ &\qquad - \int_{\tilde{x}}^1 f(E\mu + p^B - p^A - \tau(2x-1))\, dx \bigg] = 0. \end{aligned}$$

Totally differentiating this with respect to p^A, p^B, and $\tilde{x}$, and using symmetry, that is $\tilde{x} = 1/2$, $p^A = p^B$, and

$$\frac{dp^A}{d\tilde{x}} = \frac{dp^B}{d(1-\tilde{x})} = -\frac{dp^B}{d\tilde{x}} \quad (\text{at } \tilde{x} = 1/2)$$

one obtains

$$\begin{aligned} &2\frac{dp^A}{d\tilde{x}} \bigg\{ -\int_0^{1/2} f(E\mu - \tau(1-2x))\, dx - \int_{1/2}^1 f(E\mu - \tau(2x-1))\, dx \\ &\quad - p^A \int_0^{1/2} f'(E\mu - \tau(1-2x))\, dx \\ &\quad + p^A \int_{1/2}^1 f'(E\mu - \tau(2x-1))\, dx \bigg\} \\ &\quad - \frac{dp^A}{d\tilde{x}} \bigg\{ \int_0^{1/2} f(E\mu - \tau(1-2x))\, dx \\ &\qquad + \int_0^{1/2} f(E\mu - \tau(2x-1))\, dx \bigg\} + 1 - 2F(E\mu) = 0. \end{aligned}$$

Now, given that

$$\begin{aligned} \int_0^{1/2} f(E\mu - \tau(1-2x))\, dx &= \int_{1/2}^1 f(E\mu - \tau(2x-1))\, dx \\ &= \frac{1}{2\tau}[F(E\mu) - F(E\mu - \tau)] \end{aligned}$$

and

$$\int_0^{1/2} f'(E\mu - \tau(1-2x))\,dx = \int_{1/2}^{1} f'(E\mu - \tau(2x-1))\,dx,$$

one obtains

$$\frac{dp^A}{d\tilde{x}} = \frac{\tau[1-2F(E\mu)]}{3[F(E\mu) - F(E\mu-\tau)]},$$

which is positive (negative) if and only if the Pearson median skewness is negative (positive). This proves part (i). Note that, similarly, one can obtain

$$\frac{dp^B}{d\tilde{x}} = -\frac{\tau[1-2F(E\mu)]}{3[F(E\mu) - F(E\mu-\tau)]}.$$

Part (ii) is immediate from part (i) and from checking that $\partial\pi_2^A/\partial p^B$ is positive. For part (iii), note that at the symmetric equilibrium we have

$$\frac{\partial\pi_2^A}{\partial p^B} = \frac{p^A}{\tau}[F(E\mu) - F(E\mu-\tau)].$$

Then, from Lemma 1 and part (ii) we can obtain the total effect to be equal to $(2/3)p^A[1-2F(E\mu)]$, which is positive (negative) if and only if the Pearson median skewness is negative (positive).

Proof of the Statements in Footnote 8. This proof relates the skewness of the distribution of valuations to consumer risk aversion with respect to the physical fit of the product characteristics. To get this interpretation, define the physical fit of product i with a consumer as $\tilde{\mu}_i$, with cumulative distribution function $\widetilde{F}(\tilde{\mu}_i)$ with the support $[\underline{\tilde{\mu}}, \bar{\tilde{\mu}}]$.

The gross benefit derived from the physical performance $\tilde{\mu}_i$ would be $\mu_i = \mu(\tilde{\mu}_i)$, where the function $\mu(\ )$ is strictly increasing. Then, the cumulative distribution of μ_i can be obtained to be $F(\mu_i) = \widetilde{F}(\mu^{-1}(\mu_i))$. In the same way, the expected value of μ_i is $E_F[\mu_i] = E_{\widetilde{F}}[\mu(\tilde{\mu}_i)]$, and the median of μ_i, m, is determined by $F(m) = \widetilde{F}(\mu^{-1}(m)) = 1/2$.

It is well known (Pratt 1964) that concave transformations of $\mu(\ )$ make the consumer more risk averse with respect to the physical performance of the product. Denote, then, the index of increasing risk aversion by ρ, with $\mu(\tilde{\mu}_i;\rho)$ such that

$$\frac{\partial}{\partial\rho}\left\{\frac{\partial^2\mu}{\partial\tilde{\mu}_i^2}\Big/\frac{\partial\mu}{\partial\tilde{\mu}_i}\right\} < 0.$$

Define the certainty equivalent, $c(\rho)$, as $\mu(c(\rho);\rho) = E_{\widetilde{F}}[\mu(\tilde{\mu}_i;\rho)]$. Then, by Pratt (1964) we know that $dc(\rho)/d\rho < 0$. We then have that the skewness measure $2F(E_F\mu_i) - 1$ is decreasing in the index of consumer risk aversion ρ. To see this, it suffices to show that $F(E_F\mu_i)$ is decreasing in ρ. Now,

$$F(E_F\mu_i) = \widetilde{F}(\mu^{-1}(E_{\widetilde{F}}[\mu(\tilde{\mu}_i;\rho)])) = \widetilde{F}(c(\rho)),$$

where the second equality results from the definitions of certainty equivalent and inverse function. Finally, because $\widetilde{F}$ is increasing and $c(\rho)$ is decreasing, the result follows.

Note that the skewness measure $2F(E\mu) - 1$ is exactly the one that ends up being used in the proof of Proposition 1. Note also that for a consumer with infinitely large risk aversion, $c(\rho) = \underline{\tilde{\mu}}$, which yields $2F(E_F\mu_i) - 1 = -1$; i.e., the Pearson median skewness is negative. Therefore, by continuity, the Pearson median skewness is also negative for high levels of risk aversion. Note that this is true for any definition of the physical performance of the product, $\tilde{\mu}_i$, and for any cumulative distribution function $\widetilde{F}(\cdot)$.

Note also that if $\widetilde{F}(\cdot)$ is symmetric and $\mu(\cdot)$ is concave, then $F(\cdot)$ is negatively skewed because the certainty equivalent c is strictly less than $E\tilde{\mu}_i$ for $\mu(\cdot)$ concave, $\widetilde{F}(E_{\widetilde{F}}\tilde{\mu}_i) = 1/2$ for $\widetilde{F}(\cdot)$ symmetric, and $F(E_F\mu_i) = \widetilde{F}(c)$.

References

Akcura, T., F. F. Gönül, E. Petrova. 2003. Consumer learning and brand valuation: An application on over-the-counter drugs. *Marketing Sci.* **23**(1).

Bain, J. 1956. *Barriers to New Competition*. Harvard University Press, Cambridge, MA.

Beggs, A., P. Klemperer. 1992. Multiperiod competition with switching costs. *Econometrica* **60** 651–666.

Bergemann, D., J. Välimäki. 1996. Learning and strategic pricing. *Econometrica* **64** 1125–1149.

Bucklin, R. E., J. M. Lattin. 1991. A two-state model of purchase incidence and brand choice. *Marketing Sci.* **10** 24–39.

Caminal, R., C. Matutes. 1990. Endogenous switching costs in a duopoly model. *Internat. J. Indust. Organ.* **8** 353–373.

Danaher, P. J., I. W. Wilson, R. Davis. 2003. A comparison of online and offline consumer brand loyalty. *Marketing Sci.* **22**(1) 461–476.

Desai, P. 2000. Multiple messages to retain retailers: Signaling new product demand. *Marketing Sci.* **19** 381–389.

Fader, P., J. Lattin. 1993. Accounting for heterogeneity and nonstationarity in a cross-sectional model of consumer purchase behavior. *Marketing Sci.* **12** 304–317.

Golder, P., G. Tellis. 1993. Pioneer advantage: Marketing logic or marketing legend. *J. Marketing Res.* **30** 158–170.

Guadagni, P., J. Little. 1983. A logit model of brand choice calibrated on scanner data. *Marketing Sci.* **2** 203–238.

Heiman, A., E. Muller. 1996. Using demonstration to increase new product acceptance: Controlling demonstration time. *J. Marketing Res.* **33** 422–430.

Iyer, G., D. Soberman. 2000. Markets for product modification information. *Marketing Sci.* **19** 203–225.

Kalra, A., S. Rajiv, K. Srinivasan. 1998. Response to competitive entry: A rationale for delayed defensive reaction. *Marketing Sci.* **17** 380–405.

Kalyanaram, G., G. L. Urban. 1992. Dynamic effects of the order of entry on market share, trial penetration, and repeat purchases for frequently purchased consumer goods. *Marketing Sci.* **11** 235–250.

Kim, B-D., M. Shi, K. Srinivasan. 2001. Reward programs and tacit collusion. *Marketing Sci.* **20** 99–120.

Klemperer, P. 1995. Competition when consumers have switching costs: An overview with application to industrial organization, macroeconomics, and international trade. *Rev. Econom. Stud.* **62** 515–539.

Krishnamurthy, L., S. P. Raj. 1991. An empirical analysis of the relationship between brand loyalty and consumer price elasticity. *Marketing Sci.* **10** 172–183.

Kuksov, D. 2003. Buyer search costs and endogenous product design. Working paper, University of California, Berkeley, CA.

Lattin, J. M. 1987. A model of balanced choice behavior. *Marketing Sci.* **6** 48–65.

Mehta, N., S. Rajiv, K. Srinivasan. 2003. Price uncertainty and consumer search: A structural model of consideration set formation. *Marketing Sci.* **22** 58–84.

Moorthy, S., K. Srinivasan. 1995. Signaling quality with a money-back guarantee: The role of transaction costs. *Marketing Sci.* **14** 442–466.

Neelamiegham, R., D. C. Jain. 1999. Consumer choice process for experience goods: An econometric model and analysis. *J. Marketing Res.* **36** 373–386.

Papatla, P., L. Krishnamurthi. 1992. A probit model of choice dynamics. *Marketing Sci.* **11** 189–206.

Pedrick, J. H., F. S. Zufryden. 1991. Evaluating the impact of advertising media plans: A model of consumer purchase dynamics using single-source data. *Marketing Sci.* **10** 111–130.

Pratt, J. 1964. Risk aversion in the small and in the large. *Econometrica* **32** 122–136.

Roy, R., P. K. Chintagunta, S. Haldar. 1996. A framework for investigating habits, the hand of the past, and heterogeneity in dynamic brand choice. *Marketing Sci.* **15** 280–299.

Schmalensee, R. 1982. Product differentiation advantages of pioneering brands. *Amer. Econom. Rev.* **72** 349–365.

Seetharaman, P. B., A. Ainslie, P. K. Chintagunta. 1999. Investigating household state dependence effects across categories. *J. Marketing Res.* **36** 488–500.

Vilcassim, N. J., D. C. Jain. 1991. Modeling purchase-timing and brand-switching behavior incorporating explanatory variables and unobserved heterogeneity. *J. Marketing Res.* **28** 29–41.

Wernerfelt, B. 1991. Brand loyalty and market equilibrium. *Marketing Sci.* **10** 229–245.