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A Welfare Evaluation of History-based Price Discrimination

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Abstract

We design an asymmetric duopoly model with inherited market dominance such that the dominant firm and the small firm can price discriminate based on consumers' purchase history. We show that uniform pricing softens competition leading to higher industry profits than under history-based pricing. Consumers benefit from history-based price discrimination unless the switching cost is sufficiently high and the inherited degree of dominance is sufficiently weak. A ban on history-based pricing would typically introduce a distributional conflict between consumers and producers. Finally, we establish that the gains to industry profits associated with uniform pricing exceed the associated losses to consumers.

JEL Classification: D4, L1, L41

Keywords: Market Dominance, History-based pricing, Consumer loyalty, Poaching, Price Discrimination, Horizontal differentiation.

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1. Introduction

The European Commission published guidance on its enforcement priorities in applying Article 82 to abusive exclusionary conduct by dominant undertakings in December 2008. These guidelines attempt to present an economic and effects-based approach to evaluate the effects of various business practices, which could qualify as an abuse of a dominant market position. Price discrimination is one of the major business practices under scrutiny in these guidelines. Our study presents an effects-based evaluation of history-based price discrimination by conducting a welfare analysis of such a business practice. In particular, we will compare the effects of history-based price discrimination for consumer surplus and industry profits with those associated with uniform pricing.

It has become common practice in many industries, for example, cable TV, telecommunication, service industries and energy industries, to apply history-based price discrimination, i.e. to differentiate the prices directed to old and new customers. Typically new customers are targeted by aggressive price offers (introductory offers or poaching prices), which are designed to attract new customers or to induce rival firms' customers to switch even when those customers are already locked-in in another customer relationship. In this study we will conduct a welfare analysis of history-based price discrimination within the framework of an asymmetric duopoly model where the dominant firm as well as its small rival can apply history-based pricing. We address the following questions: Can history-based pricing be viewed as an instrument for a dominant firm to induce exclusion of smaller rivals? Does it prevent competition on the merits, thereby preventing consumers from enjoying the benefits of competition? Does history-based pricing make dominance persistent? And most importantly, which are precisely the effects of history-based pricing for consumer surplus and total welfare?

Competition lawyers and judges tend to view history-based price discrimination conducted by dominant firm, as any form of discrimination, in a rather skeptical, if not resentful, way (e.g. Möschel (1999)). Such a view has often been based on a form-based approach to the implementation of competition law. A number of European antitrust cases have established how

history-based price discrimination might facilitate predation in a way which would, according to competition authorities or courts, qualify as an abuse of a dominant market position. The ECS-AKZO case[1] is the seminal case exemplifying this. AKZO directed poaching prices to ECS's customers with the intention of excluding ECS from the market. Spector (2005) presents a thorough discussion of this aspect. Another example is the Irish Sugar case, where the dominant firm applied a scheme of target rebates such that the rebate was more favorable to particular customers of competing sugar packers. The Swedish Competition Authority vs. TeliaSonera from year 2005 is still another example illustrating how selective poaching offers by a dominant firm to a small rival's customers may qualify as an abuse of market dominance. In this case TeliaSonera directed selective poaching offers exclusively to customers of Bredbandsbolaget, a small regional rival in the Swedish market for fixed line telecommunications.[2] For an extensive and systematic account of European competition law towards price discrimination we refer to Geradin and Petit (2005).

In this study we adopt a standard Hotelling model to analyze the effects of history-based price discrimination in asymmetric industries, where one of the firms is assumed to have a dominant market position. We focus on a duopoly industry endowed with an inherited position of dominance, where, for simplicity, dominance is assumed to mean a market share larger than 50%.[3] We find that uniform pricing is a more efficient instrument than history-based pricing for the dominant firm to defend its market share advantage. We show that consumers benefit from history-based price discrimination unless the switching cost is sufficiently high. The switching cost threshold, above which consumers benefit from uniform pricing, depends on whether the inherited dominance is weak or strong. However, uniform pricing softens competition in the duopolistic industry leading to higher industry profits under uniform pricing. Consequently, unless the switching costs are sufficiently large, a ban on history-based price discrimination would redistribute surplus from

[1]European Commission Decision 85/609 of 14 December 1985, ECS/Akzo, OJ L 374 of 31 December 1985, 1–27.

[2]Stockholm District Court Case 28 October 2005 Dnr 873/2005.

[3]Of course, in competition law there is a general verbal characterization of market dominance. For example, the European Commission defines dominance to be a position of economic strength making it possible for the dominant undertaking to behave to an appreciable extent independently of its competitors, its customers and ultimately of its consumers.

consumers to producers. Finally, we establish that the gains to industry profits associated with uniform pricing under all circumstances exceed the associated losses to consumers.

Our study has strong implications for competition policy, not only with respect to the implementation of Article 82 in Europe but also in light of US Section 2 of the Clayton Act, which renders any activity that aims at substantially eliminating competition or creating a monopoly as illegal per se. We find that a policy of banning history-based price discrimination leads to higher prices in most consumer segments, and, therefore, tends to reduce overall consumer surplus. Moreover, a ban on price history-based discrimination tends to soften competition and promote industry profits.

Our study is structured as follows: Section 2 presents a short literature review and identifies our contribution to this literature. The analytical part of our study is divided into three sections. Section 3 presents a detailed equilibrium analysis of competition with history-based pricing. Section 4 characterizes the equilibrium with uniform pricing. Section 5 evaluates the implications for welfare of history-based pricing. Section 6 concludes.

2. Literature Review

With monopoly, price discrimination is a pricing instrument whereby the monopolist can shift surplus from the consumers in order to promote its profits. As shown initially by Thisse and Vives (1988), the consequences of price discrimination change dramatically in an oligopoly. They demonstrate that when firms compete strategically with completely individualized prices (perfect price discrimination) competition is intensified relative to the outcome of competition with uniform prices, but they do not focus on history-based price discrimination.

In industries with switching costs firms have strategic incentives to establish business relationships. The business relationships are profitable because firms can exploit locked-in customers up to a limit determined by the switching costs. With history-based price discrimination firms poach their rivals' customers with competitive poaching offers, which are sufficiently much lower than the prices charged to loyal customers. However, the prices charged to both customer categories

are below the equilibrium prices with uniform price schemes. Fudenberg and Tirole (2000) is a seminal contribution for a general analysis of behavior-based pricing, whereas Chen (1997), Taylor (2003), and Gehrig and Stenbacka (2004, 2007) present applications or more specialized symmetric duopoly models of this type.[4] The potential abuse of a dominant market position is not really an issue unless we focus on an asymmetric industry structure, where one firm is equipped with a dominant position. Contrary to the literature cited above, we therefore focus on an asymmetric industry structure with inherited dominance and explore the welfare implications of history-based pricing.

Chen (2008) presents a dynamic model of how behavior-based pricing by a dominant firm may facilitate predation based on exit of a small rival. Chen conducts the analysis with an arbitrary time horizon and with a segmented market such that firms do not compete head-to-head when they apply uniform pricing and he characterizes the dynamic price equilibria and some welfare properties. Compared with Chen (2008), in this study we conduct a complete welfare analysis of history-based price discrimination in an asymmetric Hotelling model such that the loyal segment of the dominant firm's market is endogenously determined.

Our study is also related to a recent literature exploring the effects of price discrimination on entry. Armstrong and Vickers (1993), Cheung and Wang (1999), and Bouckaert, Degryse, and van Dijk (2007) study important welfare effects of policies with bans on price discrimination by dominant firms. These studies focus on price discrimination within a framework where the dominant firm operates in an exogenously determined sheltered segment as well as a segment subject to competition. Relatedly, Gehrig, Shy, and Stenbacka (2010) design a Hotelling model to analyze the effect of history-based price discrimination on entry in a configuration where the entrant has no access to information about consumers' purchase histories. Within such a context they conduct a welfare analysis of history-based price discrimination. Contrary to that study, here we conduct the welfare analysis of history-based price discrimination within the context of an asymmetric duopoly model where both the dominant firm and the small rival have access to

[4] Fudenberg and Villas-Boas (2007) present an updated survey on the literature focusing on behavior-based price discrimination.

information about consumers' purchase histories.

3. History-based Price Discrimination

We focus on horizontally differentiated firms. The firms compete with respect to history-based pricing schemes. We focus on competition in an asymmetric duopoly where the dominant firm has inherited either weak (Section 3.1) or strong (Section 3.2) dominance to be defined below.

Firms A and B produce differentiated brands. Firm A (B) is located on the left (right) side of the unit interval. Consumers are uniformly distributed on the the unit interval according to increased preference for brand B (decreased preference for A). Each consumer x, $x \in [0,1]$, is endowed with a purchase history known to the firms. There are two periods labeled $t = 0$ and $t = 1$. Let the function $h(x) : [0,1] \to \{A, B\}$ describe the purchase history of each consumer x. Thus, $h(x) = A$ ($h(x) = B$) implies that the consumer indexed by x has purchased brand A (B) in period $t = 0$. Each consumer buys one unit from one of the firms in period $t = 1$.

Let c denote the unit production cost of firms A and B. Let p_A denote the price firm A sets for consumers who have already purchased brand A before, and q_A the price for those consumers who earlier purchased brand B (the competing brand). Firm B's prices, p_B and q_B, are defined analogously. We interpret p_A and p_B as the prices for *loyal* consumers, whereas q_A and q_B are *poaching* prices.

Consumers bear an exogenous cost σ when switching from one brand to another. The utility of a consumer indexed by x with a purchase history of brand $h(x) \in \{A, B\}$ is defined by

$$U(x) \stackrel{\text{def}}{=} \begin{cases} \beta - p_A - \tau x & \text{if } h(x) = A \text{ and continues to purchase brand } A \\ \beta - q_B - \tau(1-x) - \sigma & \text{if } h(x) = A \text{ and now switches to brand } B \\ \beta - p_B - \tau(1-x) & \text{if } h(x) = B \text{ and continues to purchase brand } B \\ \beta - q_A - \tau x - \sigma & \text{if } h(x) = B \text{ and now switches to brand } A. \end{cases} \quad (1)$$

The first and third rows in (1) define the utility gained by customers who are loyal to A and B, respectively. The second and fourth rows define the utility gained by switching consumers. The parameter β measures the consumer's basic satisfaction. The parameter $\tau \geq 0$ is the "transportation cost" parameter. A low value of τ will be interpreted as intense brand competition.

The brand switching cost σ captures, for example, network externalities, compatibility, or learning costs.

Let x_0 be given. We focus on a purchase history such that all consumers indexed by $x \leq x_0$ ($x > x_0$) belong to A's (B's) inherited market share. Formally, $h(x) = A$ for all $x \leq x_0$ whereas $h(x) = B$ for all $x > x_0$. With no loss of generality we assume that $x_0 > 0.5$ which we take to mean that firm A is dominant. Throughout the present duopoly study we make the simple interpretation that a firm is dominant if it has a market share exceeding 50%.[5] Figure 1 illustrates how the history of purchases relates to current brand preferences.

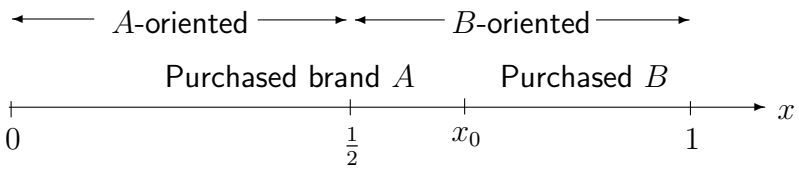

Figure 1: Characterization of purchase history.

In order to induce some consumers to switch brands we make the following assumption.

ASSUMPTION 1. *The switching cost is lower than the transportation cost parameter. Formally,* $\sigma < \tau$.

We now classify purchase history as follows.

DEFINITION 1. *We say that the purchase history* x_0 *exhibits* **weak dominance** *if* $0.5 < x_0 < \bar{x}_0 = (3\tau - \sigma)/(4\tau)$ *and* **strong dominance** *if* $x_0 \geq \bar{x}_0$.

Figure 2 illustrates an equilibrium allocation of consumers under weak dominance. The left segment in Figure 2 illustrates consumers who are loyal to brand A. These consumers pay a price of p_A. The second segment from the left is the range of consumers who previously purchased A and have been attracted by firm B at its poaching price q_B. The third range of consumers are

[5] Note that the legal characterization of market dominance, for example in European competition law, does not necessarily refer only to market share.

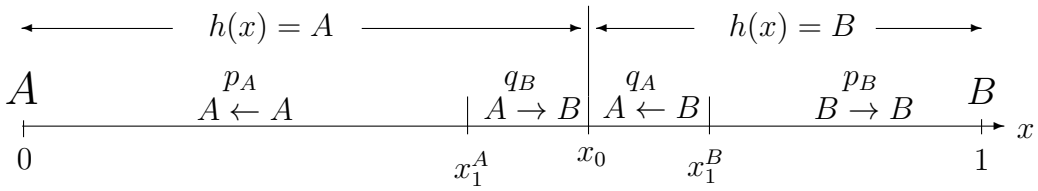

Figure 2: Consumer allocation between horizontally-differentiated brands under weak dominance. *Note*: Arrows indicate consumers' choice in each segment.

those who switch from B to A and thus pay the price q_A. The fourth range of consumers are those who are loyal to brand B and pay a price of p_B.

In contrast to Figure 2, Figure 3 illustrates this configuration under strong dominance. Strong

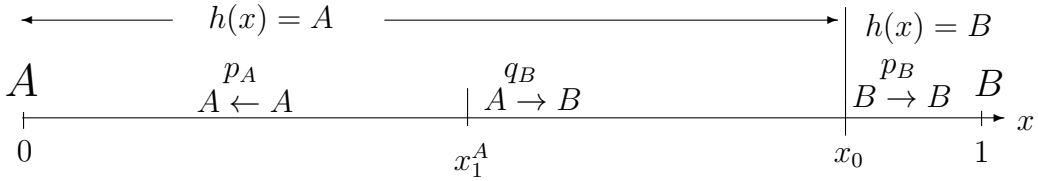

Figure 3: Consumer allocation between horizontally-differentiated brands under strong dominance.

dominance eliminates the range of consumers indexed on the interval $[x_0, x_1^B]$ in Figure 2. Therefore, in equilibrium the dominant firm A is unable to induce switching because its poaching activities would have to win consumers located much closer to firm B, hence to attract consumers with low preference for brand A.

3.1 Weak dominance

In view of the utility function (1), the consumer who has purchased A before and is now indifferent between being loyal to brand A and switching to brand B, denoted by x_1^A, is implicitly determined from $\beta - p_A - \tau x_1^A = \beta - q_B - \tau(1 - x_1^A) - \sigma$. Similarly, the consumer who has purchased B before and is now indifferent between being loyal to brand B and switching to brand A, denoted by x_1^B, is implicitly determined from $\beta - p_B - \tau(1 - x_1^B) = \beta - q_A - \tau x_1^B - \sigma$. Therefore,

$$x_1^A = \frac{1}{2} + \frac{q_B - p_A + \sigma}{2\tau} \quad \text{and} \quad x_1^B = \frac{1}{2} + \frac{p_B - q_A - \sigma}{2\tau}, \tag{2}$$

define a new allocation of consumers between the brands as illustrated in Figure 2.

In view of Figure 2, the profit functions of firms A and B are defined by

$$\begin{aligned}\pi_A(p_A, q_A) &\stackrel{\text{def}}{=} (p_A - c)x_1^A + (q_A - c)(x_1^B - x_0) \\ \pi_B(p_B, q_B) &\stackrel{\text{def}}{=} (p_B - c)(1 - x_1^B) + (q_B - c)(x_0 - x_1^A).\end{aligned} \tag{3}$$

We now solve for the Nash equilibrium prices where firm A chooses p_A and q_A to maximize π_A and firm B chooses p_B and q_B to maximize π_B. By substituting the market shares (2) into the profit functions (3) we obtain the Nash equilibrium loyalty prices

$$p_A = c + \frac{\tau(2x_0 + 1) + \sigma}{3} \quad \text{and} \quad p_B = c + \frac{\tau(3 - 2x_0) + \sigma}{3}, \tag{4}$$

and poaching prices

$$q_A = c + \frac{\tau(3 - 4x_0) - \sigma}{3} \quad \text{and} \quad q_B = c + \frac{\tau(4x_0 - 1) - \sigma}{3}. \tag{5}$$

Observe from (4) that switching costs raise loyalty prices because firms can exploit the lock-in effect generated by established business relationships. In contrast, (5) shows that switching costs result in lower poaching prices because firms have to partially subsidize the costs in order to induce switching.

Substituting the equilibrium prices (4) and (5) into (2) yields

$$x_1^A = \frac{\tau(2x_0 + 1) + \sigma}{6\tau}, \quad \text{and} \quad x_1^B = \frac{\tau(2x_0 + 3) - \sigma}{6\tau}. \tag{6}$$

Assumption 1 guarantees that $0 < x_1^A < x_1^B < 1$. Therefore, in view of Figure 2, the number of switching consumers is $x_1^B - x_1^A = (\tau - \sigma)/(3\tau)$.

We now compute the equilibrium market shares of firms A and B. From (6), in view of Figure 2, the market share of the dominant firm is

$$m_1^A = x_1^A + (x_1^B - x_0) = \frac{2 - x_0}{3} < x_0. \tag{7}$$

Consequently, with history-based price discrimination, the market share of the dominant firm decreases. The market share of the small firm is

$$m_1^B = 1 - x_1^B + x_0 - x_1^A = \frac{1 + x_0}{3} > 1 - x_0. \tag{8}$$

Intuitively, with inherited asymmetric market shares there is a tendency for the small firm to defend its inherited customer relationships with more aggressive pricing (as seen by (4)). The dominant firm loses market share. In this respect, history-based price discrimination does not by itself induce persistent dominance unless it is combined with some additional sufficiently strong strategic advantages.

3.2 Strong dominance

In Section 3.1 we focused on inherited weak dominance. We will now shift our attention to the configuration with strong dominance as characterized in Definition 1. This would eliminate the range of consumers indexed on the interval $[x_0, x_1^B]$ in Figure 2. Therefore, in equilibrium, the dominant firm A is unable to induce switching because its poaching activities would have to win consumers located much closer to firm B. Figure 3 illustrates this configuration.

To compute the equilibrium prices supporting the configuration illustrated in Figure 3, we set firm A's poaching price to equal marginal cost, $q_A = c$. Comparing Figure 3 with Figure 2 reveals that now $x_1^B = x_0$. Substituting $q_A = c$ and $x_1^B = x_0$ into (2), firm B's best reply is to set a loyalty price of $p_B = c + \tau(2x_0 - 1) + \sigma$. Since consumers are segmented by their purchase histories, the prices p_A and q_B remain unchanged. Altogether,

$$p_A = c + \frac{\tau(2x_0 + 1) + \sigma}{3}, \quad q_A = c, \quad p_B = c + \tau(2x_0 - 1) + \sigma, \quad \text{and}$$
$$q_B = c + \frac{\tau(4x_0 - 1) - \sigma}{3}. \quad (9)$$

To prove that the prices (9) indeed constitute a Nash equilibrium we must demonstrate that firm B cannot enhance its profit by raising its loyalty price p_B. We substitute p_A, q_A, and q_B from (9) into (3) to obtain

$$\left.\frac{\partial \pi_B}{\partial p_B}\right|_{(9)} = -\frac{4x_0\tau + \sigma - 3\tau}{2\tau} < 0 \quad \text{if and only if} \quad x_0 > \frac{3\tau - \sigma}{4\tau},$$

which by Definition 1 holds for the case of strong dominance.

In view of Figure 3, the number of switching consumers is $x_0 - x_1^A = [\tau(4x_0 - 1) - \sigma]/(6\tau)$. The resulting market shares are

$$m_1^A = x_1^A = \frac{\tau(2x_0 + 1) + \sigma}{6\tau} < x_0 \quad \text{and} \quad m_1^B = 1 - m_1^A = \frac{\tau(5 - 2x_0) - \sigma}{6\tau} > 1 - x_0. \quad (10)$$

From (10) we can draw the conclusion that the market share of the dominant firm is eroded under history-based pricing. Thus, this feature holds true with inherited histories of strong dominance as well as weak dominance.

4. Uniform Pricing

In this section we focus on competition with uniform pricing. Figure 4 below illustrates the market shares when firms compete in uniform prices. Comparing Figure 4 with Figure 2 reveals that in

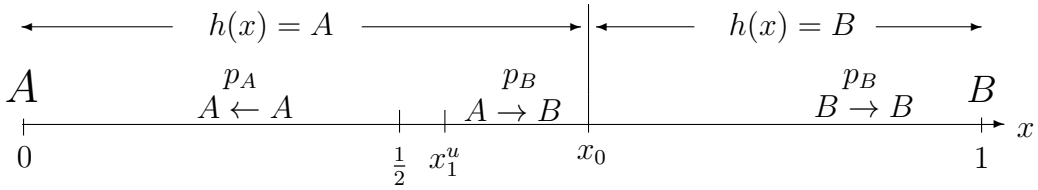

Figure 4: Consumer allocation between horizontally-differentiated brands under uniform pricing.

the absence of price discrimination consumer switching may occur in one direction only. More precisely, the small firm B may gain some consumers from the dominant firm, but not the other way around. We now characterize this equilibrium.

In view of Figure 4, with only two prices, p_A and p_B, faced by all consumers, the utility of a consumer indexed by x is now given by

$$U(x) \stackrel{\text{def}}{=} \begin{cases} \beta - p_A - \tau x & \text{if } h(x) = A \text{ and continues to buy brand } A \\ \beta - p_B - \tau(1 - x) - \sigma & \text{if } h(x) = A \text{ and now switches to brand } B \\ \beta - p_B - \tau(1 - x) & \text{if } h(x) = B \text{ and continues to buy brand } B. \end{cases} \quad (11)$$

Under uniform pricing, a consumer x_1^u who is indifferent between being loyal to brand A and switching to brand B is determined by $\beta - p_A - \tau x_1^u = \beta - p_B - \tau(1 - x_1^u) - \sigma$. Hence,

$x_1^u = (p_B - p_A + \sigma + \tau)/(2\tau)$. Firm A chooses a uniform price p_A to maximize $\pi_A = (p_A - c)x_1^u$. Similarly, firm B chooses a uniform price p_B to maximize $\pi_B = (p_B - c)(1 - x_1^u)$. The unique Nash-Bertrand equilibrium in prices and firm A's market share are given by

$$p_A^u = c + \tau + \frac{\sigma}{3}, \quad p_B^u = c + \tau - \frac{\sigma}{3}, \quad \text{and} \quad x_1^u = \frac{1}{2} + \frac{\sigma}{6\tau} > \frac{1}{2}, \tag{12}$$

where superscript "u" indicates uniform pricing. From (12) we can directly observe that with uniform prices the inherited dominance (captured by x_0) has no effect on the price equilibrium. Of course, in the presence of switching costs firm B must undercut A's price with a margin proportional to the switching costs in order to gain market share from A. Furthermore, in equilibrium dominance persists as long as the there is some (even arbitrarily small) switching cost.

To investigate how different pricing methods affect the degree of market dominance we compare firm A's market share under uniform pricing (12) with A's market share under history-based pricing (7) with weak dominance. This comparison yields $x_1^u - m_1^A = (1 - x_0)/3 > 0$. This implies the following result.[6]

Result 1. *The equilibrium market share of the firm with inherited market dominance is always larger under uniform pricing than under history-based pricing.*

From Result 1 we can draw the conclusion that uniform pricing is more useful than history-based pricing for the dominant firm as an instrument to defend dominance.

Another dimension of evaluation is to compare the equilibrium prices under uniform and history-based price discrimination. Comparing (12) with (4) and (5), we find that $p_A^u - p_A = 2\tau(1 - x_0)/3 > 0$, $p_A^u - q_A = 2(2x_0\tau + \sigma)/3 > 0$, $p_B^u - q_B = 4\tau(1 - x_0)/3 > 0$. Also, $p_B^u - p_B = 2(x_0\tau - \sigma)/3 > 0$ if $\sigma/\tau < x_0 < (3\tau - \sigma)/(4\tau)$.

Based on these price comparisons we can conclude that competition with history-based pricing generates lower prices than competition with uniform pricing with the potential exception of the

[6] The identical conclusion for inherited strong dominance can be reached in a straightforward way.

loyalty price p_B charged by the small firm. The small firm charges a higher price p_B with history-based pricing than with uniform pricing if the degree of inherited dominance is very weak, that is, if x_0 is close to 0.5, and if the switching costs are large, that is, σ is sufficiently close to τ.

5. Welfare Analysis

So far we have explored the effects of history-based price discrimination on prices and market shares. We next investigate the welfare consequences of history-based price discrimination in an asymmetric duopoly. Such an investigation is very important as a basis for a policy maker, operating with a well-defined welfare objective, to formulate a policy towards history-based price discrimination exercised by a dominant firm.

5.1 Comparing uniform pricing with history-based pricing under weak dominance

Consumer surplus under uniform pricing is

$$CS^u = \int_0^{x_1^u} (\beta - p_A^u - \tau x)dx + \int_{x_1^u}^{x_0} [\beta - p_B^u - \tau(1-x) - \sigma]dx + \int_{x_0}^{1} [\beta - p_B^u - \tau(1-x)]dx, \quad (13)$$

where p_A^u, p_B^u, and x_1^u are given in (12).

Similarly, consumer surplus under history-based price discrimination is

$$CS^d = \int_0^{x_1^A} (\beta - p_A - \tau x)dx + \int_{x_1^A}^{x_0} [\beta - q_B - \tau(1-x) - \sigma]dx + \int_{x_0}^{x_1^B} [\beta - q_A - \tau x - \sigma]dx + \int_{x_1^B}^{1} [\beta - p_B - \tau(1-x)]dx, \quad (14)$$

where p_A, q_A, p_B, q_B, x_1^A, and $x_1^B$are given in (4), (5), and (6).

Subtracting (13) from (14), our calculations show that

$$CS^d - CS^u = -\frac{\tau^2(52x_0^2 - 52x_0 - 1) + 2\sigma\tau(17 - 18x_0) - \sigma^2}{36\tau}. \quad (15)$$

Let $0 \leq s \leq 1$. Substituting $\sigma = s\tau$ into (15),

$$CS^d - CS^u = -\frac{\tau[s^2 + 2s(18x_0 - 17) - 52x_0^2 + 52x_0 + 1]}{36} > 0 \tag{16}$$

if

$$s < 17 - 18x_0 - 2\sqrt{2}\sqrt{47x_0^2 - 83x_0 + 36} \quad \text{for} \quad \frac{1}{2} < x_0 < \frac{3}{4} - \frac{s}{4}. \tag{17}$$

Figure 5 illustrates the sign of $CS^d - CS^u$ in the (x_0, s) space.

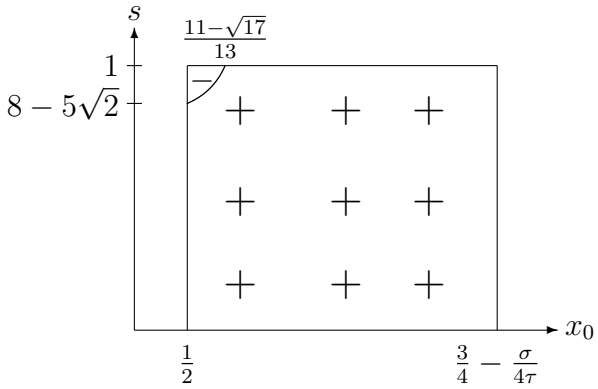

Figure 5: Differences in consumer surplus.

Result 2. *Under weak dominance, consumer surplus is higher with history-based price discrimination than with uniform pricing if and only if condition (17) holds.*

In view of Figure 5, history-based price discrimination benefits consumers for most values of σ and x_0. However, for high switching cost σ ($\sigma > 0.93\tau$) combined with a very low degree of inherited dominance x_0 ($0.5 < x_0 < 0.53$) consumers are worse off under history-based price discrimination. Consequently, unless faced with the particular combination of high switching cost ($\sigma > 0.93\tau$) and a very low degree of inherited dominance ($0.5 < x_0 < 0.53$) a competition authority with consumer welfare as its objective should not oppose to history-based price discrimination.

As our comparison of history-based prices and uniform prices in the previous section showed, history-based price discrimination tends to yield lower prices than uniform pricing and therefore consumers benefit from history-based pricing for most parameter combinations. However, we also

pointed out that the small firm charges a higher price p_B with history-based pricing than with uniform pricing if the degree of inherited dominance is very weak, that is, if x_0 is close to 0.5, and if the switching costs are large (σ is sufficiently close to τ). Under those circumstances when condition (17) fails to hold the loyalty price charged by the small firm with history-based pricing is so much higher than the uniform price that consumer surplus with uniform pricing exceeds that with history-based price discrimination.

We now calculate the equilibrium profit of each firm under uniform pricing. Substituting (12) into the profit under uniform pricing yields

$$\pi_A^u = \frac{(3\tau+\sigma)^2}{18\tau} \quad \text{and} \quad \pi_B^u = \frac{(3\tau-\sigma)^2}{18\tau}. \tag{18}$$

Therefore, under uniform pricing, the profit advantage of the dominant firm is $\pi_A^u - \pi_B^u = 2\sigma/3 > 0$.

Next, we calculate the equilibrium profit of each firm under history-based pricing. Substituting (4), (5), and (6) into (3) yields

$$\pi_A^d = \frac{5\tau^2(2x_0^2-2x_0+1)+2\sigma\tau(3x_0-1)+\sigma^2}{9\tau} \quad \text{and}$$
$$\pi_B^d = \frac{5\tau^2(2x_0^2-2x_0+1)+2\sigma\tau(2-3x_0)+\sigma^2}{9\tau}. \tag{19}$$

Therefore, under history-based pricing, the profit advantage of the dominant firm is $\pi_A^d - \pi_B^d = 2\sigma(2x_0-1)/3 < 2\sigma/3$. Hence, the profit advantage of the dominant firm is smaller under history-based pricing compared with uniform pricing. Furthermore, from (18) and (19) we find that aggregate industry profit is always higher under uniform pricing as can be seen from

$$(\pi_A^d+\pi_B^d)-(\pi_A^u+\pi_B^u) = \frac{\tau^2(20x_0^2-20x_0+1)+2\sigma\tau+\sigma^2}{9\tau} < 0. \tag{20}$$

Consequently, firms have a mutual interest to compete in uniform prices rather than in prices based on consumers' purchase histories.

With the exception of very high switching cost ($\sigma > 0.93\tau$) combined with a very low degree of inherited dominance ($0.5 < x_0 < 0.53$), history-based prices generate a distributional

conflict between firms and consumers. We therefore evaluate whether the benefits to consumers associated with history-based pricing exceed the firms' profit loss.

We define social welfare as the sum of consumer surplus and firms' profits, $W = CS + \pi_A + \pi_B$. Under uniform pricing, social welfare is given by

$$W^u = \frac{5\sigma^2 - 9\tau^2 + 18\tau(2\beta + \sigma - 2c - 2x_0\sigma)}{36\tau}. \tag{21}$$

Social welfare under history-based pricing is

$$W^d = \frac{2\tau^2(7x_0^2 - 7x_0 - 1) + 2\tau(9\beta - 9c - 2\sigma) + 5\sigma^2}{18\tau}. \tag{22}$$

Subtracting (21) from (22)) yields

$$W^d - W^u = \frac{\tau^2(28x_0^2 - 28x_0 + 5) + 2\sigma\tau(18x_0 - 13) + 5\sigma^2}{36\tau}. \tag{23}$$

It can be easily established that (23) is strictly increasing with x_0. Furthermore, $W^d(\bar{x}_0) - W^u(\bar{x}_0) = -(9\sigma^2 + 10\sigma\tau - \tau^2)/(144\tau) < 0$ for $\bar{x}_0 = (3\tau - \sigma)/(4\tau)$, which is the upper bound on x_0 by Definition 1.

Result 3. *Social welfare is higher under uniform pricing compared with history-based pricing.*

With Hotelling competition, price changes generate a redistribution of surplus between consumers and producers, whereas aggregate switching costs and transportation costs are "real" deadweight losses to the economy. In order to understand the sources behind the total welfare gains associated with uniform pricing it is therefore valuable to highlight the effects of history-based pricing on aggregate switching costs and transportation costs. With history-based pricing the number of switching consumers is $(x_0 - x_1^A) + (x_1^B - x_0)$, whereas the number of switching consumers with uniform pricing is $(x_0 - x_1^u)$. Based on (6) and (12) it can directly be verified that the number of switching consumers with history-based pricing exceeds that associated with uniform pricing for an inherited history with weak dominance. Therefore history-based price discrimination generates higher aggregate switching costs than uniform pricing. Furthermore, with uniform pricing the

switching also decreases the degree of preference mismatch, leading to lower aggregate transportation costs as some consumers located to the right of 0.5 switch to B. With history-based pricing the effect of switching on aggregate transportation costs is not a priori clear, because the consumers switching from A to B face reduced transportation costs, whereas those switching from B to A face increased transportation costs. Our total welfare comparison establishes analytically that uniform pricing induces lower aggregate switching costs and transportation costs than history-based price discrimination.

5.2 Comparing uniform pricing with history-based pricing under strong dominance

Under strong dominance, consumer surplus with history-based pricing is

$$CS^d = \int_0^{x_1^A} (\beta - p_A - \tau x)dx + \int_{x_1^A}^{x_0} [\beta - q_B - \tau(1-x) - \sigma]dx + \int_{x_0}^{1} [\beta - p_B - \tau(1-x)]dx, \quad (24)$$

where p_A, p_B, q_B, and x_1^A are given in (9) and (10).

Subtracting (13) from (24), we find

$$CS^d - CS^u = \frac{(1-x_0)[\tau(16-7x_0) - 13\sigma]}{9} > 0 \quad \text{if and only if}$$
$$\sigma < \frac{\tau(16-7x_0)}{13} \quad \text{with} \quad \frac{3}{4} - \frac{\sigma}{4\tau} < x_0 < 1. \quad (25)$$

Therefore,

Result 4. *Under strong dominance, consumer surplus is lower with history-based price discrimination than with uniform pricing if switching costs are sufficiently high, more precisely, if* $\sigma > \tau(16-7x_0)/13$.

Comparing Result 4 with Result 2 we can conclude that the implications of history-based price discrimination are sensitive to whether there is strong or weak dominance. In both cases, consumers benefit from uniform prices when there are sufficiently high switching costs, but the switching

cost threshold for this is much higher with weak dominance. With weak dominance consumer surplus with uniform pricing exceeds that with history-based pricing if $\sigma > 0.93\tau$, as the discussion after Result 2 makes clear. According to Result 4 this threshold exceeds the threshold for this to happen with inherited strong dominance.

Using (9) and (10), the equilibrium profit of each firm with history-based pricing under strong dominance is

$$\pi_A^d = \frac{[\tau(2x_0+1)+\sigma]^2}{18\tau} \quad \text{and} \quad \pi_B^d = \frac{\tau^2(46x_0-20x^2-17)+2\sigma\tau(10-13x_0)+\sigma^2}{18\tau}. \tag{26}$$

Comparing industry profit under history-based price discrimination (26) with industry profit under uniform pricing (18) yields

$$(\pi_A^d+\pi_B^d)-(\pi_A^u+\pi_B^u) = \frac{(1-x_0)[\tau(8x_0-17)+11\sigma]}{9} > 0 \quad \text{if and only if} \quad \sigma > \frac{\tau(17-8x_0)}{11}. \tag{27}$$

Contrary to the case with weak dominance (20) , we now find that the adoption of history-based price discrimination could be profit enhancing. This happens for sufficiently high switching costs.

Finally, similar to (23), the difference in social welfare is

$$W^d - W^u = -\frac{(1-x_0)[\tau(1-x_0)+2\sigma]}{9} < 0. \tag{28}$$

Therefore,

Result 5. *Social welfare is higher under uniform pricing compared with history-based pricing.*

Under history-based pricing the number of switching consumers is $(x_0 - x_1^A)$, whereas this number is $(x_0 - x_1^u)$ under uniform pricing. Based on (10) and (12) we can directly draw the conclusion that behavior-based price discrimination generates higher aggregate switching costs than uniform pricing. History-based pricing also leads to higher aggregate transportation costs with an inherited history of strong dominance.

6. Conclusion

We design an asymmetric Hotelling model with inherited market dominance in a duopolistic industry where two firms, the dominant firm and the small firm, can price discriminate between consumers based on their purchase history. We find that uniform pricing is more useful than history-based pricing as an instrument for the dominant firm to defend its market share advantage. We show that uniform pricing tends to soften price competition in the duopolistic industry leading to higher industry profits under uniform pricing than under behavior-based price discrimination.[7] We establish that consumers benefit from history-based price discrimination unless the switching cost is sufficiently high and the inherited degree of dominance is sufficiently weak. Consequently, unless the switching costs are sufficiently large and the inherited degree of dominance is sufficiently weak a ban on history-based price discrimination would introduce a distributional conflict between consumers and producers with the consumers as losers. Finally, we establish that the gains to industry profits associated with uniform pricing exceed the associated losses to consumers.

Policy-related evaluations of price discrimination typically focus on whether this business practice is abusive based on exclusionary or exploitative effects. Our analysis of the asymmetric duopoly model implies that competition with history-based price discrimination typically tends to intensify competition and thereby promote consumer welfare. In light of this conclusion our analysis of consumer surplus tends to give no support for policies to ban history-based price discrimination. However, at the same time our analysis reaches the unambiguous conclusion that uniform pricing promotes total welfare. This means that concerns for industry profits will eventually shift the policy recommendation in favor of banning history-based price discrimination. To the extent increased industry profits facilitate increased investments and innovation such concerns could even enhance future consumer surplus. Our model could be enriched to incorporate such dynamic considerations.

When evaluating the antitrust implications of price discrimination an influential recent approach, including, for example, Innes and Sexton (1994) and Karlinger and Motta (2007), seems

[7] Uniform pricing always softens competition with an inherited history of weak dominance. This holds true also with strong dominance as long as the switching cost is not too high.

to persistently emphasize the following tradeoff. On the procompetitive side, for an oligopolistic industry operating within a given market structure, price discrimination intensifies competition. On the anticompetitive side, with price discrimination the dominant firm can induce exclusion more effectively by targeting competitive price offers to limited market segments, which makes it possible for the dominant firm to achieve exclusionary effects at lower costs. Our results regarding the implications of history-based price discrimination for competition and welfare in an asymmetric Hotelling model are perfectly consistent with this view as far as the procompetitive effect is concerned. However, in light of the related analysis undertaken in Gehrig, Shy, and Stenbacka (2010) of the effects of history-based price discrimination on entry, the results for the asymmetric Hotelling model do not support this view as far as the exclusionary anticompetitive aspects are concerned. In fact, as Gehrig, Shy, and Stenbacka (2010) make clear, with asymmetric Hotelling competition the entry decision of a firm with no access to information about consumers' purchase histories is invariant to whether the incumbent implements history-based pricing or uniform pricing. Furthermore, as far as the welfare implications are concerned consumers tend to benefit from behavior-based price discrimination if also the small firm can apply behavior-based pricing, whereas behavior-based pricing reduces consumer surplus if the dominant firm has exclusive access to price discrimination, as Gehrig, Shy, and Stenbacka (2010) demonstrate. This finding suggests that the welfare implications of history-based pricing are highly case-specific. Our analysis implies that there is no simple and universal policy to deal with history-based pricing. Nevertheless, from the point of view of topical European competition policy related to the application of Article 82, our analysis has a very robust implication.

Our analysis offers strong support for an effects-based approach to the evaluation of history-based price discrimination as a business practice, which could potentially qualify as abusive conduct if applied by a dominant firm. In this regard the analysis provides strong support in favor of the effects-based approach suggested by Gual et al. (2006) to guide European antitrust policy.

Our analysis has been restricted to an asymmetric Hotelling model with the special feature of inelastic demand at the industry level. Our general conclusion is that history-based pricing tends to intensify competition within such a framework. This conclusion would be reinforced if

we incorporate demand expansion effects, because the returns from the poaching activities would then be further stimulated by the option of attracting new, unattached consumers. Thus, in the presence of such demand effects the poaching incentives would be even stronger, thereby promoting consumer welfare.

Throughout this study we have analyzed the implications of history-based pricing on the ability of a dominant firm to maintain, or possibly strengthen, its dominance within the framework of a limited horizon. Of course, from a theoretical perspective the strategic interaction between the dominant firm and the weak firm could continue for many periods. Within such a framework one could investigate the dynamics of dominance and, in particular, characterize the market shares towards which the process would converge.[8] Of course, such an analysis would quickly be extremely complicated if the firms are able to maintain information on customer histories consisting of several periods.[9] Our present analysis could be viewed as imposing a restriction on the firms so that these are able to maintain records of customer histories only for limited periods of time.

It is worth relating our analysis also to another class of relevant studies about dynamic pricing. For example, Caminal and Matutes (1990) derive equilibrium configurations where firms offer loyalty discounts, and do not charge loyalty premia.[10] An essential feature in that approach is that lower prices are applied to loyal customers than to customers who switch supplier. In this type of models loyalty discounts are a device to endogenously generate switching costs. An essential feature in this type of models is that firms commit to the discount schedule upfront, so that the consumers take this commitment into account when choosing with which supplier to establish a business relationship. Thus, compared to our model this approach exhibits a completely divergent intertemporal structure of the price equilibrium. It remains an interesting challenge for future research to explore under which circumstances price commitments would and

[8] With respect to the dynamics of price equilibria and market shares Chen (2008) and Beggs and Klemperer (1992) have made valuable contributions. The have not, however, conducted a welfare analysis to fully explore the antitrust implications.

[9] A complete implementation of history-based pricing during T periods would split the market into 2^{T+1} segments, each with its own history-contingent price.

[10] Caminal and Claici (2007) have subsequently developed that analysis further.

could emerge as an equilibrium outcome.

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