Competing with Experience Goods*

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ABSTRACT

In several markets consumers can only gain further information regarding about how well a product fits their preferences by experiencing it after the purchase. Furthermore, while some consumers may have a better fit with one given product, other consumers may end up appreciating more another product. In addition, firms may not have any significant private information regarding which consumers value more or less their own product. In such markets, consumers then try products and only keep on buying them if they provide a good fit. Furthermore, after trying a product a product a consumer has more information about that product than about the untried products. These features generate, in general, dynamic effects because the market shares in one period affect demands in the next 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 negativity of the skewness of the distribution of valuations is then shown to be related to consumer risk aversion with respect to the physical performance of the good. With negative skewness it is shown in a two-period model that, as expected, firms compete more aggressively in the first period, and charge higher prices in the last period. The analysis of the infinite-horizon case with overlapping generations of consumers shows that these two effects average out in higher prices. In this later case, I also characterize oscillating market share dynamics, and comparative statics of the equilibrium with respect to degree of skewness, consumer and firm patience, and importance of the experience in the ex-post valuation of the product.

1. Introduction

In several markets consumers can only gain further information regarding about how well a product fits their preferences by experiencing it after the purchase. This type of products has then been classified as *experience goods* (Nelson 1970).[1] For example, a consumer might only learn about how much it appreciates a restaurant after trying it, or how well a piece of clothing wears for that consumer, after wearing it for awhile. Similarly, a consumer might only learn how much a certain bank meets his needs after banking there for some time.

Furthermore, in several of these markets an important part of the different valuations for the different products are idiosyncratic to each consumer, that is, consumers have different relative valuations (after experiencing them) of one product over another. In addition, firms may not have any significant private information regarding which consumers value more or less their own product.[2]

In such markets consumers, when purchasing a product, learn about its valuation to them. Then, in future periods there is an informational differentiation in the sense that a consumer knows more about the products that were tried than about the products that were not tried. It is then argued that this informational advantage confers an advantage to the products that were bought first. The idea is that after trying a product and understanding its valuation, a consumer may prefer the product for which he knows more about the valuation than the product which valuation remains mostly uncertain. In this sense, firms may compete fiercely for consumers to try first their products. 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.[3]

This paper examines the competitive effects of these informational advantages.

In order to get started, it is important to understand that when one consumer tries a product it 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 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 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

[1] This is in contrast with search goods where a consumer can fully evaluate the fit with a product prior to purchase.

[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. These issues are further discussed below.

[3] See also Schmalensee (1982).

probability that that product's valuation is above the mean valuation than below. Note that the negative skewness of the distribution ends up being quite intuitive in the sense that consumers are concerned about trying another product because they are concerned about getting a very poor draw.

Then, I show that the skewness of the distribution over valuations is related to the risk aversion of consumers with respect to the physical performance of the product. In fact, greater risk inversion translates into the distribution over valuations being more negatively skewed.

With a negatively skewed distribution of valuations, in a two-period model one can then show that firms compete aggressively in the first period and more softly in the second period. Several additional interesting effects are uncovered: The softer competition in the second period is not only due to some consumers having a greater preference from the product they chose first, but also because the revelation of different valuations alters the differentiation in the market. Also interestingly, in the first period the marginal consumers foresee that by choosing one product they get a higher expected price in the next period, and are therefore less price sensitive. This is a force towards higher prices in the first period, and it increases with consumer patience. Comparative statics with respect to the importance of the consumer experience, to the skewness of the distribution of valuations, and to the firms' patience are also obtained.

However, although the two-period model helps provide some intuition of the economic forces at work, one may still wonder whether the effects being found are affected by either the last or initial period features. Furthermore, one may wonder how the effect of cutting prices in the first period and increasing prices in the second period averages out in an infinite-horizon model where consumers are constantly coming into the market. Such a model with overlapping generations of consumers is analyzed and one finds that steady state prices are higher the greater the informational differentiation effects, that is, the greater the distribution of valuations is negatively skewed. The steady state prices are also found to be increasing in both consumer patience and in the importance of the experience in the ex-post valuation of the product, and decreasing in firm patience.

One also obtains that the market share dynamics are oscillating, with the firm with a greater market share in one period, having the smaller market share in the next period. This is because the firm with the greater market share ends up pricing higher to take advantage of the greater number of consumers that experience a good fit with their product. This higher price then yields a lower market share from the new generation of consumers in the market. The convergence to the steady state is slower when the information differentiation effects are greater (more negatively skewed distribution of valuations), when the firm patience is greater, when the consumer patience is smaller, and when the importance of the experience in the ex-post valuation of the product is greater.

There is a literature on experience goods affecting the market structure that is related to this paper. Following, Bain (1956), several authors have argued that informational differentiation is a barrier to entry to potential entrants (which is translated in this paper to a potential advantage of having a greater initial market share).[4] Schmalensee (1982) shows that a high quality incumbent may deter entry because of the existing informational differentiation. Farrell (1986) argues that moral hazard on the part of the entrant may also create a barrier to entry even for a low-quality incumbent. Bagwell (1990) shows the same result for the case of adverse selection. These later two papers rely on the entrant having private information about some dimension of quality that affects all consumers equally, which is not considered in the current paper, and that may not be too important with well-established firms.[5]

Without assuming any private information by competing firms, Bergemann and Välimäki (1996) look at the case of homogeneous consumers and focus on the consumer experimentation problem. In contrast, here I look at heterogeneous consumers (also without private information by the firms) but get away from the consumer experimentation issues by limiting consumers to be in the market for only two periods.[6]

This paper is also quite related to the literature on competition with switching costs where firms gain in the future from having a higher market share today, because consumers have a preference for the products they buy first (Beggs and Klemperer 1992, Klemperer 1995).[7] In fact, this paper can be seen as endogeneizing one central explanation for switching costs, "the uncertainty about the quality of untested brands" (Klemperer 1995, p. 517).[8] Endogeneizing this explanation is important for several reasons. First, it is not clear what is measured by the switching cost parameter

[4]Golder and Tellis (1993), Kalyanaram, Robinson, and Urban (1995), and Erdem and Keane (1996) discuss several studies that provide some empirical support to this argument.

[5]Also in the case in which firms choose, under private information, some dimension of quality that affects all consumers equally, there has been some work on competitive market interaction. Riordan (1986) looks at quality choice and price signaling in a model with monopolistic competition and repeat purchases under commitment by the firms. Liebeskind and Rumelt (1989) investigate quality choice with uncertain outcomes and without price commitment by the firms. Gale and Rosenthal (1992) look at quality choice without price or quality commitment by the firms.

[6]Bergemann and Välimäki (1997) consider heterogeneous consumers, only one generation of consumers, and uncertain valuation regarding only one of the two competing firms. Vettas (1998) considers homogeneous consumers and equal valuation for all firms in a free-entry industry. It could be argued that the work on diffusion models by Bass (1969) is also in this spirit. Shapiro (1983) studies the monopoly case (see also Kim 1992 and Hoerger 1993).

[7]The literature on consumer loyalty is also quite related: See, for example, Guadagni and Little (1983) or Wernerfelt (1991).

[8]See also Caminal and Matutes (1990) for endogeneizing switching costs through loyalty programs.

in a market with experience goods. Second, by having the model fully specified one is able to completely determine the role played by each of the primitive parameters in the experience goods framework. For example, one can show that the skewness of the prior distribution of valuations plays a crucial role on whether the market behaves as if there are "switching costs." Also interestingly, the consumers gaining more information on the products they try changes the level of differentiation between the products in the market, which does not have a direct equivalent in a switching costs model. The consumers that get a bad draw in the product that they try first, always go and try the competitor's product, also unlike in a switching costs model.

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 depend on the skewness of the prior distribution of valuations, and relates this skewness to consumer risk aversion with respect to the physical performance of the good. Section 4 analyzes the two-period model, and section 5 looks at the infinite horizon case. Section 6 concludes.

2. The Model

Two firms, A and B, produce at zero marginal cost nondurable goods A and B, respectively. There is a continuum of consumers with mass normalized to one who live for two periods. In the next two sections I only consider one generation of consumers. In section 5 I consider overlapping generations of consumers. 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 preferences are characterized by the triple (μ_A, μ_B, x) which are fixed through their life. 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 benefit 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.[9] The support of μ_i is $[\underline{\mu}, \overline{\mu}]$. I distinguish between the wealth-equivalent gross benefit μ_i and the physical fit between a consumer and product i. This distinction is important because the mapping from physical fit to wealth-equivalent gross benefit allows us to interpret the cumulative distribution

[9]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 than prior to the experience with one of the products. The idea that the degree of differentiation changes with experience is robust; the idea that differentiation increases with experience depends critically on the common priors assumption.

function over μ_i as related to consumer risk aversion with respect to the physical fit of the product. This relation is discussed in the next section.

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 cumulative 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 "travelling" 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 $\overline{\mu} - \underline{\mu}$ to τ helps determine the relative importance of the experience 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 $\overline{\mu} - \underline{\mu}$, 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 $\overline{\mu}$ large) such that, if a consumer has a very poor experience with a product he chooses to try the other product for all x. 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.[10] As discussed in the next section, consumers may still be risk averse with respect to the physical fit of either product. The expected value of the gross benefit of either product, μ_A or μ_B, is assumed high enough such that in equilibrium all consumers will purchase one of the products in each period.

The independence in the population between the gross benefits μ_A and μ_B is just to guarantee that a consumer does not learn about one brand from trying the other brand. This is the extreme case where experience with a product does not give any information about the benefit provided by other products. The independence in the population between x and either μ_A or μ_B is just to have no interaction between the observable characteristics of a product and the characteristics that are only learned through experience. The main messages of the results in the paper would still go through with some interaction between these two types of product characteristics.

[10]If the net benefit of the purchase of this product is small in comparison to the consumers' income, then the consumers are locally risk-neutral with respect to the purchase of this product. All the messages of this paper carry also through in a model in which consumers are risk averse with respect to their wealth-equivalent net benefit of buying a product. In such a model there would be an even greater advantage of the product that was bought first. Note also that, even for specific utility functions, such a model would become too complex in order to obtain several of the results presented here.

Because consumers live only for two periods (this could also be seen as the consumers changing completely tastes after two periods) there is no role for experimentation, that is trying different products in order to choose in the future the product that provides the best fit.[11] However, the current structure still captures several important aspects of markets with experience goods: First, consumers after finding a good fit 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.

The lifetime net benefit of a consumer is the discounted sum of the net benefits of the two periods the consumer is in the market with discount factor δ_C, with $0 \leq \delta_C < 1$.

In the second period in the market, 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, $E\mu_B - \tau(1-x) - p_B$, 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. Note that if the experience in the first period was good, high μ_A, the consumer will buy product A in this second period. If, on the other hand, there was a poor experience, low μ_A, the consumer chooses product B. In fact, the marginal consumers are characterized by $\mu_A = E\mu_B - \tau(1-2x) + p_A - p_B$, as it can be seen in Figure 1. Pairs (μ_A, x) above the line choose product A in the second period. Pairs below the line choose product B. One result used in the figure and showed below is that if one consumer of type x chose product A in his first period in the market, then one consumer of type $\widehat{x} < x$ also chose product A in that period.

In order to see this result consider now the decisions by the consumers in their first period in the market, suppose period t. A consumer with type x has expected value of lifetime net benefits of buying product A of $E\mu_A - \tau x - p_{At} + \delta_C E\{\max[\mu_A - p_{At+1} - \tau x, E\mu_B - p_{Bt+1} - \tau(1-x)]\}$, where p_{it} represents the price charged by firm i in period t. Similarly, the expected value of lifetime net benefits of buying product B is $E\mu_B - \tau(1-x) - p_{Bt} + \delta_C E\{\max[\mu_B - p_{Bt+1} - \tau(1-x), E\mu_A - p_{At+1} - \tau x]\}$.

Subtracting the latter from the former one obtains

$$\begin{gathered} p_{Bt} - p_{At} - \tau(2x-1) + \delta_C F(E\mu - \tau(1-2x) + p_{At+1} - p_{Bt+1})[E\mu - p_{Bt+1} - \tau(1-x)] \\ +\delta_C \int_{E\mu-\tau(1-2x)+p_{At+1}-p_{Bt+1}}^{\overline{\mu}} f(\mu)[\mu - p_{At+1} - \tau x]\, d\mu - \delta_C F(E\mu - \tau(2x-1) \\ +p_{Bt+1} - p_{At+1})[E\mu - p_{At+1} - \tau x] - \delta_C \int_{E\mu-\tau(2x-1)+p_{Bt+1}-p_{At+1}}^{\overline{\mu}} f(\mu)[\mu - p_{Bt+1} - \tau(1-x)]\, d\mu. \end{gathered}$$

[11] See Bergemann and Välimäki (1996) for the case of experimentation with homogeneous consumers and constant tastes.

Differentiating with respect to x one obtains $-2\tau + \delta_C\tau[2F(E\mu - \tau(1-2x) + p_{At+1} - p_{Bt+1}) + 2F(E\mu - \tau(2x-1) + p_{Bt+1} - p_{At+1}) - 2]$ which is negative. Therefore, if a consumer, in his first period in the market, with type x chooses to purchase product A, then any other consumer with type $\widehat{x} < x$ also chooses to purchase product A.

In each period t, firms choose simultaneously the prices to be charged, p_{At} and p_{Bt}. 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 equilibrium. The case of $\delta_C = \delta_F$ is immediate from the results below.

I am interested in the Markov perfect equilibria of this game, i.e., equilibria in which each firm's strategy in each period depends only on the payoff-relevant state variables in that period. In this particular game the payoff-relevant state variables in each period are the stocks of previous customers of each of the firms still in the market in that period. From above, this reduces to the type x of a consumer that is still in the market and was indifferent between products A and B in the previous period.

3. Dynamic Effects of Experience Goods

In this section I investigate, in a simplified way, what is the impact of the existing market shares on the firms' future profitability and equilibrium behavior. Suppose that we are in the second period of a two-period model. How does the market share obtained in the first period affect profits and equilibrium behavior in the second period? How is the answer to this question affected by consumer risk aversion with respect to the physical performance of the product? I answer these two questions in each of the following subsections.

3.1. Dynamic Effects of Market Shares

Suppose that the market share of firm A in the previous period was $\widetilde{x}$. From above we know that the consumers that chose product A are the ones with type $x < \widetilde{x}$. Because of the assumption of the market being covered, the market share of firm B was $1 - \widetilde{x}$. The profit of firm A as a function the prices being charged, p_A and p_B, is then

$$\pi_2^A = p_A\{\int_0^{\widetilde{x}} [1 - F(E\mu + p_A - p_B - \tau(1-2x))]\,dx + \int_{\widetilde{x}}^1 F(E\mu + p_B - p_A - \tau(2x-1))\,dx\},$$

where the first term in the demand comes from the consumers that chose product A in the previous period and found a good fit, high μ_A, and the second term comes from the consumers that chose product B in the previous period and found a poor fit, low μ_B.

In order to find the equilibrium effect of the previous period market shares on this period's profit, we know by the envelope theorem that

$$\frac{d\pi_2^A}{d\widetilde{x}} = \frac{\partial\pi_2^A}{\partial\widetilde{x}} + \frac{\partial\pi_2^A}{\partial p_B}\frac{dp_B}{d\widetilde{x}}.$$

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

PROPOSITION 1: *Suppose that* $|p_A - p_B - \tau(1-2\widetilde{x})| < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$. *Then, if* $1 - F(E\mu - z) - F(E\mu + z) > 0$, *for* $0 \leq z < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$, *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* $0 \leq z < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$, *then the direct effect of the previous period market share on this period's profit is negative.*

PROOF: Direct differentiation gets $\frac{\partial\pi_2^A}{\partial\widetilde{x}} = p_A[1 - F(E\mu + p_A - p_B - \tau(1-2\widetilde{x})) - F(E\mu + p_B - p_A - \tau(2\widetilde{x}-1))]$. If $1 - F(E\mu - z) - F(E\mu + z) > (<)0$, for $0 \leq z < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$ this derivative is positive (negative) given that $|p_A - p_B - \tau(1-2\widetilde{x})| < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$.

Q.E.D.

The condition that $\mid p_A - p_B - \tau(1-2\widetilde{x}) \mid < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$ is just the condition 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, both $\widetilde{x} = \frac{1}{2}$ and $p_A = p_B$, the condition is trivially satisfied.

The condition $1 - F(E\mu - z) - F(E\mu + z) > 0$, for $0 \leq z < \min[E\mu - \underline{\mu}, \overline{\mu} - E\mu]$ implies that the Fisher skewness, defined by $\frac{E[(\mu - E\mu)^3]}{E[(\mu - E\mu)^2]^{3/2}}$, is negative. In addition, note that if $\widetilde{x} = \frac{1}{2}$ generates an equilibrium $p_A = p_B$ (that is, the symmetric equilibrium case, in both the first and second period) the only condition that is required is that $1 - 2F(E\mu) > 0$ which is equivalent to the condition that the mean of μ be smaller than the median, m, with $F(m) = \frac{1}{2}$. Note also that the Pearson Median Skewness is defined by $\frac{E\mu - m}{E[(\mu - E\mu)^2]^{1/2}}$. Importantly, note that the set of probability distributions of valuations with zero skewness has measure zero in the set of all possible probability distributions of valuations.

In order 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.

PROPOSITION 2: *Consider a symmetric equilibrium. Then an increase in the market share of a firm in the previous period increases (decreases) the equilibrium price of that firm if and only if the Pearson Median Skewness is negative (positive).*

PROOF: The first order condition for firm A is $\int_0^{\widetilde{x}}[1-F(E\mu+p_A-p_B-\tau(1-2x))]\,dx+\int_{\widetilde{x}}^1 F(E\mu+p_B-p_A-\tau(2x-1))\,dx+p_A[-\int_0^{\widetilde{x}} f(E\mu+p_A-p_B-\tau(1-2x))\,dx-\int_{\widetilde{x}}^1 f(E\mu+p_B-p_A-\tau(2x-1))\,dx]=0$. Totally differentiating this and the first order condition for firm B with respect to p_A, p_B, and $\widetilde{x}$, and using symmetry, that is $\widetilde{x}=\frac{1}{2}$ and $p_A=p_B$ one obtains $\frac{dp_A}{d\widetilde{x}}=\frac{p_A[1-2F(E\mu)]}{6\int_0^{1/2} f(E\mu-\tau(1-2x))\,dx}$ which is positive (negative) if and only if the Pearson Median Skewness is negative (positive).

Q.E.D.

This result points out that the intuitive idea that, in a market with experience goods, a firm with a greater market share chooses a higher price depends critically on the distribution over valuations being negatively skewed. One can now get immediately the direction of the strategic effect of market share on the profit of the firm.

PROPOSITION 3: *Consider a symmetric equilibrium. Then, the strategic effect of the firm's market share on its profit is negative (positive) if and only if the Pearson Median Skewness is negative (positive).*

PROOF: It is immediate from Proposition 2 and checking that $\frac{\partial \pi_2^A}{\partial p_B}$ is positive.

Q.E.D.

This proposition shows that the direct and strategic effects are in opposite directions. The next proposition shows that the direct effect dominates when we are close to the symmetric equilibrium.

PROPOSITION 4: *Consider a symmetric equilibrium. Then, 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).*

PROOF: At the symmetric equilibrium we have $\frac{\partial \pi_2^A}{\partial p_B} = 2p_A \int_0^{1/2} f(E\mu - \tau(1-2x))\, dx$. Then, from propositions 1 and 3 we can obtain the total effect to be equal to $\frac{2}{3}p_A[1-2F(E\mu)]$ which is positive (negative) if and only if the Pearson Median Skewness is negative (positive).

Q.E.D.

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.

3.2. Relation between Distribution over Valuations and Risk Aversion

This subsection relates the skewness of the distribution of valuations to consumer risk aversion with respect to physical fit of the product characteristics. In order to get this interpretation define the physical fit of product i with a consumer as $\widetilde{\mu}_i$, with cumulative distribution function $\widetilde{F}(\widetilde{\mu}_i)$ over the support $[\underline{\widetilde{\mu}}, \overline{\widetilde{\mu}}]$.

The gross benefit derived from the physical performance $\widetilde{\mu}_i$ would be $\mu_i = \mu(\widetilde{\mu}_i)$, where the function $\mu()$ is strictly increasing. Then, the cumulative distribution over 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 $E_F[\mu_i] = E_{\widetilde{F}}[\mu(\widetilde{\mu_i})]$, and the median of μ_i, m, is denoted by $F(m) = \widetilde{F}(\mu^{-1}(m)) = \frac{1}{2}$.

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 ρ as an index of increasing risk aversion, with $\mu(\widetilde{\mu}_i; \rho)$ such that $\frac{\partial}{\partial \rho}\{\frac{\partial^2 \mu}{\partial \widetilde{\mu}_i^2} / \frac{\partial \mu}{\partial \widetilde{\mu}_i}\} < 0$. Define the certainty equivalent, $c(\rho)$, as $\mu(c(\rho); \rho) = E_{\widetilde{F}}[\mu(\widetilde{\mu}_i; \rho)]$. Then, by Pratt (1964) we know that $\frac{dc(\rho)}{d\rho} < 0$. We are now ready to state the result that relates the cumulative distribution function over valuations and consumer risk aversion.

PROPOSITION 5: *The skewness measure $2F(E_F\mu_i) - 1$ is decreasing in the index of consumer risk aversion ρ.*

PROOF: It suffices to show that $F(E_F\mu_i)$ is decreasing in ρ. Now, $F(E_F\mu_i) = \widetilde{F}(\mu^{-1}(E_{\widetilde{F}}[\mu(\widetilde{\mu}_i; \rho)])) = \widetilde{F}(c(\rho))$ where the second equality results from the definitions of certainty equivalent and inverse function. Finally, because $\widetilde{F}$ is monotonically increasing, and $c(\rho)$ is decreasing we have the result in the proposition.

Q.E.D.

Note that the skewness measure $2F(E\mu) - 1$ is exactly the one that ends up being used in Proposition 4. Note also that for a consumer with infinitely risk aversion, $c(\rho) = \underline{\widetilde{\mu}}$, and therefore $2F(E_F\mu_i) - 1 = -1$, i.e., the Pearson Median Skewness is negative. Then, 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, $\widetilde{\mu}_i$, and for any cumulative distribution function $\widetilde{F}()$.

4. The Two-Period Model

4.1. Preliminaries

Consider now the full two-period horizon, where in the first period consumers learn their valuation of the product they try, and in the second period consumers decide whether to buy again the product which they bought in the first period, or whether to buy a new product. In order to be able to fully solve the model, we consider a specific distribution over valuations that is negatively skewed. The positively skewed case is briefly discussed in the conclusion section.

In the remaining of the paper the cumulative distribution over valuations is assumed uniform with a mass at the top. That is $F(\mu) = (1-\alpha)\frac{\mu-\underline{\mu}}{\overline{\mu}-\underline{\mu}}$ for $\underline{\mu} \leq \mu < \overline{\mu}$ and $F(\mu) = 1$ for $\mu = \overline{\mu}$. That is, the mass at the top is $\alpha > 0$. Throughout, I also restrict $\alpha < \frac{1}{2}$, the median is strictly smaller than $\overline{\mu}$, and $\overline{\mu} - \underline{\mu} > 2\tau$ so that what is learned through experiencing a product can be always more important than what can be inspected prior to purchase. Throughout I also denote $v_i = \mu_i - \underline{\mu}$, and $V = \overline{\mu} - \underline{\mu}$.

The mean of μ_i is $E\mu_i = \underline{\mu} + V\frac{1+\alpha}{2}$. The median is $m = \underline{\mu} + \frac{V}{2(1-\alpha)} > E\mu_i$. The standard deviation is $E[(\mu_i - E\mu_i)^2]^{1/2} = V\frac{\sqrt{(1-\alpha)(1+3\alpha)}}{2\sqrt{3}}$. The Fisher skewness is $\frac{E[(\mu_i-E\mu_i)^3]}{E[(\mu_i-E\mu_i)^2]^{3/2}} = -\frac{2\alpha^2(4-\alpha)}{3^{3/2}\sqrt{1-\alpha}(1+3\alpha)^{3/2}}$, the Pearson Median Skewness is $\frac{E\mu_i - m}{\sqrt{E[(\mu_i-E\mu_i)^2]}} = -\frac{\sqrt{3}\alpha^2}{(1-\alpha)^{3/2}\sqrt{1+3\alpha}}$, and the $2F(E\mu_i) - 1$ skewness measure is $-\alpha^2$. All skewness measures are negative and decreasing in α (the absolute value is increasing in α). The parameter α can then be seen as a measure of the skewness of the distribution over valuations.[12] As argued above α can also be interpreted as an index of consumer risk aversion with respect to the physical performance of a product.

For possible benchmarks consider the case where products (or tastes) change completely from period to period and the case where consumers are fully informed about the gross benefits of the competing products.

[12]Because α also affects the mean valuation, when doing comparative statics I also consider the case in which V decreases when α increases such that the mean valuation, $\underline{\mu} + V\frac{1+\alpha}{2}$, remains constant.

When products change completely from period to period, the expected gross benefits $E\mu_i$ cancel out, and the equilibrium becomes exactly like the traditional Hotelling case with prices equal to τ and profit for each firm equal to $\frac{\tau}{2}$.

When consumers are fully informed about the gross benefits of the competing products, demand for each firm as function of the prices is less straightforward. Demand for firm A is composed of all consumer types (v_A, v_B, x) satisfying $v_A - \tau x - p_A > v_B - \tau(1-x) - p_B$. For x satisfying $p_A - p_B > \tau(1-2x)$, which is equivalent to $x > \frac{\tau + p_B - p_A}{2\tau}$, demand for firm A is $\{\frac{(1-\alpha)^2}{2V^2}\{V - [p_A - p_B - \tau(1-2x)]\}^2 + \frac{\alpha(1-\alpha)}{V}\{V - [p_A - p_B - \tau(1-2x)]\}\}\,dx$ where the first term is from consumers with $v_A \neq V$ and the second term is from consumers with $v_A = V$. For $p_A - p_B < \tau(1-2x)$, which is equivalent to $x < \frac{\tau + p_B - p_A}{2\tau}$, demand for firm A is $\{\frac{(1-\alpha)^2}{V^2}\{V^2 - \frac{1}{2}\{V - [\tau(1-2x) - p_A + p_B]\}^2\} + \{1 - (1-\alpha)^2 - \frac{\alpha(1-\alpha)}{V}\{V - [\tau(1-2x) - p_A + p_B]\}\}\}\,dx$ where the first term is from consumers with $v_A \neq V$ and $v_B \neq V$ and the second term is from consumers with either $v_A = V$ or $v_B = V$. Integrating over x and making some simple calculations one obtains the total demand for firm A, D_A, as

$$\begin{aligned} D_A \;=\; & \int_{\frac{\tau+p_B-p_A}{2\tau}}^{1} \frac{1-\alpha}{V}[V - p_A + p_B + \tau(1-2x)]\{\frac{1+\alpha}{2} + \frac{1-\alpha}{2V}[p_B - p_A + \tau(1-2x)]\}\,dx \,+ \\ & \int_0^{\frac{\tau+p_B-p_A}{2\tau}} \{\frac{(1-\alpha)^2}{V^2}[\frac{V^2}{2} + V[p_B - p_A + \tau(1-2x)] - \frac{[p_B - p_A + \tau(1-2x)]^2}{2}] \\ & +[\alpha - \frac{\alpha(1-\alpha)}{V}[p_A - p_B - \tau(1-2x)]]\}\,dx. \end{aligned} \tag{1}$$

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 equilibrium price to be

$$p_i = \frac{\tau V^2}{\alpha^2 V^2 + 2(1-\alpha)V\tau - \tau^2(1-\alpha)^2}, \text{ for } i = A, B. \tag{2}$$

Given $V > 2\tau$ it can be seen that the equilibrium price under full information is higher than the equilibrium price when the products change completely from period to period, τ. Moreover, as expected, the equilibrium prices are increasing in the two differentiation measures, V and τ. Note also that when α and τ go to zero, the equilibrium prices converge to $\frac{V}{2}$.

Note also that this full information case may not be seen as too related to the experience goods case analyzed in this paper in the sense that, because consumers only live for two periods, they never have a chance of making the decision of which product to buy while having full information.

4.2. Second Period

In order to solve the two-period case we solve the game backwards from the last period. The second period analysis ends up being just a particular case of the analysis in the previous section. Suppose that $\widetilde{x}$ consumers bought product A in the first product. As stated above, these are then the consumers with type $x < \widetilde{x}$.

From the $\widetilde{x}$ consumers that purchased product A in the first period, the ones satisfying $v_A > V\frac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)$ will keep on purchasing product A. This generates a demand for product A from the consumers that purchased product A in the first period of $\widetilde{x}\alpha + \widetilde{x}\frac{1-\alpha}{V}[V\frac{1-\alpha}{2} - p_{A2} + p_{B2} + \tau(1-\widetilde{x})]$. The demand for product B from the consumers that purchased product A in the first period is $\widetilde{x}\frac{1-\alpha}{V}[V\frac{1+\alpha}{2} - p_{B2} + p_{A2} - \tau(1-\widetilde{x})]$. One can make similar computations for the $(1-\widetilde{x})$ consumers that purchased product B in the first period. One can then obtain the total demand in the second period, aggregating over the consumers that purchased either product A or product B in the first period, for product A as $D_{A2} = \widetilde{x}\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{B2} - p_{A2})$ and for product B as $D_{B2} = (1-\widetilde{x})\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{A2} - p_{B2})$.

Note that demands are independent of the parameter τ, the importance of the product characteristics that can be inspected prior to purchase. This is because we have assumed that the experience of the product is sufficiently important such that if it is very poor it results in changing the product being purchased, and if it is very good it results in purchasing the same product. This will occur if V is sufficiently large in comparison to τ.[13] Note also that, as argued above, demand is increasing in the firm's market share in the previous, and this effect is bigger when α is greater, i.e., the distribution over valuations is more negatively skewed.

The price equilibrium results from each firm maximizing its profit, $\max_{p_{i2}} p_{i2}D_{i2}$, for $i = A, B$. This results in

$$p_{A2} = V[\frac{1+\alpha}{2} + \frac{\alpha^2(1+\widetilde{x})}{3(1-\alpha)}] \tag{3}$$

$$p_{B2} = V[\frac{1+\alpha}{2} + \frac{\alpha^2(2-\widetilde{x})}{3(1-\alpha)}]. \tag{4}$$

The equilibrium price for each firm is increasing in the firm's market share and in the skewness parameter, α, as expected. Note also that is $\alpha = 0$, the equilibrium prices would be $\frac{V}{2}$ greater than τ, because there is now greater differentiation in the market.

[13]In this particular case the condition is $V > 2\tau$, as assumed above.

The equilibrium profits are $\pi_2^A = V(1-\alpha)[\frac{1+\alpha}{2} + \frac{\alpha^2(1+\widetilde{x})}{3(1-\alpha)}]^2$ and $\pi_2^B = V(1-\alpha)[\frac{1+\alpha}{2} + \frac{\alpha^2(2-\widetilde{x})}{3(1-\alpha)}]^2$. It is also clear that for α sufficiently small (but positive) there is no profitable deviation by either firm.

4.3. Consumer Behavior in First Period

When making the decision of which product to buy in the first period, consumers are able to foresee the 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 $\underline{\mu} + Ev - p_{A1} - \tau x$ in the first period. In the second period, if $v_A > V\frac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)$ the consumer buys product A also in the second period and gets an expected net benefit of $\underline{\mu} + E[v_A \mid v_A > V\frac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)] - \tau x - p_{A2}$. If, on the other hand, $v_A < V\frac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)$ the consumer buys product B in the second period and gets an expected net benefit of $\underline{\mu} + V\frac{1+\alpha}{2} - \tau(1-x) - p_{B2}$. The discounted value of the expected net benefits if the consumer chooses product A is then

$$\underline{\mu} + \delta_C\underline{\mu} + Ev - p_{A1} - \tau x + \delta_C\{\text{Prob}[v_A > V\tfrac{1+\alpha}{2} - \tau(1-2x) - p_{B2} + p_{A2}][E[v_A \mid v_A > V\tfrac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)] - \tau x - p_{A2}] + \text{Prob}[v_A < V\tfrac{1+\alpha}{2} - \tau(1-2x) - p_{B2} + p_{A2}][V\tfrac{1+\alpha}{2} - \tau(1-x) - p_{B2}]\}. \tag{5}$$

Similarly, the discounted value of the expected net benefits if the consumer chooses product B can be obtained to be

$$\underline{\mu} + \delta_C\underline{\mu} + Ev - p_{B1} - \tau(1-x) + \delta_C\{\text{Prob}[v_B > V\tfrac{1+\alpha}{2} - \tau(2x-1) - p_{A2} + p_{B2}][E[v_B \mid v_B > V\tfrac{1+\alpha}{2} + p_{B2} - p_{A2} - \tau(2x-1)] - \tau(1-x) - p_{B2}] + \text{Prob}[v_B < V\tfrac{1+\alpha}{2} - \tau(2x-1) - p_{A2} + p_{B2}][V\tfrac{1+\alpha}{2} - \tau x - p_{A2}]\}. \tag{6}$$

We can also obtain $\text{Prob}[v_A > V\frac{1+\alpha}{2} - \tau(1-2x) - p_{B2} + p_{A2}] = \alpha + \frac{1-\alpha}{V}[V\frac{1-\alpha}{2} - p_{A2} + p_{B2} - \tau(2x-1)]$ and $E[v_A \mid v_A > V\frac{1+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)] = \frac{1}{\alpha + \frac{1-\alpha}{V}[V\frac{1-\alpha}{2} - p_{A2} + p_{B2} - \tau(2x-1)]}\{\alpha V + \frac{1-\alpha}{2V}[V\frac{1-\alpha}{2} - p_{A2} + p_{B2} - \tau(2x-1)][V\frac{3+\alpha}{2} + p_{A2} - p_{B2} - \tau(1-2x)]\}$. Similarly one can obtain expressions for $\text{Prob}[v_B > V\frac{1+\alpha}{2} - \tau(2x-1) - p_{A2} + p_{B2}] = \alpha + \frac{1-\alpha}{V}[V\frac{1-\alpha}{2} - p_{B2} + p_{A2} - \tau(1-2x)]$ and $E[v_B \mid v_B > V\frac{1+\alpha}{2} + p_{B2} - p_{A2} - \tau(2x-1)] = \frac{1}{\alpha + \frac{1-\alpha}{V}[V\frac{1-\alpha}{2} - p_{B2} + p_{A2} - \tau(1-2x)]}\{\alpha V + \frac{1-\alpha}{2V}[V\frac{1-\alpha}{2} - p_{B2} + p_{A2} - \tau(1-2x)][V\frac{3+\alpha}{2} + p_{B2} - p_{A2} - \tau(2x-1)]\}$.

In order to obtain the marginal consumer with type $\widetilde{x}$ that is indifferent between buying product

A or product B in the first period, we make (5) equal to 6 to obtain

$$p_{B1} - p_{A1} + \tau(1 - 2\tilde{x}) + \alpha^2\delta_C[p_{B2} - p_{A2} + \tau(1 - 2\tilde{x})] = 0. \quad (7)$$

Using (3) and (4) one can then obtain $\tilde{x}$ as a function of p_{A1} and p_{B1} as

$$\tilde{x} = \frac{\tau + p_{B1} - p_{A1} + \delta_C\alpha^2[\tau + \frac{V\alpha^2}{3(1-\alpha)}]}{2\tau + 2\delta_C\alpha^2[\tau + \frac{V\alpha^2}{3(1-\alpha)}]}. \quad (8)$$

Remember that we already noted that the demand in the first period for product A is $D_{A1} = \tilde{x}$ and demand for product B is $D_{B1} = 1 - \tilde{x}$. From this equation one can get the following result.

PROPOSITION 6: *In the first period, demand is less sensitive to the firm's price the greater are* $\tau, V, \alpha,$ *and* δ_C.

PROOF: Direct differentiation of (8) with respect to p_{A1} and τ, V, α, or δ_C obtains the result.

When the consumers are myopic, $\delta_C = 0$, the demand in the first period is exactly as in the traditional Hotelling case. In order to understand the role of V, α, and δ_C on one firm's own price sensitivity 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 $\alpha > 0$), and that firm is going to charge a higher price in the second period. Therefore, consumers become less price sensitive in the first period. This effect disappears if consumers are myopic ($\delta_C = 0$) or if firms do not charge a higher price in the second period when they have a higher first period market (i.e., if the distribution of valuations is not negatively skewed, $\alpha = 0$). The effect is greater the greater consumers value the future, higher δ_C, and the greater the increase in the second period price as a result of an increase in the firm's market share, greater V and α. This is a force towards higher prices in the first period, and it increases with consumer patience. Interestingly, note that if $\tau = 0$, even though the products are not differentiated in the first period, demands are not infinitely price sensitive if δ_C and α are strictly greater than zero.

4.4. Firms' Decisions in First Period

Each firm i in the first period chooses the price to maximize $p_{i1}D_{i1} + \delta_F\pi_2^i$. The first order conditions result in

$$\frac{1}{2} - \frac{p_{i1}}{2\tau + 2\delta_C\alpha^2[\tau + \frac{V\alpha^2}{3(1-\alpha)}]} - \frac{\delta_F V}{2\tau + 2\delta_C\alpha^2[\tau + \frac{V\alpha^2}{3(1-\alpha)}]}\frac{\alpha^2}{3(1-\alpha)}, \text{ for } i = A, B. \quad (9)$$

From this one can get the following result, that characterizes the equilibrium of the two-period model.

PROPOSITION 7: *Consider the two-period case. The equilibrium prices in the first period are* $p_{i1} = \tau + \delta_C \alpha^2 (\tau + \frac{V\alpha^2}{3(1-\alpha)}) - \delta_F \frac{V\alpha^2}{3(1-\alpha)}$. *The equilibrium prices in the second period are* $p_{i2} = \frac{V}{2(1-\alpha)}$. *The equilibrium net present value of profits for each firm is* $\frac{1}{2}(p_{i1} + \delta_F p_{i2})$.

The first period prices are increasing on the observable differentiation parameter, τ, and on how much consumers value the future, δ_C, and decreasing on 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 then 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. Note that 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 $\alpha > 0$. Note also that both the first and second period prices are below the full information prices in 2.

The effects of the distribution skewness parameter (or risk aversion parameter), α, and the importance of experience of a product, V, are presented in the next proposition.

PROPOSITION 8: *The first period equilibrium prices are decreasing in* V *if and only if* $\delta_F - \delta_C \alpha^2 > 0$, *which is satisfied for* δ_F *close to* δ_C. *The discounted value of profits are increasing in* V. *The first period equilibrium prices are decreasing in* α *if and only if* $\frac{V}{3(1-\alpha)^2}[\delta_F(1-\alpha) - \delta_C \alpha^2 (4-3\alpha)] - 2\delta_C \tau > 0$, *which is satisfied for* δ_F *close to* δ_C *and* V *much greater than* τ. *The discounted value of profits are increasing in* α.

PROOF: Differentiation of the equilibrium prices and profits with respect to V and α yields the results.

Q.E.D.

The effect of the importance of experience of a product, V, is composed of two parts. On one hand if the marginal consumers value the future, they understand that buy choosing one product, they are more likely to have to pay a higher price in the second period, which is higher the higher is V. 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 α^2, the skewness of the distribution of valuations.

On the other hand, a greater importance of experience of product, greater V, 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_F close to δ_C, the second force dominates and first period prices decrease in V.

However, note that the effect of V on the discounted value of profits is unambiguous: Firms always benefit from consumers putting a greater importance on the experience of the products. This is because in the second period firms always benefit from a greater V (it is like greater differentiation in the second period), 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 parameter (also interpreted as risk aversion), α, is composed of two parts. On one hand if the marginal consumers value the future, they understand that buy choosing one product, they are more likely to have to pay a higher price in the second period, which is higher the higher is α. 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 (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 α^2, the skewness of the distribution of valuations, (iii) the greater the importance of the experience of the products (greater V) because it results in higher future prices, and (iv) the greater the importance of the observable characteristics of the products (greater τ) because they are more likely to affect the net benefit also in the second period.

On the other hand, a more negatively skewed distribution of valuations (more risk aversion), greater α, 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, and the greater the importance of the experience of the products, V. For δ_F close to δ_C, and the experience being much more important than the observable characteristics of the products (V much greater than τ) the second force dominates and first period prices decrease in α.

However, note that the effect of α on the discounted value of profits is unambiguous: Firms always benefit from distribution of valuations being more negatively skewed (greater consumer risk aversion). This is because in the second period firms always benefit from a greater α (the benefits of a greater first period market share are greater), and the competition for market share in the first period is never sufficiently aggressive to overcome this second period effect.

Because when changing α one is also changing the mean of the distribution of valuations, which is $\underline{\mu} + V\frac{1+\alpha}{2}$, one could possibly argue that the comparative statics on α results from increasing the valuation for each product. One can then do comparative statics on α while changing V to keep $V\frac{1+\alpha}{2} = k$, a constant. The next proposition presents the result.

PROPOSITION 9: *Suppose $V\frac{1+\alpha}{2} = k$. Then an increase in α, with the corresponding decrease in V, results always in a higher discounted value of profits and results in a decrease in the first period prices if and only if $\frac{V}{3(1-\alpha)(1-\alpha^2)}[\delta_F - \delta_C\alpha^2(2-\alpha^2)] - \delta_C\tau > 0$. This later condition is satisfied if δ_F is close to δ_C and if V is much greater than τ and is implied by the corresponding condition in Proposition 8.*

PROOF: Realizing that $\frac{dV}{d\alpha} = -\frac{V}{1+\alpha}$ and differentiating with respect to α and V the equilibrium prices and profits yields the results.

Q.E.D.

This result shows that the results of Proposition 8 with respect to the distribution skewness parameter go through even when we restrict the mean of the distribution to remain constant: The discounted value of equilibrium profits increases when the distribution of valuations is more negatively skewed (greater consumer risk aversion) and for the interesting values of the parameters the first period equilibrium prices decrease with the distribution skewness parameter.

5. Infinite Horizon

5.1. Preliminaries

Although the two-period model helps provide some intuition of the economic forces at work, one may still wonder whether the effects being found are affected by either the last or initial period features. Furthermore, one may wonder how the effect of higher α or V resulting in cutting prices in the first period and increasing prices in the second period averages out in an infinite-horizon model, where consumers are constantly coming into the market. Here I consider such a model with overlapping generations of consumers, such that in each period the market has a mass of two. I find that steady state prices are higher the greater the informational differentiation effects, that is, the greater the distribution of valuations is negatively skewed. The steady state prices are also found to be increasing in both consumer and firm patience, and in the importance of the experience in the ex-post valuation of the product.

Consider period t. Consider first the consumer behavior for consumers that entered the market in period $t-1$. For these consumers, demands for the two products are exactly as in the second period of the two-period case considered in the previous section. Demand from these consumers for product A is $\widetilde{x}_{t-1}\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{Bt} - p_{At})$ and for product B is $(1-\widetilde{x}_{t-1})\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{At} - p_{Bt})$, where $\widetilde{x}_{t-1}$ denotes the type of the marginal consumer born in period $t-1$ for product A (or for product B) in period $t-1$.

Consider now the consumer behavior of the consumers that enter the market in period t. Following (7), one obtains that the marginal consumer, $\widetilde{x}_t$ satisfies

$$p_{Bt} - p_{At} + \tau(1 - 2\widetilde{x}_t) + \alpha^2\delta_C[p_{Bt+1} - p_{At+1} + \tau(1 - 2\widetilde{x}_t)] = 0. \tag{10}$$

In the computation of the Markov-perfect equilibria I restrict attention to equilibria in affine strategies, that is, $p_{At} = p_A(\widetilde{x}_{t-1})$ and $p_{Bt} = p_B(\widetilde{x}_{t-1})$, where the functions $p_A()$ and $p_B()$ are linear functions of $\widetilde{x}_{t-1}$, and, as noted above, $\widetilde{x}_{t-1}$ summarizes the payoff-relevant state variables in period t. This focus on affine strategies is further discussed below.

Then, we can write $p_{At+1} - p_{Bt+1} = a + b\widetilde{x}_t$, where a and b are real numbers to be computed in the equilibrium. We can then rewrite (10) as

$$\widetilde{x}_t = \frac{y + p_{Bt} - p_{At}}{2y} \tag{11}$$

where $y \equiv \tau + \delta_C(\tau - a)\alpha^2$ and $b = -2a$ because $p_{At+1} = p_{Bt+1}$ for $\widetilde{x}_t = \frac{1}{2}$ in a symmetric equilibrium.

Total demand in period t for firm A is then $\frac{y+p_{Bt}-p_{At}}{2y} + \widetilde{x}_{t-1}\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{Bt} - p_{At})$. The problem for firm A in period t can be then be written as the right hand side of

$$W_A(\widetilde{x}_{t-1}) = \max_{p_{At}} p_{At}[\frac{y + p_{Bt} - p_{At}}{2y} + \widetilde{x}_{t-1}\alpha^2 + \frac{1-\alpha^2}{2} + \frac{1-\alpha}{V}(p_{Bt} - p_{At})] + \delta_F W_A(\frac{y + p_{Bt} - p_{At}}{2y}), \tag{12}$$

where $W_A(x)$ is the net present value of profits for firm A from period t on if the marginal consumer buying the product in $t-1$ and living in period t had type x. The solution to the right hand side gives $p_{At} = p_A(\widetilde{x}_{t-1})$. Similar expressions can be written for firm B with functions $W_B(x)$ and $p_B(\widetilde{x}_{t-1})$.

As stated above I am looking for Markov perfect equilibria where the price strategies $p_A(\widetilde{x}_{t-1})$ and $p_B(\widetilde{x}_{t-1})$, are affine in $\widetilde{x}_{t-1}$ and this is already assumed in the construction of the demand for product A in (11). Note also that if $W_A(x)$ on the right hand side of (12) is quadratic, then $W_A(x)$ on the left hand side results indeed quadratic in x. There may be equilibria that are not affine, but all the equilibria of any finite-horizon version of this game are in affine strategies. Furthermore, when such a finite horizon goes to infinity, the equilibria of the finite game have as a limit the equilibrium in affine strategies that is presented here (the infinite game).

Given that the firms are symmetric, we are looking for a symmetric equilibrium with $W_A(x) = W_B(1-x) = W(x), \forall x$. Denote also

$$W(x) = c + \overline{d}x + \overline{e}x^2 \tag{13}$$

$$p_A(x) = f + gx. \tag{14}$$

From the solution to (12) and the corresponding problem for firm B, and from equalizing in (12) the constant term, the term in $\widetilde{x}_{t-1}$, and the term in $\widetilde{x}_{t-1}^2$, we can obtain $a, b, c, \overline{d}, \overline{e}, f$, and g. Throughout I also define $e \equiv \frac{\delta_F \overline{e} V}{y}$ and $d \equiv \delta_F V \overline{d}$.

5.2. *Characterization of Equilibrium*

In this subsection I characterize the Markov perfect equilibrium. The reader less interested in this more technical material may want to jump directly to the next subsection where I start presenting results on the comparative statics and properties of the equilibrium. From the first order conditions of the problem (12) and the corresponding problem for firm B one can obtain $p_{At} - p_{Bt} = \frac{-2\alpha^2 Vy + 4\alpha^2 Vy\widetilde{x}_{t-1}}{3V + 6y(1-\alpha) - 2e}$ which yields

$$a = \frac{-2\alpha^2 Vy}{3V + 6y(1-\alpha) - 2e}. \tag{15}$$

By the definition of y we can then obtain

$$\frac{\delta_C \tau \alpha^2 + \tau - y}{\delta_C \alpha^2} = \frac{-2y\alpha^2 V}{3V + 6y(1-\alpha) - 2e} \tag{16}$$

which gives a relation between y and e.

From $\widetilde{x}_t = \frac{y+p_{Bt}-p_{At}}{2y}$, we can then obtain the equation of motion of market shares as

$$\widetilde{x}_t - \frac{1}{2} = -\frac{2\alpha^2 V}{3V + 6y(1-\alpha) - 2e}(\widetilde{x}_{t-1} - \frac{1}{2}). \tag{17}$$

The equilibrium price in period t for firm A is

$$p_{At} = \frac{2yV - d - ey}{V + 2y(1-\alpha)} + \frac{-\alpha^2 yV + 2yV\alpha^2 \widetilde{x}_{t-1}}{3V + 6y(1-\alpha) - 2e} \tag{18}$$

from which one can directly obtain $f = \frac{2yV-d-ey}{V+2y(1-\alpha)} + \frac{-\alpha^2 yV}{3V+6y(1-\alpha)-2e}$ and $g = \frac{2yV\alpha^2}{3V+6y(1-\alpha)-2e}$.

In order to compute y and e we can use the equality in the terms in $\widetilde{x}_{t-1}^2$ in (12) to obtain

$$\begin{aligned} \frac{ey}{\delta_F V} &= \frac{2y\alpha^2 V}{3V + 6y(1-\alpha) - 2e}[-\frac{2\alpha^2 V}{3V + 6y(1-\alpha) - 2e} + \alpha^2 - \frac{1-\alpha}{V}\frac{4\alpha^2 yV}{3V + 6y(1-\alpha) - 2e}] \\ &+ \frac{ey}{V}\frac{4\alpha^4 V^2}{[3V + 6y(1-\alpha) - 2e]^2}. \end{aligned} \tag{19}$$

Defining $T \equiv 3V + 6y(1-\alpha) - 2e$ one can write (16) and (19) as

$$y = h_1(T) \equiv \tau\frac{(1 + \delta_C\alpha^2)T}{T - 2\delta_C\alpha^4 V} \tag{20}$$

$$y = h_2(T) \equiv \frac{T^3 - 3VT^2 + 4\alpha^4 V^3 \delta_F}{6(1-\alpha)(T^2 - 4\alpha^4 V^2\delta_F) + 16V^2\delta_F\alpha^4(1-\alpha)}, \tag{21}$$

respectively. Substituting (20) into (21) one obtains the following quartic equation on T :

$$\begin{aligned} h_3(T) \equiv\ & T^4 - T^3[2\delta_C\alpha^4 V + 6\tau(1-\alpha)(1+\delta_C\alpha^2) + 3V] + 6\delta_C\alpha^4 V^2 T^2 + T[4\alpha^4 V^3\delta_F \\ & + 8\tau\delta_F\alpha^4 V^2(1-\alpha)(1+\delta_C\alpha^2)] - 8\delta_C\delta_F\alpha^8 V^4 = 0. \end{aligned} \tag{22}$$

After solving for this equation one can then obtain directly, $y, e, a, b,$ and g.

In order to find the appropriate solution for T, T^*, note that $h_2(T)$ is increasing in T if and only if $\mid T \mid > 2\sqrt{\delta_F}\alpha^2 V$. For $T < -2\sqrt{\delta_F}\alpha^2 V$ there is no solution of (22) because $h_2(T)$ is negative while $h_1(T)$ is positive. For $T > 2\sqrt{\delta_F}\alpha^2 V$ there is only one solution because $h_1(T)$ is decreasing but positive, while $h_2(T)$ increases from a negative number to infinity. Because for the Markov perfect equilibrium we need that the market share dynamics is mapping into $[0,1]$, we have T satisfying $\mid T \mid > 2\alpha^2 V$, which allows us to conclude that the appropriate solution for T, T^* satisfies $T^* > 2\alpha^2 V$. See Figure 2 for a graphic representation of $h_1(T)$ and $h_2(T)$. The explicit expression for T^* is presented in the Appendix. We can also find out that $(3-\alpha)V < T^* \leq 3V + 6\tau$ because

$h_3((3-\alpha)V) < 0$ and $h_3(3V+6\tau) \geq 0$. Furthermore, we then know that $\frac{\partial h_3(T^*)}{\partial T} > 0$. For $\alpha \to 0$, we have $T \to 3V+6\tau, y \to \tau, e \to 0, d \to 0, a \to 0, b \to 0, f \to \frac{2V\tau}{V+2\tau}$, and $g \to 0$. See also Table 1 for values of T^* and y as a function of α.

Table 1
Characterization of Equilibrium for Different α.
$V = 4, \tau = 1, \delta_C = .95, \delta_F = .95$.

α	T^*	y	$\frac{2\alpha^2 V}{T^*}$	$\overline{p}$
.0	18.0	1.00	.000	1.33
.1	17.5	1.01	.005	1.38
.2	17.0	1.04	.019	1.44
.3	16.6	1.09	.043	1.52
.4	16.2	1.17	.079	1.61
.5	15.7	1.28	.127	1.74

5.3. Price Sensitivity of First-Time Consumers

From the demand from the first-time consumers, $\frac{y+p_{Bt}-p_{At}}{2y}$ for firm A, it is clear that these consumers are less price sensitive the greater is y. The comparative statics of y with respect to the different parameters yields then the following result.

PROPOSITION 10: *First-time consumers are less price sensitive the greater are α, τ, δ_C, and δ_F. For small α first-time consumers are less price sensitive the greater is V.*

PROOF: See Appendix.

Increasing the importance of the observable differentiation, τ, decreases, as expected, the consumer price sensitivity. As in the two-period model, we confirm in this more general model, that increases in α, δ_C, and V make the first-time consumers less price sensitive.[14] The marginal first-time 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 $\alpha > 0$), and that firm is going to charge a higher price in the next period. Therefore, consumers become less price

[14] I could not find parameter values where the result on V would reverse when α was not small.

sensitive in the first period they are in the market. The effect is greater the greater consumers value the future, higher δ_C, and the greater the increase in the next period price as a result of an increase in the firm's market share, greater importance of the experience of the product (greater V), and the more the distribution of valuations is negatively skewed (greater α). An interesting part of this result is that the firms, even though competing for a new generation of consumers (unlike in the two-period model) still raise their prices when they have a greater demand in the previous period. In this regard, note that, unlike in the two-period model, if $\tau \to 0$, demands from the first-time consumers become infinitely price sensitive. Table 1 presents the value for y as a function of α.

The role of how firms value the future, δ_F, is quite interesting. On one hand one could expect that the firms being more forward looking would make them compete more for the new generations of consumers in anticipation of the future gains, and therefore, raise less the price when having a higher market share in the previous period, which would result in higher price sensitivity from the first-time consumers. On the other hand, when firms value the future more they also realize that the potential gains from having had a large market share in the previous period are to be had when they are possible, because the competition for future gains is very intensive. This makes firms charge higher prices when they have higher market shares, which causes first-time consumers to be less price sensitive. It turns out that this latter effect dominates the former in this model.

Because when changing α one is also changing the mean of the distribution of valuations, which is $\underline{\mu} + V\frac{1+\alpha}{2}$, one could possibly argue that the comparative statics on α results from increasing the valuation for each product. One can then do comparative statics on α while changing V to keep $V\frac{1+\alpha}{2} = k$, a constant. The next proposition presents the result.

Proposition 11: *Suppose $V\frac{1+\alpha}{2} = k$. Then an increase in α, with the corresponding decrease in V results in the first-time consumers becoming less price sensitive.*

Proof: See Appendix.

This result shows that the results of Proposition 10 with respect to the distribution skewness parameter go through even when we restrict the mean of the distribution to remain constant: The first-time consumers become less price sensitive when the distribution of valuations is more negatively skewed (greater consumer risk aversion).

5.4. Market Share Dynamics

From (17) above the market share dynamics can be written as

$$\widetilde{x}_t - \frac{1}{2} = -\frac{2\alpha^2 V}{T}(\widetilde{x}_{t-1} - \frac{1}{2}) \qquad (23)$$

from which we can derive several implications.

PROPOSITION 12: *The market shares converge to a steady-state with* $50-50$ *division of the market for all starting points. The convergence to steady-state goes through oscillating market shares. The convergence is slower the greater are* α *and* δ_F*, and the smaller are* τ *and* δ_C*. For* α *small, the convergence is slower the greater is* V*.*

PROOF: Noting that $T^* \in [(3-\alpha)V, 3V+6\tau]$ yields convergence to a steady-state through oscillating market shares. Direct differentiation, using $\frac{dT^*}{d\alpha} < 0$, $\frac{dT^*}{d\delta_F} < 0$, $\frac{dT^*}{d\tau} > 0$, $\frac{dT^*}{d\delta_C} > 0$, and $\frac{dT^*}{dV} > 0$, yields the comparative statics results.

Q.E.D.

The $50-50$ steady-state shows that any initial advantage of a firm disappears through time. This can be seen as due to entry of new generations of consumers. The convergence to the steady-state goes through oscillating market shares, with the firm with a larger market share in a given period being the firm with the smaller market share in the next period. This is because, the firm that just had a high market share will price higher to take advantage of the consumers that got a positive experience with the firm's product, and this results in a smaller market share of the new generation of consumers. See Figure 3 for an example of the oscillating market shares towards the steady-state.

The convergence to steady-state becomes slower when either the distribution of valuations becomes more negatively skewed (greater consumer risk aversion, greater α) or the experience of the product becomes more important (greater V). In either of these cases a firm gains more from charging a higher price following a period with a large market share, and this results in slower convergence the $50-50$ division of the market. Table 1 presents values for $\frac{2\alpha^2 V}{T}$ as a function of α.

When firms value the future more, greater δ_F, they realize that the potential gains from having had a large market share in the previous period are to be had when they are possible, because the competition for future gains is very intensive. This makes firms charge higher prices when they have higher market shares, which again causes the convergence to steady-state to become slower.

When the importance of the observable characteristics of the products is greater, higher τ, the convergence to steady-state is faster, because relatively, firms have less incentive to price higher when they had a higher market share in the previous period. Similarly, when consumers value the future more, greater δ_C, they become less price sensitive, as discussed above. Then, a firm charging a higher price in a certain period does not loose too many consumers, which means that we are going to get faster to the $50-50$ division of the market.

As above, because when changing α one is also changing the mean of the distribution of valuations, which is $\underline{\mu} + V\frac{1+\alpha}{2}$, one could possibly argue that the comparative statics on α results from increasing the valuation for each product. One can then do comparative statics on α while changing V to keep $V\frac{1+\alpha}{2} = k$, a constant. The next proposition shows that the result on the comparative statics on α remains unchanged.

PROPOSITION 13: *Suppose $V\frac{1+\alpha}{2} = k$. Then an increase in α, with the corresponding decrease in V results in a slower convergence to the steady-state.*

PROOF: From the proof of Proposition 11 we know that $\frac{\partial T^*}{\partial \alpha} - \frac{\partial T^*}{\partial V}\frac{V}{1+\alpha} < 0$. Because $\frac{\partial \alpha^2 V}{\partial \alpha} - \frac{\partial \alpha^2 V}{\partial V}\frac{V}{1+\alpha} > 0$, we can then get the result.

Q.E.D.

5.5. *Steady-State Prices and Profits*

Consider now the steady-state prices and profits. Note first that because in steady-state the demand for each firm has mass one ($\frac{1}{2}$ from each generation of consumers) the profit per period is equal to the steady-state price, call it $\overline{p}$. Differentiating (12) at the steady-state we can obtain, using the envelope theorem,

$$\frac{dW(\frac{1}{2})}{d\widetilde{x}_{t-1}} = \overline{p}[\alpha^2 + (\frac{1}{2y} + \frac{1-\alpha}{V})\frac{dp_{Bt}}{d\widetilde{x}_{t-1}}] + \delta_F \frac{dW(\frac{1}{2})}{d\widetilde{x}_t}\frac{\partial \widetilde{x}_t}{\partial p_{Bt}}\frac{dp_{Bt}}{d\widetilde{x}_{t-1}}. \tag{24}$$

Using $\frac{\partial \widetilde{x}_t}{\partial p_{Bt}} = \frac{1}{2y}$ and $\frac{dp_{Bt}}{d\widetilde{x}_{t-1}} = -\frac{2y\alpha^2 V}{T}$, one can obtain

$$\frac{dW(\frac{1}{2})}{d\widetilde{x}_{t-1}} = \frac{\alpha^2 \overline{p}}{T + \delta_F \alpha^2 V}[T - 2(1-\alpha)y - V].$$

The first order condition for prices at $\widetilde{x}_{t-1} = \frac{1}{2}$ is

$$\frac{y - \overline{p}}{2y} + \frac{1}{2} - \frac{1-\alpha}{V}\overline{p} + \delta_F \frac{dW(\frac{1}{2})}{d\widetilde{x}_{t-1}}[-\frac{1}{2y}] = 0.$$

Substituting for $\frac{dW(\frac{1}{2})}{d\widetilde{x}_{t-1}}$ one can then obtain the steady-state prices as

$$\overline{p} = \frac{2y}{1 + 2y\frac{1-\alpha}{V} + \frac{\delta_F \alpha^2 [T - 2(1-\alpha)y - V]}{T + \delta_F \alpha^2 V}}. \tag{25}$$

For α small one can easily check that the steady-state prices are greater than the first-period prices, and smaller that the second-period prices in the two-period model. Therefore, the steady-state prices are also smaller than the full-information equilibrium prices. From (25) one can also derive the following result.

Proposition 14: *Consider α small. Then the steady-state prices and profits increasing in α, V, τ, and δ_C, and decreasing in δ_F.*

Proof: See Appendix.

As expected, greater differentiation in either observable (τ) or experienced product characteristics (V) result in higher prices. When the distribution over valuations becomes more negatively skewed (greater consumer risk aversion with respect to the physical performance of the product, i.e., greater α) steady-state prices increase. That is, the first-period (in the two-period model) effect of cutting prices is dominated by the second-period effect of raising prices. Table 1 presents the steady-state prices as a function of α. If we increase α and simultaneously decrease V to keep the mean valuation constant, $V\frac{1+\alpha}{2} = k$, one also finds that when $\alpha \to 0$, we have

$$\frac{1}{\alpha}\frac{d\overline{p}}{d\alpha}_{|V\frac{1+\alpha}{2}=k} \to \frac{\tau V(4\delta_C V + 8\tau)}{(V + 2\tau)^2} > 0,$$

that is, steady-state prices and profits are still increasing in α.

When consumers value the future more, greater δ_C, they become less price sensitive in their first period in the market, as shown above, and this leads to higher steady-state prices and profits.

When firms value the future more, greater δ_F, steady-state prices decrease because firms value more the future gains of having greater market share, and therefore, compete more for market share.

6. Conclusion

This paper considers the competitive effects of the potential informational advantages of a product that has been experienced 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. Note also that the negative skewness of the distribution ends up being quite intuitive in the sense that consumers are concerned about trying another product because they are concerned about getting a very poor draw.

The paper shows that the skewness of the distribution over valuations is related to the risk aversion of consumers with respect to the physical performance of the good. In fact, greater risk inversion translates into the distribution over valuations being more negatively skewed.

I investigate a two-period model, to gain intuition on the economic forces at work, and an infinite-horizon model, to check for robustness of the results, and see how some counter effects in the two period model average out in the infinite horizon.

Overall, for a negatively skewed distribution one finds that steady state prices and profits are higher the greater the informational differentiation effects, that is, the greater the distribution of valuations is negatively skewed. The steady state prices are also found to be increasing in consumer patience, and in the importance of the experience in the ex-post valuation of the product. Prices are decreasing in how much firms value the future. One also obtains that the market share dynamics are oscillating, with the firm with a greater market share in one period, having the smaller market share in the next period. Several comparative statics with respect to the speed of convergence to the steady-state are also presented.

For completeness let me briefly discuss how the results would change if the distribution over valuations were positively skewed. In that case (and in this model) firms are hurt by having a greater market share from the first-time consumers, and therefore compete less for them. Because in steady-state the competition for generation of consumers with age two is the same as the one presented above, overall prices increase in the skewness of the distribution. In terms of the market share dynamics, because the firm that has a higher previous period market share is the one charging a price, the market share dynamics are monotonic (and not oscillating) towards the steady-state.

APPENDIX

Explicit expression for appropriate solution T^* for $h_3(T) = 0$. For the solution to this quartic equation we follow Birkhoff and MacLane (1996, pp. 107-108). Remember $h_3(T) \equiv T^4 - T^3[2\delta_C\alpha^4 V + 6\tau(1-\alpha)(1+\delta_C\alpha^2) + 3V] + 6\delta_C\alpha^4V^2T^2 + T[4\alpha^4V^3\delta_F + 8\tau\delta_F\alpha^4V^2(1-\alpha)(1+\delta_C\alpha^2)] - 8\delta_C\delta_F\alpha^8V^4$. Define $\gamma_3 \equiv -[2\delta_C\alpha^4V + 6\tau(1-\alpha)(1+\delta_C\alpha^2) + 3V], \gamma_2 \equiv 6\delta_C\alpha^4V^2, \gamma_1 \equiv [4\alpha^4V^3\delta_F + 8\tau\delta_F\alpha^4V^2(1-\alpha)(1+\delta_C\alpha^2)]$, and $\gamma_0 \equiv -8\delta_C\delta_F\alpha^8V^4$. Define also $Q \equiv \frac{3\gamma_1\gamma_3 - 4\gamma_0) - \gamma_2^2}{9}$, $R = \frac{-9\gamma_2(\gamma_1\gamma_3 - 4\gamma_0) - 27(4\gamma_2\gamma_0 - \gamma_1^2 - \gamma_3^2\gamma_0) + 2\gamma_3^3}{54}$, and $Y \equiv \frac{\gamma_2}{3} + 2\sqrt{-Q}\cos\{\frac{\arccos\frac{R}{\sqrt{-Q^3}}}{3}\}$. Then,

$$T^* = -\frac{\gamma_3}{4} + \frac{1}{2}\sqrt{\frac{1}{4}\gamma_3^2 - \gamma_2 + Y} + \frac{1}{2}\sqrt{\frac{\gamma_3^2}{2} - \gamma_2 - Y + \frac{4\gamma_3\gamma_2 - 8\gamma_1 - \gamma_3^3}{4}\frac{1}{\sqrt{\frac{\gamma_3^2}{4} - \gamma_2 + Y}}}. \tag{i}$$

Proof of Proposition 10: In order to proof the proposition we have to check the comparative statics of y with respect to $\alpha, V, \tau, \delta_C$, and δ_F. First remember that $\frac{\partial h_3(T^*)}{\partial T} > 0$, so that the sign of the derivative of T^* with respect to any parameter is equal to minus the sign of the derivative of $h_3()$ with respect to that parameter.

(i) Consider first the comparative statics with respect to α. We have

$$\begin{aligned}\frac{\partial h_3(T^*)}{\partial\alpha} = \; & T^{*^2}\{24\delta_C\alpha^3V^2 + T^*[6(1+\delta_C\alpha^2)\tau - 12\delta_C\alpha(1-\alpha)\tau - 8\delta_C\alpha^3V]\} + \\ & 4\alpha^3V^2\delta_FT^*[4V + 8(1-\alpha)(1+\delta_C\alpha^2)\tau - 2\alpha(1+\delta_C\alpha^2)\tau + 4\delta_C\alpha^2(1-\alpha)\tau] \\ & -64\delta_F\delta_C\alpha^7V^4. \end{aligned} \tag{ii}$$

Consider first the first term, the term without δ_F. If $6(1+\delta_C\alpha^2)\tau - 12\delta_C\alpha(1-\alpha)\tau - 8\delta_C\alpha^3V > 0$ the first term is positive. If, on the other hand, $6(1+\delta_C\alpha^2)\tau - 12\delta_C\alpha(1-\alpha)\tau - 8\delta_C\alpha^3V < 0$ the worst case for the first term to be negative is when $T^* = 3V + 6\tau$. Substituting in the first term one obtains $24\delta_C\alpha^3V^2 + (3V+6\tau)[6(1+\delta_C\alpha^2)\tau - 12\delta_C\alpha(1-\alpha)\tau - 8\delta_C\alpha^3V] = \delta_C\alpha^2V\tau(54-48\alpha) + 18V\tau(1-2\delta_C\alpha) + 6\tau^2[6(1-2\delta_C\alpha) + 18\delta_C\alpha^2] > 0$. Then the first term in (ii) is always positive. Consider now the second and third terms in (ii). Because the term in T^* is always positive, the worst case for the sum of the second and third term to be negative is when $T^* = (3-\alpha)V$. Considering this case, the sum of second and third terms becomes $4\alpha^3\delta_FV^2\{4V(3-\alpha-4\delta_C\alpha^4) + (3-\alpha)\tau[(8-10\alpha)(1+\delta_C\alpha^2) + 4\delta_C\alpha^2(1-\alpha)]\} > 0$. Then, $\frac{\partial h_3(T^*)}{\partial\alpha} > 0$, which yields $\frac{dT^*}{d\alpha} < 0$.

Finally, note that $\frac{dy}{d\alpha} = \frac{\partial h_1(T^*)}{\partial \alpha} + \frac{\partial h_1(T^*)}{\partial T}\frac{dT^*}{d\alpha}$. One can directly check that

$$\frac{\partial h_1(T^*)}{\partial \alpha} = \tau T^* \frac{2\delta_C \alpha T + 4\delta_C \alpha^5 V + 8\delta_C \alpha^3 V}{(T^* - 2\delta_C \alpha^4 V)^2} > 0,$$

and $\frac{\partial h_1(T^*)}{\partial T} = -\tau \frac{2\delta_C \alpha^4 V(1+\delta_C \alpha^2)}{(T^* - 2\delta_C \alpha^4 V)^2} < 0$. Therefore, we obtain $\frac{dy}{d\alpha} > 0$.

(ii) Consider now the comparative statics with respect to τ. We have

$$\frac{\partial h_3(T^*)}{\partial \tau} = -(1-\alpha)(1+\delta_C \alpha^2)T^*(6{T^*}^2 - 8\alpha^4 \delta_F V^2) < 0. \qquad \text{(iii)}$$

Then, $\frac{dT^*}{d\tau} > 0$.

Now, note that $\frac{dy}{d\tau} = \frac{\partial h_2(T^*)}{\partial \tau} + \frac{\partial h_2(T^*)}{\partial T}\frac{dT^*}{d\tau}$. One can directly check that $\frac{\partial h_2(T^*)}{\partial \tau} = 0$, and $\frac{\partial h_2(T^*)}{\partial T} = \frac{3{T^*}^2({T^*}^2 - 4\alpha^4 V^2 \delta_C)}{2(1-\alpha)(3{T^*}^2 - 4\delta_C \alpha^4 V^2)^2} > 0$. This yields $\frac{dy}{d\tau} > 0$.

(iii) Consider now the comparative statics with respect to δ_F. We have

$$\frac{\partial h_3(T^*)}{\partial \delta_F} = 4\alpha^4 V^2[T^*(V + 2\tau(1-\alpha)(1+\delta_C \alpha^2)) - 2\delta_C \alpha^4 V^2] > 0. \qquad \text{(iv)}$$

Then we know that $\frac{dT^*}{d\delta_F} < 0$.

Note also that $\frac{dy}{d\delta_F} = \frac{\partial h_1(T^*)}{\partial \delta_F} + \frac{\partial h_1(T^*)}{\partial T}\frac{dT^*}{d\delta_F}$. One can directly check that $\frac{\partial h_1(T^*)}{\partial \delta_F} = 0$, and we already know that $\frac{\partial h_1(T^*)}{\partial T} < 0$. Therefore, we obtain $\frac{dy}{d\delta_F} > 0$.

(iv) Consider now the comparative statics with respect to δ_C. We have

$$\frac{\partial h_3(T^*)}{\partial \delta_C} = 2\alpha^2 {T^*}^2[3\alpha^2 V^2 - (2\alpha^2 V + 3\tau(1-\alpha))T^*] + 8\alpha^6 V^2[T^*(1-\alpha)\tau - \alpha^2 V^2]. \qquad \text{(v)}$$

Note that the first term is decreasing in T^*, and the second term in increasing in T^*. Therefore, (v) is smaller than the expression where we substitute $T^* = (3-\alpha)V$ in the first term and $T^* = 3V + 6\tau$ in the second term, which yields $2\alpha^2 V^2 \tau^2\{-\alpha^2(3-\alpha)^2(3-2\alpha)(\frac{V}{\tau})^2 - 3(1-\alpha)[(3-\alpha)^2 - 4\alpha^4]\frac{V}{\tau} + 24\alpha^4(1-\alpha)\}$ which is negative because $\frac{V}{\tau}$ is assumed greater then two. Then $\frac{\partial h_3(T^*)}{\partial \delta_C} < 0$, and $\frac{dT^*}{d\delta_C} > 0$.

Note also that $\frac{dy}{d\delta_C} = \frac{\partial h_2(T^*)}{\partial \delta_C} + \frac{\partial h_2(T^*)}{\partial T}\frac{dT^*}{d\delta_C}$. One can directly check that $\frac{\partial h_2(T^*)}{\partial \delta_C} = 0$, and we already know that $\frac{\partial h_2(T^*)}{\partial T} > 0$. Therefore, we obtain $\frac{dy}{d\delta_C} > 0$.

(v) Consider now the comparative statics with respect to V. We have

$$\frac{\partial h_3(T^*)}{\partial V} = -T^{*^2}[(2\delta_C\alpha^4+3)T^*-12\delta_C\alpha^4V]+4\delta_F\alpha^4V\{[3V+4(1-\alpha)(1+\delta_C\alpha^2)\tau]T^*-8\delta_C\alpha^4V^2\}. \quad \text{(vi)}$$

This expression is smaller than $-V\tau^2\{(\frac{V}{\tau})^2[(3-\alpha)^3(3+2\delta_C\alpha^2)-12\delta_C\alpha^4(3-\alpha)^2-36\alpha^4+32\alpha^8]-120\alpha^4\frac{V}{\tau}-96\alpha^4\}$ because the first term in (vi) is decreasing in T^*, the second term in (vi) is increasing in T^* and δ_F, and $(1-\alpha)(1+\delta_C\alpha^2)$ is decreasing in α. Given that $\frac{V}{\tau}$ is assumed greater than 2, the term $(\frac{V}{\tau})^2[(3-\alpha)^3(3+2\delta_C\alpha^2)-12\delta_C\alpha^4(3-\alpha)^2-36\alpha^4+32\alpha^8]-120\alpha^4\frac{V}{\tau}-96\alpha^4$ can be shown to be always positive, which implies that $\frac{\partial h_3(T^*)}{\partial V}<0$, i.e., $\frac{dT^*}{dV}>0$.

Finally, note that $\frac{dy}{dV}=\frac{\partial h_1(T^*)}{\partial V}+\frac{\partial h_1(T^*)}{\partial T}\frac{dT^*}{dV}$. For $\alpha\to 0$, $\frac{dT^*}{dV}\to 3$, $\frac{1}{\alpha^4}\frac{\partial h_1(T^*)}{\partial T}\to-\frac{2\delta_C\tau V}{(3V+6\tau)^2}$, and $\frac{1}{\alpha^4}\frac{\partial h_1(T^*)}{\partial V}\to\frac{2\delta_C\tau}{3V+6\tau}$, which yields $\frac{1}{\alpha^4}\frac{dy}{dV}\to\frac{12\delta_C\tau^2}{(3V+6\tau)^2}>0$ which shows that $\frac{dy}{dV}$ is positive for α small.

Q.E.D.

Proof of Proposition 11: Realizing that $\frac{dV}{d\alpha}=-\frac{V}{1+\alpha}$ and differentiating with respect to α and V from the proof of Proposition 10 one can write

$$\frac{dy}{d\alpha}_{|V\frac{1+\alpha}{2}=k}=\frac{\partial h_1}{\partial\alpha}-\frac{\partial h_1}{\partial V}\frac{V}{1+\alpha}-\frac{\partial h_1}{\partial T}\frac{1}{\frac{\partial h_3}{\partial T}}[\frac{\partial h_3}{\partial\alpha}-\frac{\partial h_3}{\partial V}\frac{V}{1+\alpha}].$$

One can obtain

$$\begin{aligned}(1+\alpha)[\frac{\partial h_3}{\partial\alpha}-\frac{\partial h_3}{\partial V}\frac{V}{1+\alpha}] \;=\;& T^{*^2}\{24\delta_C\alpha^3V^2+12\delta_C\alpha^4V^2+T^*[6\tau(1-2\delta_C\alpha)(1+\alpha)\\ &+18\delta_C\alpha^2\tau(1+\alpha)+V(3-6\delta_C\alpha^4-8\delta_C\alpha^3)]\}+4\alpha^3V^2\delta_F\tau[4V(1+\alpha)+\\ &(8-10\alpha)(1+\delta_C\alpha^2)(1+\alpha)\tau+4\delta_C\alpha^2\tau(1-\alpha^2)-3\alpha V\\ &-4\alpha\tau(1-\alpha)(1+\delta_C\alpha^2)]-64\delta_C\delta_F\alpha^7V^4-32\delta_C\delta_F\alpha^8V^4 \qquad \text{(vii)}\end{aligned}$$

which is positive given $T^*\in[(3-\alpha)V,3V+6\tau]$ and $\alpha\in[0,\frac{1}{2}]$. Note also that

$$\frac{\partial h_1}{\partial\alpha}-\frac{\partial h_1}{\partial T}\frac{V}{1+\alpha}=\frac{T^*\delta_C}{(1+\alpha)(T^*-2\delta_C\alpha^4V)^2}\{2\alpha T^*+2\alpha^2T^*+8\alpha^3V+6\alpha^4V+4\delta_C\alpha^5V+2\delta_C\alpha^6V\}>0 \qquad \text{(viii)}$$

which, given $\frac{\partial h_1}{\partial T}<0$ and $\frac{\partial h_3}{\partial T}>0$, allows us to conclude that

$$\frac{dy}{d\alpha}_{|V\frac{1+\alpha}{2}=k}>0.$$

Q.E.D.

Proof of Proposition 14: When $\alpha \to 0$, one can obtain $\frac{dT^*}{d\alpha} \to -6\tau$, $\frac{dT^*}{dV} \to 3$, $\frac{dT^*}{d\tau} \to 6$, $\frac{1}{\alpha^2}\frac{dT^*}{d\delta_C} \to 6\tau$, $\frac{1}{\alpha^4}\frac{dT^*}{d\delta_F} \to -\frac{4V^2}{9(V+2\tau)}$, $\frac{1}{\alpha}\frac{dy}{d\alpha} \to 2\delta_C\tau$, $\frac{1}{\alpha^4}\frac{dy}{dV} \to \frac{12\delta_C\tau^2}{(3V+6\tau)^2}$, $\frac{dy}{d\tau} \to 1$, $\frac{1}{\alpha^2}\frac{dy}{d\delta_C} \to \tau$, $\frac{1}{\alpha^8}\frac{dy}{d\delta_F} \to \frac{8\delta_C\tau V^3}{81(V+2\tau)^3}$. Differentiating (25) one can then obtain when $\alpha \to 0$ that $\frac{d\overline{p}}{d\alpha} \to \frac{4\tau^2V}{(V+2\tau)^2} > 0$, $\frac{d\overline{p}}{dV} \to \frac{4\tau^2}{(V+2\tau)^2} > 0$, $\frac{d\overline{p}}{d\tau} \to \frac{2V^2}{(V+2\tau)^2} > 0$, $\frac{1}{\alpha^2}\frac{d\overline{p}}{d\delta_C} \to \frac{2\tau V^2}{(V+2\tau)^2} > 0$, and $\frac{1}{\alpha^2}\frac{d\overline{p}}{d\delta_F} \to -\frac{4\tau V^2}{9(V+2\tau)^2} < 0$. By continuity for α small we get the result in the proposition.

Q.E.D.

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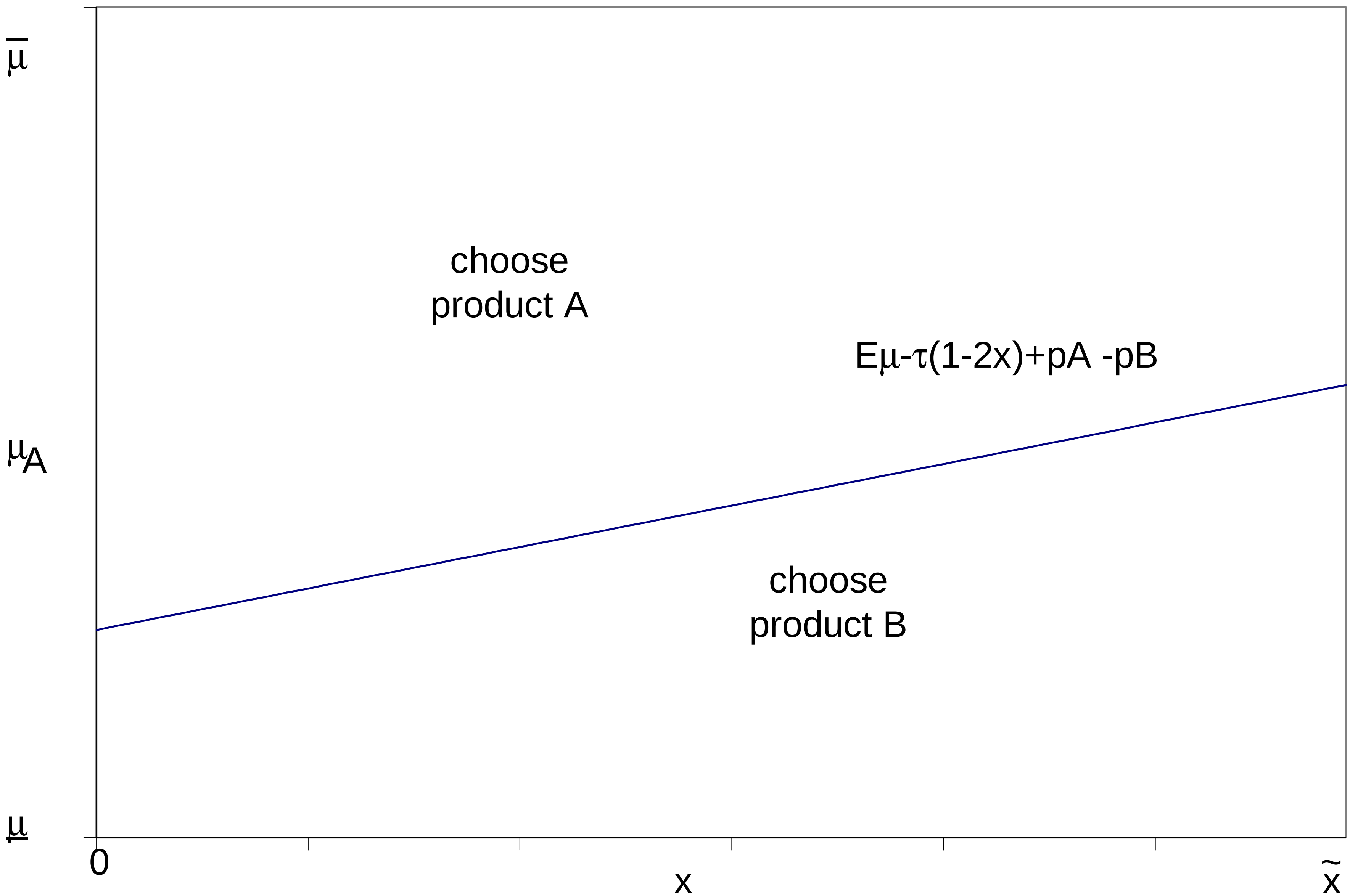

Figure 1: Choice in second period for consumers having bought product A in first period.

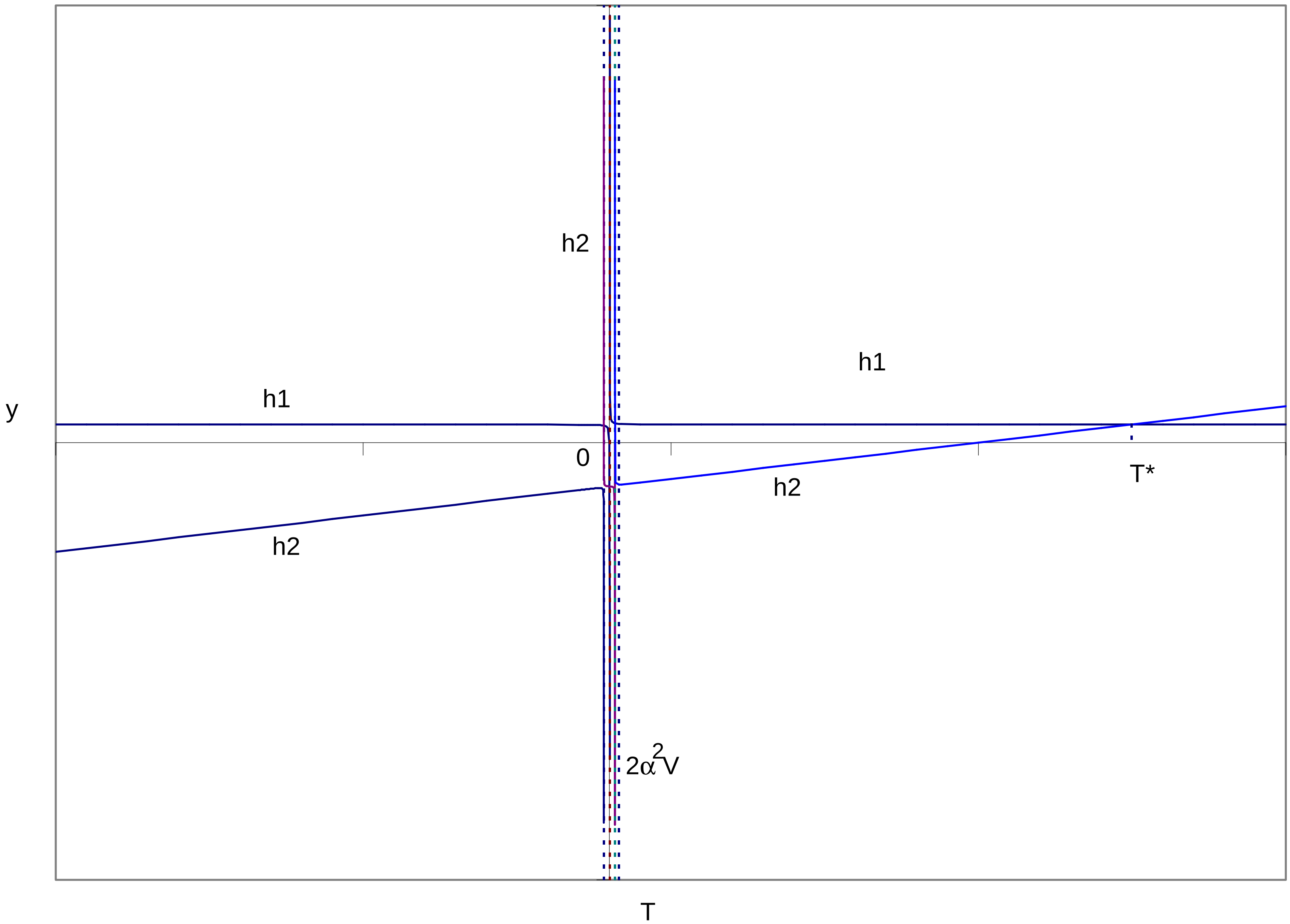

Figure2a: Curves h1(T) and h2(T) determining T*.

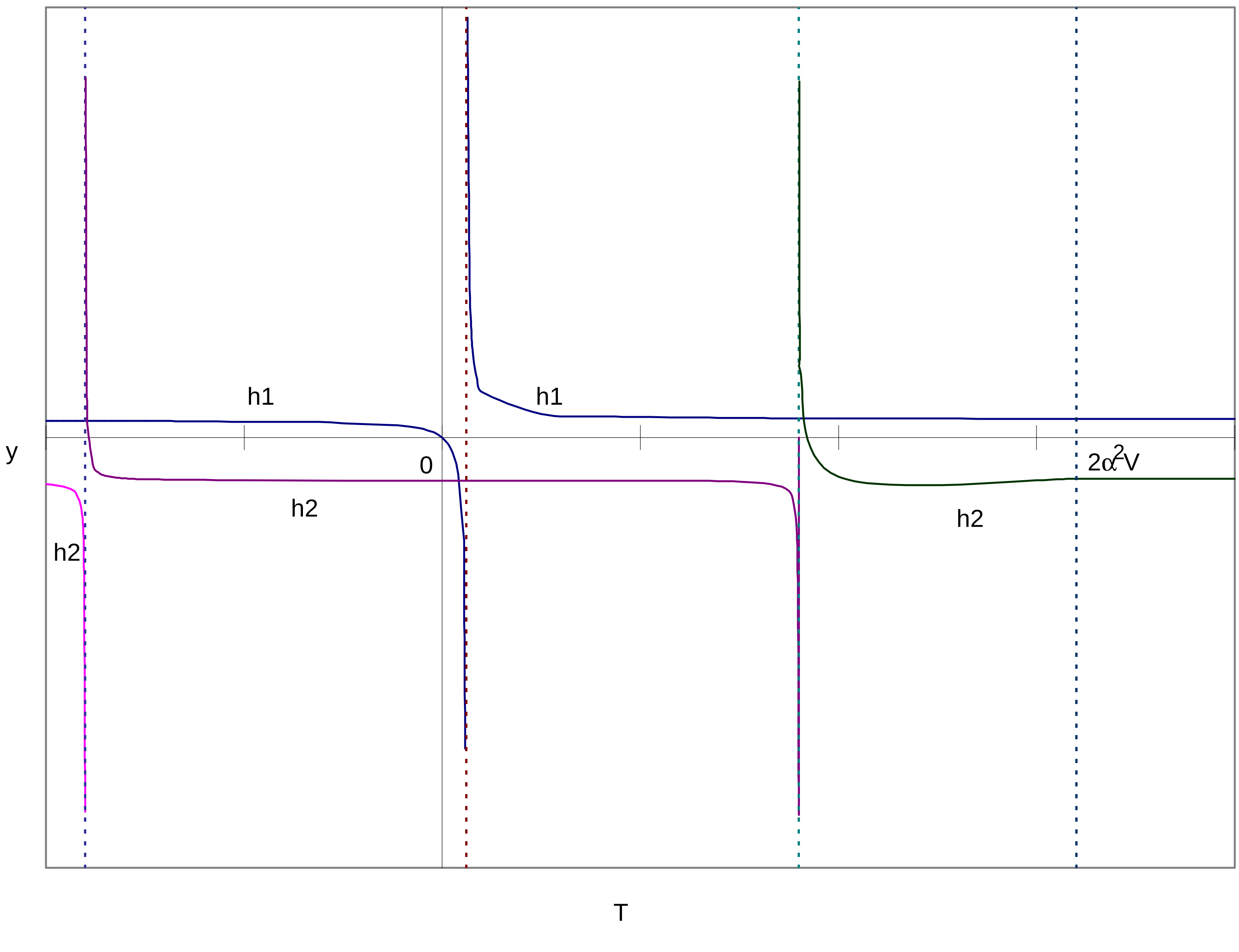

Figure 2b: Curves h1(T) and h2(T) close to T=0.

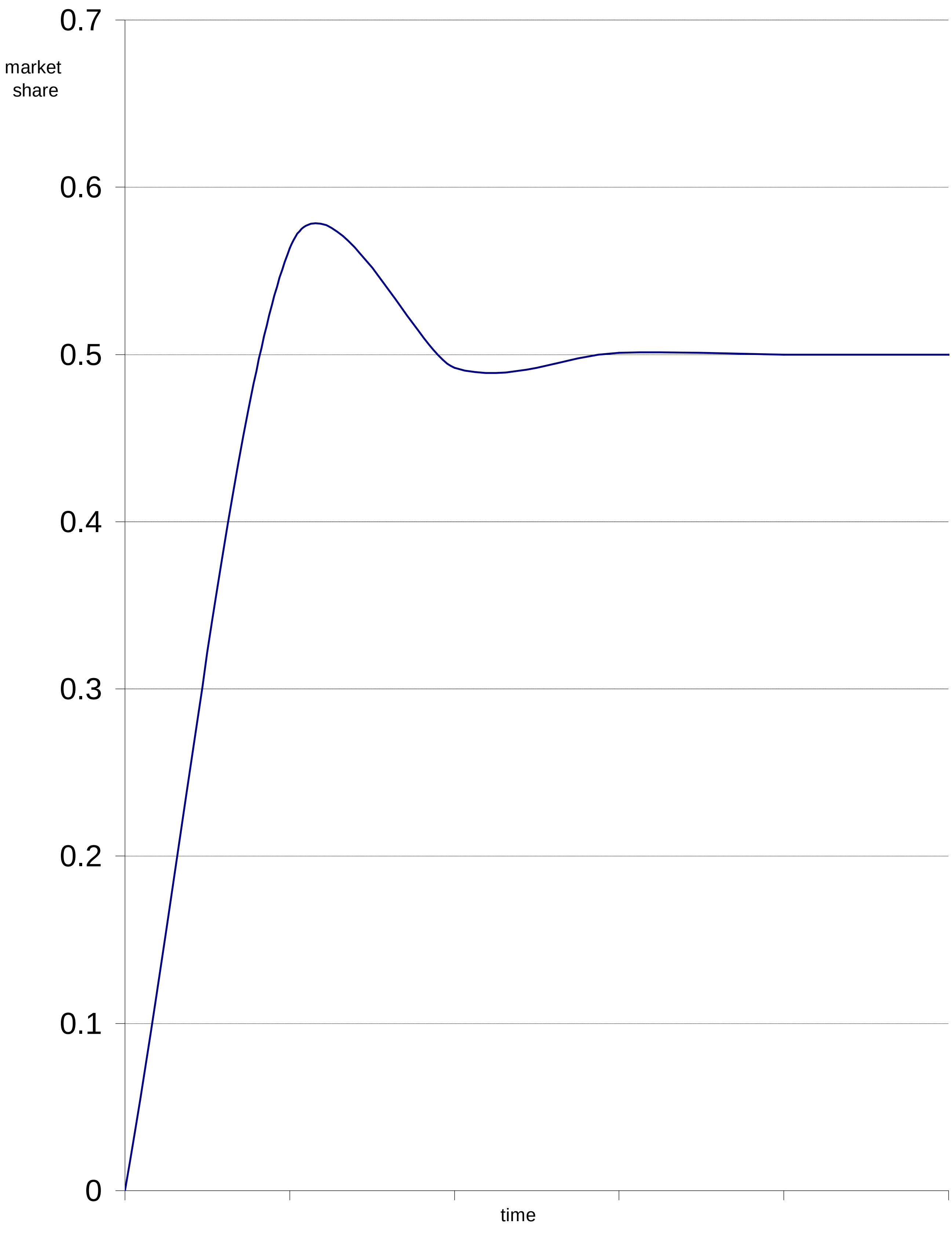

Figure 3: Oscillating market shares through time.