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The competitiveness of markets with switching costs

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This article examines a two-period differentiated-products duopoly in which consumers are partially "locked in" by switching costs that they face in the second period. While these switching costs naturally make demand more inelastic in the second period, they also do so in the first period, because consumers recognize that a firm with a higher market share charges a higher price in the second period and hence is a less attractive supplier to which to be attached. Prices are lower in the first period than subsequently, because firms compete for market share that is valuable later. But prices may be higher in both periods than they would be in a market without switching costs.

1. Introduction

■ I model a two-period market where two firms offer differentiated products that are substitutes, but where the costs of changing suppliers in the second period partially force consumers to continue using the products they initially selected. A central conclusion, one contrasting with that emerging from von Weizsäcker's (1984) model, is that the market may be less competitive in both periods than a market with no switching costs.

In many markets consumers face substantial changeover costs of switching from a product to one of its substitutes. One reason is that there may be learning costs, such as the costs of switching to a new brand of computer or cake mix after learning to use another brand. These may be large even if the brands are functionally very similar. A second reason is that there may be transaction costs, such as the costs of closing an account with one bank and opening another with a competitor, of changing one's long-distance telephone service, or of returning rented equipment to one supplier to rent similar equipment from an alternative supplier. A third reason is that firms may create artificial switching costs, such as repeat-purchase coupons and "frequent-flyer" programs that reward customers for repeated travel on the same airline, and so penalize brand-switchers.[1]

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[1] If a consumer must purchase a brand to discover its suitability (that is, each brand is an experience good in the terminology of Nelson (1970)), then, in expectation, the consumer faces a loss of utility from switching to an untested brand from one that he has tried and liked. In this case, however, there are additional complications owing to the possibility that prices are used as signals of quality and owing to the existence of groups of consumers who tried a brand and did not like it. There may also be psychological costs, as when, for no obvious economically rational reason, consumers make repeat purchases from simple habit or loyalty. See Klemperer (1986) for more examples of switching costs.

Von Weizsäcker (1984) presents a model in which products are differentiated by both characteristics and a switching cost that must be paid by any consumer using a product that he did not purchase in the previous period.[2] His main conclusion is that if consumers' tastes for the underlying product characteristics may change over time, then higher switching costs generally make markets more competitive. The reason is that the higher are the switching costs, the more consumers' choices are influenced by the future when their tastes are uncertain and the relatively less important are their current preferences. In effect, the products are less differentiated. With sufficiently high switching costs, a consumer will always buy from the same firm in the future. Therefore, if future tastes are unknown, then today's tastes are relatively unimportant in comparison with any price difference that is expected to last.

Von Weizsäcker's results depend critically, however, on the assumption that any difference between the firms' prices is expected to last. He assumes a "reputation equilibrium" in which firms are committed to maintaining the same price in every period. I, on the other hand, show that a firm has an incentive to raise price in the later stage of a market's development, so as to exploit the consumers who initially bought its product. Higher switching costs reduce consumers' flexibility, and thereby reduce firms' elasticities of demand. Thus, in a subgame-perfect equilibrium the outcomes are *less* competitive—with higher profits— after the initial period.

The dependence of future profits on the number of locked-in customers *may* lead to more competitive behavior in the initial period (before consumers have attached themselves to suppliers) than if there were no switching costs. But second-period switching costs also change the structure of demand in the *first* period. Consumers with rational expectations recognize that a firm with a lower first-period price will gain a greater market share and that a firm with a higher market share will charge a higher price in the second period (since a firm with a higher market share places more weight on exploiting existing customers than on attracting new ones, while a firm with a lower market share charges a lower price to win customers). Thus, even in the first period consumers are less tempted by a price cut than in a market without switching costs. Switching costs make demand more inelastic in both the initial and subsequent period. In a two-period market switching costs may make the market less competitive in *both* periods.

I present the model in Section 2 and analyze in Section 3 how the second-period equilibrium depends on the first-period market shares. Knowledge of this dependence allows us to solve for the first-period equilibrium, and hence the outcome of the whole game, in Section 4. I conclude in Section 5.

2. The model

■ I follow von Weizsäcker (1984) in adding switching costs and intertemporally changing tastes to a standard spatial location model of product differentiation. The differences between this model and von Weizsäcker's are: (i) I look for a subgame-perfect equilibrium in which firms are not forced to charge the same price in every period; (ii) I extend the model by assuming that a fraction $v \in [0, 1]$ of consumers leave the market after the first period and are replaced by new consumers; and (iii) I restrict the model to two periods.

In the first period consumers with reservation price r, net of transport and switching costs, for one unit of the product are arrayed with unit density along the line segment $(0, t)$ with firms A and B at 0 and t, respectively. A consumer at x has a "transport" cost x of using A's product or $(t - x)$ of using B's product. Thus, the firms' products are

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[2] For models of switching costs without functional product differentiation, see Farrell (1985), Klemperer (1984, 1987a), Summers (1985), and Wernerfelt (1985). See Klemperer (1986, 1987b) for models considering the implications of switching costs for new entry into a market.

close substitutes—a consumer will buy only from one supplier in any period—but they are not identical.

In the second period consumers are again arrayed with unit density along the line segment, they again have reservation price r, net of transport and switching costs, for one unit of the product, and a consumer at x has a transport cost x of using A's product or $(t - x)$ of using B's product. A fraction μ have tastes for underlying product characteristics in the second period that are independent of their first-period tastes; for them the second-period location on the line segment is independent of their first-period location. A fraction ν of first-period consumers leave the market after the first period (will not purchase again at any price) and are replaced by new consumers, who are also uniformly distributed along the line. The remaining fraction $(1 - \mu - \nu)$ have constant tastes for the underlying product characteristics. For simplicity, assume that the density of consumers joining the market after the first period equals the density of consumers leaving the market. Assume also that whether a first-period consumer has fixed tastes for underlying product characteristics, has changing tastes, or leaves the market is independent of his position on the line segment, unaffected by his first-period decision, and unknown to him until after his first-period purchase.

Consumers' tastes for underlying product characteristics are thus represented by their position on the line segment and taken into account through transport costs. In addition, a consumer has a switching cost s of purchasing a product that he has not previously purchased.[3] Assume that $s \in (0, t)$, so that at least some consumers' preferences for underlying product characteristics can outweigh their switching costs.[4]

Both firms and consumers have rational expectations and discount second-period revenues and costs by a factor λ in first-period terms. They cannot store the product between periods.

In each period each firm has marginal costs c per unit and no fixed costs, and noncooperatively chooses a price to maximize total future discounted profits. Assume that $r \geq c + s + (t/2) + [t/(\mu + \nu)]$ to ensure that in equilibrium all consumers purchase in each period.[5] Also assume that ν is sufficiently large that the first-order conditions define an equilibrium of the two-period game. (See further discussions of this in footnotes 8 and 15.) We write firms' first-period prices as p_1^A and p_1^B. These result in first-period profits π_1^A and π_1^B and market shares σ^A and σ^B (with $\sigma^A + \sigma^B = 1$). Firms' second-period choices of prices p_2^A and p_2^B and their second-period profits π_2^A and π_2^B depend on these market shares.[6] As usual, therefore, we must examine this dependence first, since to compute the first-period equilibrium we must know how future profits depend on first-period market shares.

3. The second period

■ In this section I analyze the second period of a market with switching costs, after consumers have attached themselves to suppliers in the first period. I compute firms' optimal

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[3] Thus, all consumers face a start-up cost s in the first period, regardless of the firm from which they buy. Since this cost is unavoidable, it would make no difference to the analysis if the first-period start-up cost were different from the second-period switching cost (provided that r is sufficiently large).

[4] If $s > t$, then even the consumers with changing preferences for underlying product characteristics always buy from the same firm in symmetric equilibrium, and the problem becomes equivalent to one in which no consumers have changing preferences ($\mu = 0$). For the case $\mu = 0$, however, the analysis here is valid without need of the requirement that $s < t$.

[5] Whether consumers have the same reservation prices in both periods and the same reservation prices as one another is, in fact, unimportant. For all the analysis, except that of the case $\mu + \nu = 0$ in Section 3, it is sufficient that all consumers' reservation prices are at least $c + s + (t/2) + [t/(\mu + \nu)]$.

[6] In first-period equilibrium all consumers to the left of $\sigma^A t$ buy from A, while all those to the right buy from B (see footnote 7), so that the outcome of the first period is fully captured by the firms' market shares.

prices as functions of their first-period market shares. In contrast to von Weizsäcker (1984), I assume firms' price choices are unconstrained by any previous choices.

Consider the different groups of consumers in turn. A fraction ν of consumers are "new" consumers, who were not in the market in the first period. A new consumer at x buys from A if $p_2^A + x < p_2^B + (t - x)$ and $p_2^A + x + s \leq r$. Thus, A sells to a mass $\nu[(t + p_2^B - p_2^A)/2]$ of the new consumers, provided that $r \geq s + [(t + p_2^B + p_2^A)/2]$, which condition ensures that the marginal consumer prefers buying from A to not buying at all, and provided that $|p_2^B - p_2^A| \leq t$. If $(p_2^B - p_2^A) > t$, A sells to all of the new consumers; if $(p_2^B - p_2^A) < -t$, A sells to none of them.

A fraction $\mu\sigma^A$ of consumers bought from A in the first period but now have tastes for the underlying product characteristics that are uniformly distributed along the line segment $(0, t)$. Of these, A sells to a mass $\mu\sigma^A[(t + p_2^B - p_2^A + s)/2]$, provided $r \geq ((s + t + p_2^B + p_2^A)/2)$ so that the marginal consumer buys from some firm and provided $|p_2^B - p_2^A + s| \leq t$. If $(p_2^B - p_2^A + s) > t$, A sells to all of this group of consumers; if $(p_2^B - p_2^A + s) < -t$, A sells to none of them. Similarly, A sells to a mass $\mu\sigma^B[(t + p_2^B - p_2^A - s)/2]$ of those who bought from B in the first period but whose tastes have changed, provided $r \geq ((s + t + p_2^B + p_2^A)/2)$ and $|p_2^A - p_2^B + s| \leq t$.

Finally, a fraction $(1 - \mu - \nu)\sigma^A t$ of consumers bought from A in the first period and have unchanged tastes. Their tastes are therefore uniformly distributed along the line segment $(0, \sigma^A t)$, so all purchase from A if $p_2^A + \sigma^A t \leq p_2^B + \sigma^B t + s$ and $p^A + \sigma^A t \leq r$.[7] This latter condition guarantees that all these consumers buy from some firm, and it is always satisfied, given the other necessary conditions. Similarly, none of the consumers who bought from B in the first period and whose tastes are unchanged purchase from A if $p_2^B + \sigma^B t \leq p_2^A + \sigma^A t + s$.

Therefore, A's total second-period sales are

$$q_2^A(p_2^A, p_2^B) = \nu\left(\frac{t + p_2^B - p_2^A}{2}\right) + \mu\left[\sigma^A\left(\frac{t + p_2^B - p_2^A + s}{2}\right) + \sigma^B\left(\frac{t + p_2^B - p_2^A - s}{2}\right)\right] + (1 - \mu - \nu)\sigma^A t$$

$$= \tfrac{1}{2}\{(\sigma^A - \sigma^B)((1 - \mu - \nu)t + \mu s) + t + (\mu + \nu)(p_2^B - p_2^A)\}, \tag{1}$$

and symmetrically for B, provided that $r \geq ((p_2^A + p_2^B + t + 2s)/2)$ and

$$|(p_2^A + \sigma^A t) - (p_2^B + \sigma^B t)| \leq s \leq t - |p_2^B - p_2^A|.$$

It follows that $\partial q_2^A/\partial p_2^A = [-(\mu + \nu)]/2$ and that $\partial \pi_2^A/\partial p_2^A = q_2^A + (p_2^A - c)(\partial q_2^A/\partial p_2^A)$ $= \tfrac{1}{2}\{(\sigma^A - \sigma^B)((1 - \mu - \nu)t + \mu s) + t + (\mu + \nu)(p_2^B - 2p_2^A + c)\}$. Thus, in equilibrium, where $\partial \pi_2^A/\partial p_2^A = \partial \pi_2^B/\partial p_2^B = 0$, and under the assumption that $\mu + \nu \neq 0$,

$$p_2^A = c + \frac{1}{\mu + \nu}[t + \tfrac{1}{3}(2\sigma^A - 1)((1 - \mu - \nu)t + \mu s)]. \tag{2}$$

Hence,

$$q_2^A = \tfrac{1}{2}[t + \tfrac{1}{3}(2\sigma^A - 1)((1 - \mu - \nu)t + \mu s)] \tag{3}$$

$$\pi_2^A = \frac{1}{2(\mu + \nu)}[t + \tfrac{1}{3}(2\sigma^A - 1)((1 - \mu - \nu)t + \mu s)]^2, \tag{4}$$

and symmetrically for B, provided that the conditions for (1) to hold are satisfied and provided that the first-order conditions specify firms' global best responses.

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[7] The fact that consumers do not know before their first-period purchase whether their tastes for the underlying product characteristics will change or whether they will leave the market guarantees that in the first period all consumers to the left of $\sigma^A t$ buy from A, while all those to the right buy from B, for some $\sigma^A \in [0, 1]$.

Under our assumptions, (2)–(4) define the unique symmetric pure-strategy equilibrium, provided that $|\sigma^A - \sigma^B| < (s/t)$.[8]

Note that the firm with the higher market share charges the higher price and that its second-period market share is less than its first-period market share. The reason is that it is relatively more interested in exploiting repeat-buyers and less interested in attracting new customers than is its smaller rival, which charges a lower price to win back some market share.[9]

In a symmetric equilibrium (the existence of which I show in Section 4), $\sigma^A = \sigma^B = 1/2$, so that we can rewrite (2)–(4) as

$$p_2^A = p_2^B = c + \frac{t}{\mu + \nu}, \tag{2a}$$

$$q_2^A = q_2^B = \frac{t}{2}, \tag{3a}$$

$$\pi_2^A = \pi_2^B = \frac{t^2}{2(\mu + \nu)}. \tag{4a}$$

For comparison, in a market without switching costs (or in which all the consumers are new so that $\nu = 1$, $\mu = 0$, and $1 - \mu - \nu = 0$), in equilibrium

$$p_2^A = p_2^B = c + t \tag{5}$$

$$q_2^A = q_2^B = \frac{t}{2} \tag{6}$$

$$\pi_2^A = \pi_2^B = \frac{t^2}{2}. \tag{7}$$

It is easy to ascertain that total industry profits and the average price paid by consumers are higher in the second period of a market with switching costs than in a market without switching costs. In a symmetric equilibrium the profits and prices of both firms are higher than in a market without switching costs.

Two extreme cases of special interest are the case in which all consumers were in the market in the previous period and have unchanged preferences for the underlying product characteristics ($\mu + \nu = 0$) and the case in which all consumers who bought in the previous period have tastes that are independent of their previous period's tastes ($\mu + \nu = 1$). I consider these special cases next.

□ **Unchanged preferences across periods.** When all second-period consumers were in the market in the first period and have unchanged preferences, we have $\mu + \nu = 0$. In this case the analysis above does not suffice because of the constraint imposed by the consumers' reservation price r. Provided that $|(p_2^A + \sigma^A t) - (p_2^B + \sigma^B t)| < s$ and that $p_2^A \leq r - \sigma^A t$, we

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[8] The second-order conditions always hold locally. Indeed, each firm's profit function is concave in its price in the region in which (1) holds. But this is not sufficient to show that (2) always defines a Nash equilibrium. The problem is that a firm may want to deviate from its strategy in the candidate equilibrium defined by the first-order conditions by choosing a strategy outside the range in which (1) holds. If, however, as I assumed, ν is large enough, the first-order conditions define an equilibrium both for the second period and for the full game. They also define an equilibrium if μ is large enough and s is small. In the second-period subgame with $\sigma^A = \sigma^B$ and $s = t/2$, for example, the equations (2)–(4) describe an equilibrium for $\mu > .38$ if $\nu = 0$, for $\nu > .43$ if $\mu = 0$, and always if $(1 - \mu - \nu) = 0$. Any of these sets of conditions ensures that firms choose strategies in the range in which (1) holds. (For small μ and ν, there exists no symmetric pure-strategy equilibrium, and mixed-strategy equilibria seem hard to find.)

[9] The result that the firm with a higher market share charges the higher price in the second period is fairly general (Farrell, 1986; Klemperer, 1986).

have $\partial\pi_2^A/\partial p_2^A = \sigma^A t > 0$. But for any pair of prices such that $p_2^A > r - \sigma^A t - s$ and $p_2^B > r - \sigma^B t - s$, no consumer will buy from the firm he did not purchase from in the first period, so that each firm acts as a monopolist on its own customer base of previous purchasers of its product. Thus, only the collusive prices (i.e., the firms' joint-profit-maximizing prices) satisfy the first-order condition for a symmetric equilibrium. For $r \geq c + t$ and $\sigma^A = \sigma^B = 1/2$, these prices are $p_2^A = p_2^B = r - (t/2)$, and all consumers buy. For $r < c + t$, $p_2^A = p_2^B = (r + c)/2$, but not all consumers buy; sufficient conditions for the first-order conditions to specify global best responses for the firms, that is, to define an equilibrium, are $r \leq c + s + (3t/2) + 2\sqrt{st}$ for $s \leq t$, and $r \leq c + 2s + (5t/2)$ for $s \geq t$. By separating the consumers into two distinct groups so that neither firm can attract any of the other firm's consumers except by a large price cut, switching costs cause the fully collusive outcome to arise as a noncooperative equilibrium.

Figure 1 illustrates this. Figure 1(a) shows the distribution of consumers when there are no switching costs. For a wide range of prices (p_2^A, p_2^B such that $|p_2^A - p_2^B| < t$), the density of marginal consumers is 1. Figure 1(b) shows the case with switching costs in which consumers' tastes for the underlying product characteristics do not change. All consumers to the left of $\sigma^A t$ were previously exposed to A. Their position with respect to A is therefore unchanged, but they are a distance s—the switching cost—farther from B. Conversely, consumers to the right were exposed to B and hence have unchanged positions relative to B, but are s farther from A. It is clear that for prices such that $|(p_2^A + \sigma^A t) - (p_2^B + \sigma^B t)| < s$, there are *no* marginal consumers, and the collusive outcome may be supported.[10]

☐ **Independent preferences across periods.** At the other extreme, consider the case in which each "old" consumer's preferences for the underlying product characteristics are independent of his previous preferences, and thus independent of his previous purchases ($\mu + \nu = 1$).[11] Comparing equations (2a)–(4a) and equations (5)–(7) shows that in a symmetric equilibrium the prices and profits in the market with switching costs are *identical* to those in a market without switching costs: consumers' changing tastes completely nullify the anticompetitiveness of switching costs.

The reason is easy to see from Figure 1(c), which illustrates the case when all consumers have previously purchased, but consumers' tastes change ($\mu = 1$). A fraction σ^A of consumers are uniformly distributed on $(0, t)$ but shifted s from B, while the complementary fraction are uniformly distributed on $(0, t)$ but shifted s from A. In this case in a symmetric equilibrium the identity of the marginal consumers is altered by the switching costs but their density, 1, is not, so that the market is as competitive as if there were no switching costs: $p_2^A = p_2^B = c + t$. Although switching costs reduce the number of marginal consumers and hence reduce competition, changing tastes create new marginal consumers:

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[10] This result, that the noncooperative equilibrium involves each firm's acting as a monopolist on its own customer base, does not depend on the assumption that all consumers have the same switching cost, or on an assumption that all consumers have a switching cost at or above some strictly positive fixed value. In Klemperer (1984) I showed that if a proportion $\Gamma(x)$ of consumers have a switching cost less than or equal to x, then only the joint-profit-maximizing price satisfies the first-order conditions for a symmetric noncooperative equilibrium provided that $\Gamma(0) = 0$ and $\partial\Gamma(0)/\partial x < \infty$. The reason is that an ϵ price cut only attracts the consumers who are both within $\epsilon/2$ of $t/2$ (that is, not more than ϵ farther from the firm than from its rival) and have sufficiently small switching cost (ϵ at most), that is, fewer than $\epsilon\Gamma(\epsilon)/2$ customers, but costs the firm $\epsilon q^A = \epsilon(t/2)$.

[11] This case might arise naturally if the purchasers in different periods are different people, but second-period consumers develop switching costs by being exposed to first-period consumers' purchases. For example, universities buy computers for students in the first period, and individuals who were students in the first period purchase in the second. Former students have a switching cost of learning the system their university did not purchase, but their underlying preferences, for example, the business applications they need, may be uncorrelated with their university's.

FIGURE 1

SECOND-PERIOD DISTRIBUTIONS OF PREFERENCES WHEN ACCOUNTING FOR SWITCHING COSTS
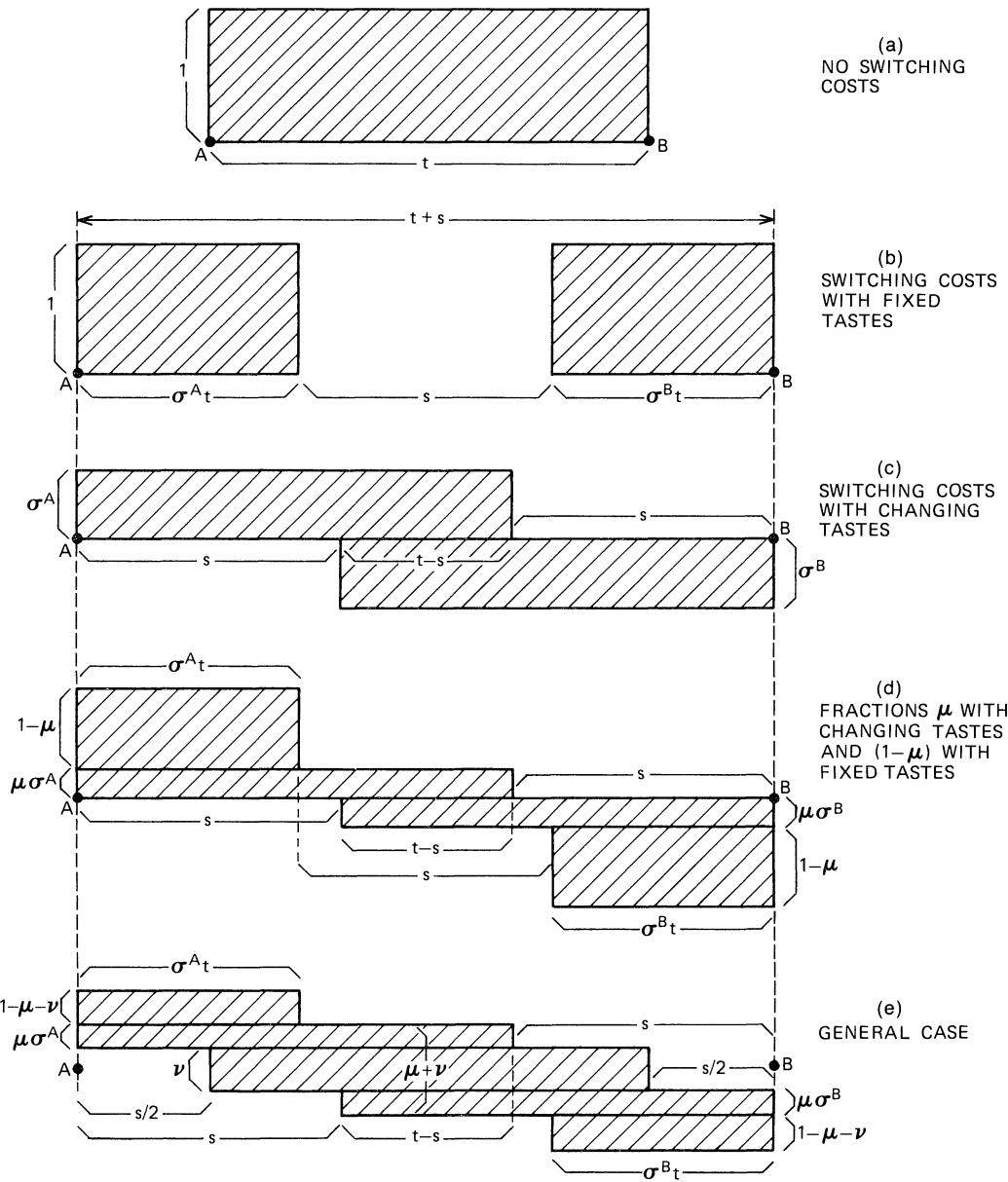
those who were previously exposed to one product but have now developed a preference for the other.[12]

□ **The general case.** Generally, in a symmetric equilibrium the firms' price-cost margin, $p - c$, is inversely proportional to the number of marginal consumers. For example, Figure 1(d) shows the distribution of consumers when the tastes of a fraction μ are uncorrelated

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[12] Again, this result does not depend on all consumers' having the same switching cost. In Klemperer (1984), I showed that for any distribution of switching costs such that no consumer has a switching cost greater than t, the price equals the price in a market without switching costs. A different distribution of switching costs simply changes the identities of the marginal consumers.

across time but others' tastes remain constant—simply a combination of Figures 1(b) and 1(c). Here the density of marginal consumers is μ, so that the symmetric equilibrium is $p_2^A = p_2^B = c + (t/\mu)$. Finally, Figure 1(e) illustrates the case in which a proportion $\nu > 0$ of consumers are new. These consumers are represented by an additional block of consumers of height ν and length t, centered halfway between the firms. Provided r is large enough that all consumers will buy from one or the other firm, all that matters is the relative distance of consumers from the two firms. The blocks of old consumers with fixed-tastes are reduced to height $(1 - \mu - \nu)$. In this case the density of marginal consumers is $(\mu + \nu)$ at a symmetric equilibrium so that $p_2^A = p_2^B = c + [t/(\mu + \nu)]$.

The outcomes in the general case lie between the collusive (joint-profit-maximizing) and the competitive (no-switching-costs) outcomes.[13]

Finally, notice that $\partial \pi_2^A / \partial \sigma^A > 0$, $\partial \pi_2^B / \partial \sigma^B > 0$, so that market share always helps each firm, and that $\partial(\partial \pi_2^A / \partial \sigma^A)/\partial s > 0$, $\partial(\partial \pi_2^B / \partial \sigma^B)/\partial s > 0$, so that the higher are switching costs, the more sensitive to market share is each firm's profit.

4. The first period

■ In the first period consumers have no ties to any particular firm, but each firm sets its price while taking into account not only the effect on its first-period profitability, but also the effect on its first-period market share and hence its second-period profitability. Firm A chooses its price p_1^A to maximize its total future discounted profits

$$\pi^A(p_1^A, p_1^B) \equiv \pi_1^A(p_1^A, p_1^B) + \lambda \pi_2^A(\sigma^A(p_1^A, p_1^B)), \tag{8}$$

while taking B's first-period price p_1^B as given.

In equilibrium we have $0 = \partial \pi^A / \partial p_1^A = (\partial \pi_1^A / \partial p_1^A) + (\lambda \partial \pi_2^A / \partial \sigma^A)(\partial \sigma^A / \partial p_1^A)$. Clearly, $\partial \sigma^A / \partial p_1^A < 0$ so that, since from the previous section $\partial \pi_2^A / \partial \sigma^A > 0$, we have $\partial \pi_1^A / \partial p_1^A > 0$. Therefore, both A and B choose lower first-period prices than these that would maximize first-period profits, given the opponent's behavior. Because market share is valuable in the future period, each firm competes more aggressively than it otherwise would to capture that market share.[14]

Although firms compete more aggressively than they would if they ignored the future, *given* first-period demand, it does *not* follow that firms compete more aggressively in the first period than they would if there were no switching costs in the second period. The existence of switching costs in the second period affects the structure of first-period demand. Foresighted consumers recognize that they will be partially locked in to their first-period supplier, and they therefore must predict second-period prices when making their first-period purchase decisions. From (2), they know that $\partial p_2^A / \partial \sigma^A > 0$ and $\partial p_2^B / \partial \sigma^B > 0$, so that a first-period price cut that increases a firm's first-period market share also foretells a second-period price rise. Thus, consumers are less attracted by a price cut; firms' first-period demands are less elastic than in an otherwise identical market with no switching costs in the second period. Consumers' rational expectations therefore mitigate the ferocity of first-period com-

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[13] Similarly, even if all old consumers' tastes change ($\mu + \nu = 1$), there will be a smaller density of marginal consumers in the market with switching costs than in a market without switching costs, and the price will be higher, if there is any correlation over time of consumers' preferences for the underlying product characteristics. The same is true if the distribution of preferences is not uniform but has a central mode or if consumers can predict their own future preferences.

[14] Firms compete most aggressively for consumers who influence many others, for example, educational institutions. This explains the fierce competition for the university and high school markets that we observe in the computer industry. It is possible to construct different models of switching costs in which a higher market share can sometimes hurt a firm by making its competitor more aggressive (Farrell, 1985; Summers, 1985; Klemperer, 1987b). In this case, firms might compete less aggressively to avoid gaining an excessive market share.

petition for market share, and, as I shall show, may even make the first period less competitive than in an otherwise identical market with no switching costs in the second period.

Using (4) and (8), we may write

$$\pi^A(p_1^A, p_1^B) = (p_1^A - c)t\sigma^A(p_1^A, p_1^B) + \frac{\lambda}{2(\mu+\nu)}\left(t + \frac{(2\sigma^A(p_1^A, p_1^B) - 1)((1 - \mu - \nu)t + \mu s))^2}{3}\right), \quad (9)$$

and symmetrically for firm B.[15]

The form of consumer expectations determines how market shares depend on first-period prices. For simplicity, begin with the case of "naive expectations," in which consumers do not take the second period into account when making first-period decisions. In this case the first period of a market with switching costs is always more competitive than that of a market without switching costs. I then turn to the case of completely rational consumer expectations and show that in this case the first period may be less competitive than if there were no switching costs.

☐ **Naive consumer expectations.** Naive expectations are a useful extreme case, and they also correspond to the case in which purchasers are different in the two periods. That is, second-period consumers face switching costs because they are exposed to first-period consumers' purchases, but their preferences are not taken into account by first-period consumers. An example might be universities that buy computers in the first period, which are used by students, who are then themselves consumers in the second period.

In this case first-period market share is determined exactly as if there were no switching costs:

$$\sigma^A(p_1^A, p_1^B) = \left(\frac{t + p_1^B - p_1^A}{2t}\right). \quad (10)$$

It follows that

$$\pi^A(p_1^A, p_1^B) = (p_1^A - c)\left(\frac{t + p_1^B - p_1^A}{2}\right) + \frac{\lambda}{2(\mu+\nu)}\left(t + \frac{\left(\frac{p_1^B - p_1^A}{t}\right)((1 - \mu - \nu)t + \mu s)}{3}\right)^2, \quad (11)$$

$$\frac{\partial \pi^A}{\partial p_1^A} = \frac{1}{2}(t + p_1^B - 2p_1^A + c) - \frac{\lambda}{(\mu+\nu)}\left(t + \frac{\left(\frac{p_1^B - p_1^A}{t}\right)((1 - \mu - \nu)t + \mu s)}{3}\right)\frac{1}{3t}((1 - \mu - \nu)t + \mu s).$$

In a symmetric equilibrium

$$p_1^A = p_1^B = c + t - \frac{2\lambda}{3(\mu+\nu)}((1 - \mu - \nu)t + \mu s), \quad (12)$$

and (this is equation (2a))

$$p_2^A = p_2^B = c + \frac{t}{(\mu+\nu)}. \quad (13)$$

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[15] We need only consider the range in which (4) holds because the assumption that ν is sufficiently large ensures that $|\sigma^A - \sigma^B| < s/t$. The reason is that when almost all first-period consumers leave the market after the first period, the second-period gains from a large first-period market share are very small. Therefore, given a candidate symmetric equilibrium defined by the first-order conditions, neither firm wants to make a large enough deviation in the first period to make market shares so asymmetric that $|\sigma^A - \sigma^B| \geq s/t$.

Total discounted profits are

$$\pi^A = \pi^B = \frac{t^2}{2}\left[1 + \lambda + \frac{\lambda}{3(\mu + \nu)}\left((1 - \mu - \nu) - \frac{2\mu s}{t}\right)\right]. \tag{14}$$

By contrast, if there are no switching costs, the two periods are not connected, so that $p_1^A = p_1^B = c + t$, and total discounted profits per firm are $\pi^A = \pi^B = t^2(1 + \lambda)/2$.

It is clear that first-period prices are always lower than in a market without switching costs. Since market share is more valuable to firms the higher are switching costs (that is, $\partial(\partial\pi_2^A/\partial\sigma^A)/\partial s > 0$, $\partial(\partial\pi_2^B/\partial\sigma^B)/\partial s > 0$), higher switching costs make the first period more competitive: $\partial p_1/\partial s < 0$.

Depending on the parameter values, firms may be either better off or worse off with switching costs than without them. If all second-period consumers are either new or have tastes for the underlying product characteristics that are completely independent of their first-period tastes ($\mu + \nu = 1$, $\mu > 0$), firms compete aggressively for market share in the first period and yet do not make any extra profits in the second period, since in the symmetric equilibrium with equal market shares the price is the same as if there were no switching costs. If, however, all second-period consumers who bought in the first period have unchanged tastes ($\mu = 0$), firms are better off with switching costs than without them.

□ **Rational consumer expectations.** If, by contrast with the above, consumers have completely rational expectations, we can compute the function $\sigma^A(p_1^A, p_1^B)$ by locating the marginal consumer, for whom the difference in the expected *second*-period surpluses from buying from the different firms in the *first* period equals the difference in his first-period surpluses from buying from the different firms.

Consider a first-period consumer located at z. That consumer's first-period surpluses from buying from firms A and B are $(r - p_1^A - z)$ and $(r - p_1^B - t + z)$, respectively.

With probability μ the consumer's tastes in the second period are uniformly distributed on $(0, t)$, and he will buy in the second-period equilibrium. Conditional on buying from A in period one and on being in this group of consumers, the consumer will again buy from firm A in the second period if his second-period location is at $x \le (t + p_2^B(\sigma^B) - p_2^A(\sigma^A) + s)/2$. The consumer's expected second-period surplus is then

$$\frac{\lambda}{t}\left[\int_{x=0}^{[t + p_2^B(\sigma^B) - p_2^A(\sigma^A) + s]/2} (r - p_2^A(\sigma^A) - x)dx + \int_{x=[t + p_2^B(\sigma^B) - p_2^A(\sigma^A) + s]/2}^{t} (r - s - p_2^B(\sigma^B) - t + x)dx\right],$$

where $p_2^A(\sigma^A)$ and $p_2^B(\sigma^B)$ are firms' second-period prices as functions of their first-period market shares.

With probability $(1 - \mu - \nu)$ the consumer is again located at z in the second period and again buys, so that his second-period surplus conditional on buying from A in the first period is $\lambda[r - p_2^A(\sigma^A) - z]$. In equilibrium, consumers whose tastes do not change will buy from the firm from which they previously bought.

With probability ν the consumer is not in the market, and so gets zero surplus in the second period.

Writing the corresponding equations for second-period surplus conditional on the consumer's buying from firm B in period one and performing the integrations, we find that the gain in total surplus (first-period surplus plus expected second-period surplus) resulting from buying from firm A rather than from firm B in the first period is

$$[p_1^B - p_1^A + t - 2z] + \lambda\left[\mu\frac{s}{t}(p_2^B(\sigma^B) - p_2^A(\sigma^A)) + (1 - \mu - \nu)(p_2^B(\sigma^B) - p_2^A(\sigma^A) + t - 2z)\right].$$

By equation (2),

$$p_2^B(\sigma^B) - p_2^A(\sigma^A) = \frac{2(1 - 2\sigma^A)}{3(\mu + \nu)}((1 - \mu - \nu)t + \mu s).$$

Finally, the marginal consumer has $z = \sigma^A t$ and is indifferent between buying from A and B, so that

$$0 = \lambda\left[\left(\frac{2(1-2\sigma^A)}{3(\mu+\nu)}((1-\mu-\nu)t+\mu s)\right)\left((1-\mu-\nu)+\frac{\mu s}{t}\right)+(1-\mu-\nu)(t-2\sigma^A t)\right]$$
$$+[(p_1^B-p_1^A)+(t-2\sigma^A t)].$$

It follows therefore that

$$\sigma^A(p_1^A, p_1^B) = \left(\frac{t+\frac{1}{y}(p_1^B-p_1^A)}{2t}\right), \tag{15}$$

and symmetrically for B, where

$$y = 1 + \lambda\left((1-\mu-\nu)+\frac{2}{3(\mu+\nu)}\left[(1-\mu-\nu)+\frac{\mu s}{t}\right]^2\right). \tag{16}$$

Note that $y \geq 1$ and that $y = 1$ if either $\nu = 1$ (all the first-period consumers leave the market and are replaced by new consumers in the second period) or $\lambda = 0$ (consumers ignore the second period in making first-period decisions—the case of naive or myopic behavior). When $y > 1$, first-period market shares are less responsive to price changes than when consumers are myopic or than when there are no switching costs in the second period.

Now, therefore,

$$\pi^A(p_1^A, p_1^B) = (p_1^A - c)\left(\frac{t+\frac{1}{y}(p_1^B-p_1^A)}{2}\right)$$
$$+\frac{\lambda}{2(\mu+\nu)}\left(t+\frac{\left(\frac{p_1^B-p_1^A}{ty}\right)((1-\mu-\nu)t+\mu s)}{3}\right)^2 \tag{17}$$

so that

$$\frac{\partial \pi^A}{\partial p_1^A} = \frac{1}{2}\left(t+\frac{1}{y}(p_1^B-2p_1^A+c)\right)$$
$$-\frac{\lambda}{(\mu+\nu)}\left(t+\frac{\left(\frac{p_1^B-p_1^A}{ty}\right)((1-\mu-\nu)t+\mu s)}{3}\right)\frac{1}{3ty}((1-\mu-\nu)t+\mu s).$$

In symmetric equilibrium

$$p_1^A = p_1^B = c + ty - \frac{2\lambda}{3(\mu+\nu)}((1-\mu-\nu)t+\mu s), \tag{18}$$

and, again,

$$p_2^A = p_2^B = c + \frac{t}{(\mu+\nu)}. \tag{19}$$

Total discounted profits are

$$\pi^A = \pi^B = \frac{t^2}{2}\left[y+\lambda+\frac{\lambda}{3(\mu+\nu)}\left((1-\mu-\nu)-\frac{2\mu s}{t}\right)\right]. \tag{20}$$

Comparison of (18) with (12) shows that the first period is less competitive when consumers have rational expectations than when they have naive expectations (since $y \geq 1$, so

that incentives for cutting price to gain market share are reduced). But the symmetric second-period equilibrium is unaffected, and comparison of (18) with (19) shows that it is still true that second-period prices are always higher than first-period prices.

Firms may be either better off or worse off with switching costs than without them, depending on whether those consumers who buy in both periods have unchanged preferences or have changing tastes for the underlying product characteristics. From (20) we can derive $\partial \pi^A/\partial \mu < 0$, $\partial \pi^B/\partial \mu < 0$, so that increasing the proportion of consumers whose second-period tastes for underlying product characteristics are independent of their first-period tastes reduces firms' profitability and makes the market more competitive (holding constant the proportion ν of new second-period consumers who were not present in the first period).

At one extreme, if all second-period consumers who bought in the first period have tastes for the underlying product characteristics that are completely independent of their first-period tastes ($\mu + \nu = 1$, $\mu > 0$), switching costs make firms worse off in the first period ($p_1^A = p_1^B < c + t$) and no better off in the second period ($p_2^A = p_2^B = c + t$).

At the other extreme, consider the important special case in which all consumers who bought in the first period have unchanged preferences for the underlying product characteristics in the second period ($\mu = 0$). Then (18) becomes

$$p_1^A = p_1^B = c + t\left[1 + \frac{\lambda}{3}(1 - \nu)\right] > c + t,$$

so that prices are always higher in the first period than in a market without switching costs, as well as higher in the second period. In this case consumers' foresight of the future effects of switching costs makes the first-period demand sufficiently inelastic to more than offset the procompetitive effect of competition for market share. The market with switching costs is less competitive in *both* periods than an otherwise identical market without switching costs.

5. Conclusion

■ My model is closely based on von Weizsäcker's (1984), but its results are very different. Because von Weizsäcker restricts firms to charging the same price in every period (including the initial period), they cannot exploit the monopoly power that switching costs give them. I do not constrain firms' price choices, and I find that firms raise their prices in the second period to take advantage of the fact that their first-period customers have become partly locked in to them as suppliers. Prices are higher than in the initial period before consumers have become attached to any supplier, and are also higher than in an otherwise identical market without switching costs. The fewer new unattached consumers there are in the second period and the less consumers' tastes change, the less consumers respond to any price difference between the firms and the less competitive is the second-period market.

Because firms' second-period profits depend on their first-period sales, firms compete more aggressively for market share in the first period than they would were they simply maximizing first-period profits. This provides an explanation for the emphasis placed on market share as a measure of corporate performance.[16] But while first-period competition is increased by each firm's expectation that market share will help it in the future, the consumers' realization that firms with higher market shares will charge higher prices in the future makes demand less elastic and thus reduces first-period competition. The net effect

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[16] Klemperer (1984, 1987a) provides a model of switching costs with products that are not functionally differentiated and obtains high second-period prices and low first-period prices for reasons analogous to those here. Katz and Shapiro (1986a, 1986b) provide related models in which market share is important as a state variable because network externalities give second-period consumers incentives to buy a product that had a large share of the market in the first period.

is ambiguous. The market may be either more or less competitive in the first period than an otherwise identical market without switching costs.

The next step in this research program is to analyze a multiperiod model (or an infinite-period model) in which firms can alter prices freely in any period. In such a model each period except the first and last has some of the characteristics of each of our two periods—firms have opposing incentives to price low to invest in market share that will be valuable to them in the future and to price high to exploit their locked-in customers. I expect that the former incentive is relatively greater for firms with a lower market share and that the latter incentive is relatively greater for firms with a higher market share. Therefore, firms with a higher market share will charge higher prices, and with foresighted consumers demand will be less elastic in every period than in a market without switching costs. The incentive to invest in market share will also be attenuated by firms' recognition that rivals with a lower market share will reduce price in the future.[17] Thus, we might expect switching costs in general to increase firms' total profits over time, and perhaps even to make markets less competitive in every period.

In the present model switching costs can either increase or reduce firms' total profits over time.[18] Increasing the proportion of consumers whose tastes change between the periods increases the market's competitiveness. If all consumers' tastes remain constant, however, prices and profits are higher in both periods than in an otherwise identical market without switching costs.

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[17] Farrell (1985), Summers (1985), and Klemperer (1987b) emphasize this effect.

[18] This is also the case in Klemperer's (1984, 1987a) model of a market with switching costs but without functional product differentiation.