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Customer Recognition and Competition

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Abstract:
We introduce three types of consumer recognition: identity recognition, asymmetric preference recognition, and symmetric preference recognition. We characterize price equilibria and compare profits, consumer surplus, and total welfare. Asymmetric preference recognition enhances profits compared with identity recognition, but firms have no incentive to exchange information regarding customer-specific preferences (symmetric preference recognition). Consumers would benefit from a policy banning information exchange regarding individual consumer preferences. Our welfare analysis shows that the gains to firms from uniform pricing (no recognition) are larger than the associated harm to consumers, regardless of which regime of customer recognition serves as the basis for comparison.

Keywords: customer recognition, price discrimination, behavior-based pricing

JEL Classifications: D4, D82, L1, L4

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1. Introduction

Technological progress, and, in particular, the Internet, has made it easier for firms to implement increasingly sophisticated methods of customer recognition that provide a basis for designing discriminatory pricing schemes. In general, a firm can acquire two types of information that can facilitate customer recognition: (a) information that identifies those consumers with whom the firm has an established customer relationship and distinguishes them from consumers who have an established customer relationship with the rival (or potentially new consumers with no established customer relationship at all) and (b) information about the preferences of its own customers. Clearly, recognition of type (a) is an essential step for pursuing recognition of type (b). Recognition of type (b) captures the idea that an established customer relationship creates an informational advantage for the firm compared with its rivals, a feature that forms an important incentive for the firm to invest in maintaining customer relationship management.

The present study calculates the price equilibria associated with different types of customer recognition. The study contributes to the literature by characterizing the effects of different types of customer recognition on profits, consumer surplus, and total welfare. More precisely, we compute, evaluate, and compare market performance associated with the following three information configurations:

- Firms can identify their own customers, but cannot learn their customers' specific preferences. We call this *identity recognition* (I).
- Firms can identify their own customers and, in addition, the individual preferences of all their customers. We call this *asymmetric preference recognition* (A).
- Firms can identify their own customers as well as the individual preferences of all consumers (including consumers buying from rival firms). We call this *symmetric preference recognition* (S). It can be achieved if, for example, all firms in a given industry exchange information about their customers' preferences.

In particular, we focus on the following questions: How does profit depend on the type of customer recognition? What is the relationship between profits associated with uniform pricing (no customer recognition) and profits generated from discriminatory pricing schemes based on the different types of customer recognition? Do firms have an incentive to engage in information exchange regarding the recognized preferences of their consumers to achieve symmetric preference recognition? What are the effects on consumers of discriminatory pricing schemes based on different types of customer recognition compared with uniform pricing? Do consumers benefit or lose from information exchange between firms if the firms are able to recognize the preferences of consumers with whom they have an established customer relationship?

During the past 15 years the literature on behavior-based or history-based price discrimination has developed a spectrum of models to analyze different types of models of price discrimination based on particular types of customer recognition. Fudenberg and Tirole (2000) is a seminal contribution for a general analysis of behavior-based pricing within the framework of a two-period Hotelling duopoly model. The Fudenberg and Tirole (2000) model has the feature that the firm can distinguish its own inherited customers from those of the rival and design a discriminatory pricing scheme that exploits the fact that a customer's past decisions reveal information about this customer's brand-specific preferences. This type of behavior-based pricing model could largely be characterized as *identity recognition* according to the terminology we introducted above. Chen (1997), Villas-Boas (1999), Shaffer and Zhang (2000),Taylor (2003), Chen (2008), Gehrig, Shy, and Stenbacka (2011), Gabrielsen (2004), Chen and Zhang (2009), Esteves (2010), and Gehrig and Stenbacka (2004, 2007) are examples of studies analyzing important theoretical aspects as well as significant implications and applications of behavior-based pricing. Fudenberg and Villas-Boas (2007) and Esteves (2009) present updated literature surveys of the literature on behavior-based price discrimination.

In this study we demonstrate that discriminatory pricing schemes based on customer recognition generate equilibrium configurations with intensified competition compared with the outcome of competition with uniform prices, where firms cannot recognize their customers or are not allowed to price discriminate. This conclusion holds true for all the different types of customer recognition: identity recognition, asymmetric preference recognition, and symmetric preference recognition. The effects on profits of pricing schemes based on identity recognition (I) are similar to those associated with history-based pricing in the presence of differentiated switching costs, originally analyzed by Chen (1997). Likewise, the configuration that we label as symmetric preference recognition (S) resembles to some degree the case of perfect price discrimination analyzed by Thisse and Vives (1988) in the sense that the firms have complete information regarding the characteristics of all customers, not only those customers with whom they have an established customer relationship. In contrast, the configuration that we denote asymmetric preference recognition (A) captures the feature that an established customer relationship gives the firm an informational advantage relative to its rival regarding the characteristics of its customers. As far as we know, the performance of price discrimination under asymmetric preference recognition has not been analyzed earlier from this perspective. This analysis is important, because, as Shin and Sudhir (2010) argue, such informational advantages constitute a major incentive for firms to invest in customer relationship management.

We establish the effects of different types of customer recognition on equilibrium profits. We show that each firm has a unilateral incentive to acquire information regarding the individual preferences of its customers. This means that pricing based on asymmetric preference recognition promotes the firm's profits compared with pricing based on identity recognition. At the same time, the firm does not have any incentive to share information regarding customer-specific preferences. The reason for this is that symmetric consumer recognition based on information exchange facilitates targeted poaching offers and therefore intensifies competition to the detriment of industry profits. It is interesting to contrast this finding with the results obtained in evaluations of information exchange in credit markets, where banks typically have an incentive to exchange information regarding the creditworthiness of individual borrowers (see Pagano and Jappelli (1993) and Padilla and Pagano (1997), or

Gehrig and Stenbacka (2007)).

We conduct a welfare analysis demonstrating that consumers are worse off under price discrimination based on asymmetric recognition of consumer preferences than under pricing based only on identity recognition, because asymmetric preference recognition improves firms' ability to extract surplus from consumers. We also demonstrate that information exchange among firms that eliminates information asymmetries between rival firms reduces consumer surplus, a complementary result to results from the analysis of information exchange in credit markets. Overall, our welfare analysis implies that consumers would benefit from a policy that bans information exchange of their individual preferences. Such a ban would maintain information asymmetry with respect to customer preferences. Nevertheless, our welfare analysis shows that the gains to firms from uniform pricing are larger than the associated loss to consumers regardless of which regime of customer recognition is used as the basis for comparison. Qualitatively this result coincides with the welfare conclusion obtained in Gehrig, Shy, and Stenbacka (2011). However, Gehrig, Shy, and Stenbacka (2011) is restricted to a model of entry with identity recognition, whereas the present analysis applies to a much broader spectrum of mechanisms for customer recognition.

Our study contributes to a recent literature evaluating the welfare effects of price discrimination. Esteves (2010) conducts a welfare analysis restricted to history-based pricing in the absence of switching costs within the context of a symmetric two-period model. Armstrong and Vickers (1993), Cheung and Wang (1999), and Bouckaert, Degryse, and van Dijk (2008) study how bans on price discrimination by dominant firms affect entry and welfare within the framework of models where the dominant firm operates in an exogenously determined sheltered segment as well as in a segment subject to competition.

Finally, our analysis is linked to an important branch of studies evaluating the effects of information exchange in oligopolies. Prominent examples of this literature include Shapiro (1986) and Gal-Or (1985, 1986). This literature generally finds that the direction of the ex ante incentives for information exchange depends on the nature of market competition (Bertrand or Cournot) and on the type of uncertainty (uncertainty concerning common demand conditions or firm-specific costs). This literature tends to reach the conclusion that information exchange often increases total welfare even though it hurts consumers (see, for example, Shapiro (1986)). Our results support this conclusion. However, our study adds an important dimension to this literature insofar as information exchange intensifies competition by stimulating poaching activities, a feature that is typically not addressed in the research approach evaluating the effects of information exchange in oligopolies.

Our study proceeds as follows. Section 2 constructs the benchmark model of identity recognition, where each firm can distinguish between its own customers and its rival's customers. Section 3 analyzes preference recognition asymmetry, where firms learn the preferences of their own customers (but not of their rival's customers). Section 4 analyzes the effects of symmetric preference recognition stemming from information exchange between firms regarding the characteristics of individual customers. Section 5 compares the effects of the different types of consumer recognition on profits, consumer surplus, and total welfare. In Section 6 the market performance associated with different types of customer recognition is compared with the performance associated with uniform pricing. Section 7 concludes.

2. Identity Recognition

Consider an industry with two firms producing differentiated products or services labeled as A and B. There are $4n$ consumers. $2n$ consumers are A-oriented, which means that they all prefer A over B if prices are equal. Similarly, $2n$ consumers are B-oriented, which means that they all prefer B over A under equal prices.

The history of this industry is as follows. Initially, consumers are equally distributed between the two firms with half of the consumers buying their ideal brand and half mismatched with their less-preferred brand. More precisely, n A-oriented consumers initially buy brand A, and n A-oriented consumers buy brand B (mismatched). Similarly, n B-oriented consumers initially buy brand B, and n B-oriented consumers buy brand A (mismatched). Starting from this configuration, all buyers regardless of their type can remain loyal to their initial supplier, or switch to the competing brand. Switching is costly to buyers. For each consumer type $i = A, B$, switching costs s are uniformly distributed on the unit interval $[0, 1]$.

Each consumer buys exactly one unit (either A or B). Let p_A denote the price firm A sets for consumers who have 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 to *loyal* consumers, whereas q_A and q_B are *poaching* prices. Let $i, j = A, B$ and $i \neq j$. Then, the utility of a consumer with switching cost s and a customer relationship with firm i is defined by

$$U_i(s) = \begin{cases} v_H - p_i & i\text{-oriented and continues to buy } i \\ v_L - p_i & j\text{-oriented and continues to buy } i \\ v_L - q_j - \sigma s & i\text{-oriented and switches to } j \\ v_H - q_j - \sigma s & j\text{-oriented and switches to } j. \end{cases} \tag{1}$$

$v_H > v_L > 0$ are the benefits to buyers. More precisely, $\Delta \stackrel{\text{def}}{=} v_H - v_L > 0$ measures the utility loss associated with a mismatch (or the utility gain from a proper match). The parameter $\sigma > 0$ measures the intensity of the switching costs, in the sense that high values of σ generate higher switching cost differentiation across buyers $s \in [0, 1]$. Subsequently, we will assume lower bounds for σ relative to the loss from a mismatch, Δ.

In view of the utility function (1), an A-oriented consumer who has purchased A before and is now indifferent between being loyal to brand A and switching to brand B, denoted by s_A^H, is determined from $v_H - p_A = v_L - q_B - \sigma s_A^H$. Similarly, a B-oriented consumer who has purchased B before and is now indifferent between being loyal to brand B and switching to brand A, denoted by s_B^H, is determined from $v_H - p_B = v_L - q_A - \sigma s_B^H$.

A B-oriented consumer who has purchased A before and is now indifferent between being loyal to brand A and switching to brand B, denoted by s_A^L, is determined from $v_L - p_A = v_H - q_B - \sigma s_A^L$. Similarly, an A-oriented consumer who has purchased B before and is now indifferent between being loyal to brand B and switching to brand A, denoted by s_B^L, is determined from $v_L - p_B = v_H - q_A - \sigma s_B^L$. Thus,

$$s_A^H = \frac{p_A - q_B - \Delta}{\sigma} \quad \text{and} \quad s_A^L = \frac{p_A - q_B + \Delta}{\sigma}, \tag{2}$$

$$s_B^H = \frac{p_B - q_A - \Delta}{\sigma} \quad \text{and} \quad s_B^L = \frac{p_B - q_A + \Delta}{\sigma}. \tag{3}$$

Figure 1 illustrates how consumers with high switching costs (high values of s) stay loyal to brand i, whereas consumers indexed with low s switch to the competing brand. It also illustrates that the switching cost threshold, above which consumers stay loyal, is higher for consumers who are initially mismatched than for consumers who are initially correctly matched with their preferred brand, that is, $s_i^L > s_i^H$.

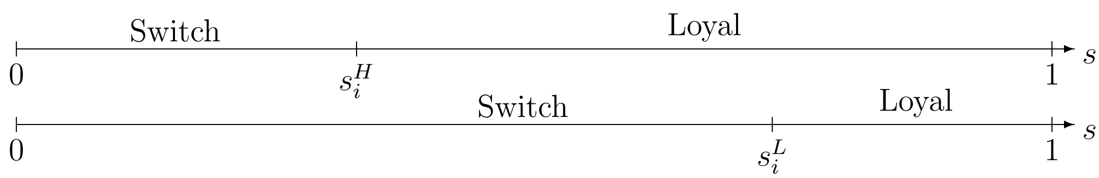

Figure 1: Allocation of brand i's loyal and switching consumers, $i = A, B$. The top figure illustrates initially correctly matched consumers, whereas the bottom figure illustrates initially mismatched consumers.

Firm A selects its loyalty price, p_A, and its poaching price, q_A, to solve

$$\max_{p_A, q_A} \pi_A = p_A(1 - s_A^H + 1 - s_A^L)n + q_A(s_B^H + s_B^L)n. \tag{4}$$

The first term in (4) is the profit from consumers who initially buy brand A and remain loyal to brand A because of high switching costs. The proportion $(1 - s_A^H)$ of A's inherited A-oriented customers (correctly matched) remain loyal, whereas the proportion $(1 - s_A^L)$ of A's inherited B-oriented customers (mismatched) stay loyal to A. The second term is the profit from consumers poached from firm B. The proportion s_B^H of consumers belonging to B's inherited segment are B-oriented, but switch in response to an attractive poaching price and low switching costs. The remaining proportion s_B^L of B's inherited A-oriented consumers are initially mismatched with brand B and accept A's poaching offer.

Similarly to (4), in (5) firm B selects its loyalty price, p_B, and its poaching price, q_B, to solve

$$\max_{p_B, q_B} \pi_B = p_B(1 - s_B^H + 1 - s_B^L)n + q_B(s_A^H + s_A^L)n. \tag{5}$$

Substituting (2) and (3) into (4) and (5), the equilibrium prices are

$$p_A^I = p_B^I = \frac{2\sigma}{3} \quad \text{and} \quad q_A^I = q_B^I = \frac{\sigma}{3}, \tag{6}$$

where the superscript I denotes equilibrium values under identity recognition. Notice that firms set the poaching prices to be lower than the loyalty prices in order to induce consumers to switch brands. Substituting (6) into (2) and (3) yields

$$s_A^{I,H} = s_B^{I,H} = \frac{1}{3} - \frac{\Delta}{\sigma} \quad \text{and} \quad s_A^{I,L} = s_B^{I,L} = \frac{1}{3} + \frac{\Delta}{\sigma}. \tag{7}$$

Equation (7) characterizes the equilibrium proportion of consumers who switch or stay loyal for each brand i, as illustrated in Figure 1. An interior equilibrium ($0 < s_i^{I,H} < s_i^{I,L} < 1$) exists as long as $\Delta < \sigma/3$.

To compute the equilibrium profits we substitute (6) and (7) into (4) and (5) to obtain

$$\pi_A^I = \pi_B^I = \frac{10}{9} n\sigma. \tag{8}$$

Consumer surplus for those who bought from firm $i = A, B$ (some remain loyal and some switch to the competing brand) is given by

$$CS_i^I = n \int_{s_i^{I,H}}^{1} (v_H - p_i^I) ds + n \int_{0}^{s_i^{I,H}} (v_L - q_j^I - \sigma s) ds$$
$$+ n \int_{s_i^{I,L}}^{1} (v_L - p_i^I) ds + n \int_{0}^{s_i^{I,L}} (v_H - q_j^I - \sigma s) ds. \tag{9}$$

The first term in (9) measures the surplus of i-oriented consumers with high switching costs who are correctly matched with firm i and stay loyal to i. The second term is the surplus of i-oriented consumers with low switching costs who are correctly matched with i, but decide to accept the poaching price offer from j (hence, become mismatched and gain a utility of v_L). The third term in (9) measures the surplus of j-oriented consumers who are initially mismatched with firm i. Because these consumers have high switching costs, they remain loyal and continue to purchase their less-preferred brand i. The fourth term is the surplus of j-oriented consumers with low switching costs who are initially mismatched with i and switch to j (their preferred brand).

Substituting the equilibrium prices (6) and the corresponding switching cost thresholds (7) into (9) yields

$$CS^I = CS^I_A + CS^I_B = \frac{2n}{9\sigma}\left[9\Delta^2 + 9\sigma(v_H + v_L) - 11\sigma^2\right]. \tag{10}$$

Finally, (8) and (10) yield total welfare

$$W^I = CS^I + \pi^I_A + \pi^I_B = \frac{2n}{9\sigma}\left[9\Delta^2 + 9\sigma(v_H + v_L) - \sigma^2\right]. \tag{11}$$

3. Asymmetric Preference Recognition

Suppose now that firms learn the exact preferences of their customers (but not the preferences of consumers who buy from the competing firm). More precisely, firm i can identify which of its $2n$ initial customers are A-oriented and which customers are B-oriented. This information enables each firm to price discriminate among its own customers according to their type.[1] Therefore, let p_i^H and p_i^L denote the price firm i charges its own type-H and type-L customers. Since firm i cannot identify the type of a consumer who purchased from the rival firm, firm i is restricted to setting a single poaching price, q_i, to attract its rival's customers.

Let $i = A, B$, $i \neq j$, and $s \in [0, 1]$. The utility function (1) of a consumer who has a customer relationship with firm i and a switching cost s is now modified to

$$U_i(s) = \begin{cases} v_H - p_i^H & i\text{-oriented and continues to buy } i \\ v_L - p_i^L & j\text{-oriented and continues to buy } i \\ v_L - q_j - \sigma s & i\text{-oriented and switches to } j \\ v_H - q_j - \sigma s & j\text{-oriented and switches to } j. \end{cases} \tag{12}$$

Applying completely analogous calculations as in the previous section we can characterize the switching cost thresholds associated with the utility function (12). The switching cost thresholds (2) and (3) are now modified to

$$s_A^H = \frac{p_A^H - q_B - \Delta}{\sigma} \quad \text{and} \quad s_A^L = \frac{p_A^L - q_B + \Delta}{\sigma}, \tag{13}$$

[1] Identity recognition, analyzed in the previous section, applies to all markets where the firms can distinguish their own customers from those of the rival. Asymmetric preference recognition requires that each firm observes the individual preferences of its customers. This might be particularly relevant in industries where firms repeatedly interact with their customers, as in certain service industries.

$$s_B^H = \frac{p_B^H - q_A - \Delta}{\sigma} \quad \text{and} \quad s_B^L = \frac{p_B^L - q_A + \Delta}{\sigma}. \tag{14}$$

Firm A selects its type-specific loyalty prices, p_A^H and p_A^L, and its poaching price, q_A, to solve

$$\max_{p_A^H, p_A^L, q_A} \pi_A = p_A^H(1 - s_A^H)n + p_A^L(1 - s_A^L)n + q_A(s_B^H + s_B^L)n. \tag{15}$$

Firm B selects its type-specific loyalty prices, p_B^H and p_B^L, and its poaching price, q_B, to solve

$$\max_{p_B^H, p_B^L, q_B} \pi_B = p_B^H(1 - s_B^H)n + p_B^L(1 - s_B^L)n + q_B(s_A^H + s_A^L)n. \tag{16}$$

Substituting (13) and (14) into (15) and (16), the equilibrium prices are

$$p_A^{A,H} = p_B^{A,H} = \frac{4\sigma + 3\Delta}{6}, \quad p_A^{A,L} = p_B^{A,L} = \frac{4\sigma - 3\Delta}{6}, \quad \text{and} \quad q_A^A = q_B^A = \frac{\sigma}{3}, \tag{17}$$

where superscript A denotes equilibrium values under asymmetric preference recognition. Substituting (17) into (13) and (14) yields

$$s_A^{A,H} = s_B^{A,H} = \frac{1}{3} - \frac{\Delta}{2\sigma} \quad \text{and} \quad s_A^{A,L} = s_B^{A,L} = \frac{1}{3} + \frac{\Delta}{2\sigma}. \tag{18}$$

An interior equilibrium ($0 < s_i^{A,H} < s_i^{A,L} < 1$) exists as long as $\Delta < 2\sigma/3$.

To compute the equilibrium profits we substitute (17) and (18) into (15) and (16) to obtain

$$\pi_A^A = \pi_B^A = \frac{n(20\sigma^2 + 9\Delta^2)}{18\sigma}. \tag{19}$$

Consumer surplus for those who bought from firm i (some remain loyal and some switch to the competing brand) is given by

$$\begin{aligned} CS_i^A = {} & n \int_{s_i^{A,H}}^{1} (v_H - p_i^{A,H})ds + n \int_0^{s_i^{A,H}} (v_L - q_j^A - \sigma s)ds \\ & + n \int_{s_i^{A,L}}^{1} (v_L - p_i^{A,L})ds + n \int_0^{s_i^{A,L}} (v_H - q_j^A - \sigma s)ds. \end{aligned} \tag{20}$$

Substituting the equilibrium prices (17) and the corresponding switching cost thresholds (18) into (20),

$$CS^A = CS^A_A + CS^A_B = \frac{n}{18\sigma}\left[9\Delta^2 + 36\sigma(v_H + v_L) - 44\sigma^2\right]. \tag{21}$$

Finally, (19) and (21) yield total welfare

$$W^A = CS^A + \pi^A_A + \pi^A_B = \frac{n}{18\sigma}\left[27\Delta^2 + 36\sigma(v_H + v_L) - 4\sigma^2\right]. \tag{22}$$

4. Symmetric Preference Recognition

We maintain the main assumption of Section 3 that firms recognize the exact preference of each of their customers. In addition, firms are now assumed to learn about the preferences of consumers who bought from the rival firm. Information exchange between the firms is one mechanism to support such a configuration. With symmetric preference recognition, all firms know the exact type of each consumer (regardless of whether consumers are A- or B-oriented), regardless of the consumer's purchase history. However, the firms are still assumed not to be able to identify the idiosyncratic switching cost of each consumer.

With symmetric preference recognition, firms can price discriminate among all consumers according their type and purchase history. Consequently, firms now can also set poaching prices according to consumer preference orientation. Let q_i^H and q_i^L denote the price firm i charges type H and type L customers of the competing firm j. For example, q_A^H (q_A^L) denotes the poaching price firm A sets for B's customers who are oriented towards brand A (brand B) and gain a benefit v_H (v_L) after they switch from B to A. As in Section 3, p_i^H and p_i^L denote the price firm i charges its own type H and type L customers.

The utility function (12) of a consumer who has a customer relationship with firm i and switching cost s is now further modified to

$$U_i(s) = \begin{cases} v_H - p_i^H & i\text{-oriented and continues to buy } i \\ v_L - p_i^L & j\text{-oriented and continues to buy } i \\ v_L - q_j^L - \sigma s & i\text{-oriented and switches to } j \\ v_H - q_j^H - \sigma s & j\text{-oriented and switches to } j. \end{cases} \tag{23}$$

Applying completely analogous calculations leading to (13) and (14) for the utility function (23), the switching cost thresholds (13) and (14) are now modified to

$$s_A^H = \frac{p_A^H - q_B^L - \Delta}{\sigma} \quad \text{and} \quad s_A^L = \frac{p_A^L - q_B^H + \Delta}{\sigma}, \tag{24}$$

$$s_B^H = \frac{p_B^H - q_A^L - \Delta}{\sigma} \quad \text{and} \quad s_B^L = \frac{p_B^L - q_A^H + \Delta}{\sigma}. \tag{25}$$

Firm A selects its loyalty prices, p_A^H and p_A^L, and its poaching prices, q_A^H and q_A^L, to solve

$$\max_{p_A^H, p_A^L, q_A^H, q_A^L} \pi_A = p_A^H(1 - s_A^H)n + p_A^L(1 - s_A^L)n + q_A^H s_B^L n + q_A^L s_B^H n. \tag{26}$$

Analogously, firm B selects its loyalty prices, p_B^H and p_B^L, and its poaching prices, q_B^H and q_B^L, to solve

$$\max_{p_B^H, p_B^L, q_B^H, q_B^L} \pi_B = p_B^H(1 - s_B^H)n + p_B^L(1 - s_B^L)n + q_B^H s_A^L n + q_B^L s_A^H n. \tag{27}$$

Substituting (24) and (25) into (26) and (27), the equilibrium prices are

$$p_A^{S,H} = p_B^{S,H} = \frac{2\sigma + \Delta}{3}, \quad p_A^{S,L} = p_B^{S,L} = \frac{2\sigma - \Delta}{3},$$
$$q_A^{S,H} = q_B^{S,H} = \frac{\sigma + \Delta}{3}, \quad \text{and} \quad q_A^{S,L} = q_B^{S,L} = \frac{\sigma - \Delta}{3}, \tag{28}$$

where superscript S denotes equilibrium values under symmetric preference recognition. Comparing (28) with (17) we can conclude that the elimination of asymmetric customer recognition reduces the variation in loyalty prices. Substituting (28) into (24) and (25) yields

$$s_A^{S,H} = s_B^{S,H} = \frac{1}{3} - \frac{\Delta}{3\sigma} \quad \text{and} \quad s_A^{S,L} = s_B^{S,L} = \frac{1}{3} + \frac{\Delta}{3\sigma}. \tag{29}$$

An interior equilibrium ($0 < s_i^{S,H} < s_i^{S,L} < 1$) exists as long as $\Delta < \sigma$. Figure 2 illustrates the differences in switching cost thresholds (18) and (29). Figure 2 reveals that shifting

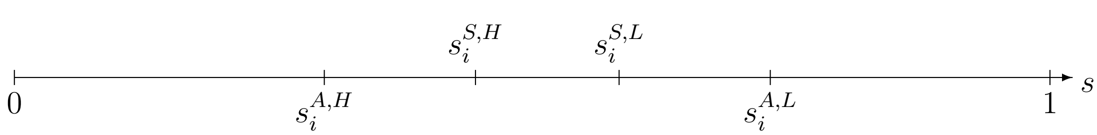

Figure 2: The effect of information exchange on switching cost thresholds.

from asymmetric to symmetric customer recognition decreases the amount of switching of consumers who are initially matched with their ideal brand ($s_i^{S,H} > s_i^{A,H}$), but increases the amount of switching of consumers who are initially matched with their less-desired brand ($s_i^{S,L} < s_i^{A,L}$).

To compute the equilibrium profits we substitute (28) and (29) into (26) and (27) to obtain

$$\pi_A^S = \pi_B^S = \frac{2n(5\sigma^2 + 2\Delta^2)}{9\sigma}. \tag{30}$$

Consumer surplus for those who bought from firm i (some remain loyal and some switch to the competing brand) is given by

$$CS_i^S = n \int_{s_i^{S,H}}^{1} (v_H - p_i^{S,H})ds + n \int_{0}^{s_i^{S,H}} (v_L - q_j^{S,L} - \sigma s)ds$$
$$+ n \int_{s_i^{S,L}}^{1} (v_L - p_i^{S,L})ds + n \int_{0}^{s_i^{S,L}} (v_H - q_j^{S,H} - \sigma s)ds. \tag{31}$$

Substituting the equilibrium prices (28) and the corresponding switching cost thresholds (29) into (31),

$$CS^S = CS_A^S + CS_B^S = \frac{2n}{9\sigma}\left[\Delta^2 + 9\sigma(v_H + v_L) - 11\sigma^2\right]. \tag{32}$$

Finally, (30) and (32) yields total welfare

$$W^S = CS^S + \pi_A^S + \pi_B^S = \frac{2n}{9\sigma}\left[5\Delta^2 + 9\sigma(v_H + v_L) - \sigma^2\right]. \tag{33}$$

5. Comparisons

Sections 2, 3, and 4 characterize equilibria under three configurations: (i) identity (history of purchase) recognition but no ability to recognize individual preferences (I), (ii) asymmetric preference recognition, where the firm learns the individual preferences of its own customers, but cannot learn the preferences of consumers with whom the firm does not have customer relationship (A), and (iii) symmetric preference recognition, where each firm learns the idiosyncratic preferences of all consumers (S). Symmetric preference recognition can be obtained by a truthful information exchange between competing firms. We now compare industry profit, consumer surplus, and total welfare across these three market configurations.

The comparisons in this section may depend on the relative magnitudes of the value of a preference match with the consumer's most-preferred brand, $\Delta = v_H - v_L$, and the switching cost parameter, σ. Table 1 provides the parameter range under which interior equilibria exist in the three market configurations. Table 1 shows that $0 < \Delta < \sigma/3$ is a sufficient condition for interior equilibria to exist in all three market configurations. But less restrictive conditions are needed for the asymmetric and symmetric equilibria.

Parameter restriction	$0 < \Delta < \dfrac{\sigma}{3}$	$0 < \Delta < \dfrac{2\sigma}{3}$	$0 < \Delta < \sigma$
Interior equilibria	I, A, S	A, S	S

Table 1: Parameter restrictions needed for existence of interior equilibria.

5.1 Profit comparisons

From (19) and (30) we can conclude that

$$(\pi_A^A + \pi_B^A) - (\pi_A^S + \pi_B^S) = \frac{n\Delta^2}{9\sigma} > 0. \tag{34}$$

Therefore, a shift from asymmetric to symmetric preference recognition imposes losses on the firms. This finding means that firms lose by mutually exchanging information regarding their consumers' preferences. From (8) and (30) we can conclude that

$$(\pi_A^S + \pi_B^S) - (\pi_A^I + \pi_B^I) = \frac{8n\Delta^2}{9\sigma} > 0. \tag{35}$$

Based on (34) and (35) we can formulate the following result.

Result 1. *Firms always benefit from recognizing the preferences of their customers, regardless of whether they share this information or not. Further, symmetric preference recognition resulting from information exchange among firms reduces the gains from preference recognition. Formally,* $\pi_i^A > \pi_i^S > \pi_i^I$ *for every firm* $i = A, B$.

Result 1 means that each firm has a unilateral incentive to acquire information regarding the individual preferences of its customers. Such customer-specific knowledge about individual preferences makes it possible for the firm to differentiate its price among its own customers. This price discrimination promotes the firm's profits compared with pricing based on identity recognition only. A comparison of the equilibrium poaching prices (6) with (17) shows that the competitive threat of being poached by the rival firm remains invariant across the configurations with asymmetric preference recognition and identity recognition.

Result 1 also demonstrates that firms do not have an incentive to share information regarding customer-specific preferences. The reason for this is that information exchange enables firms to refine their targeted poaching price offers, as characterized by (28). Such targeted poaching offers intensify competition to the detriment of industry profits. It is interesting to contrast this result with the effects of information exchange among banks regarding the creditworthiness of borrowers in loan markets. As Pagano and Jappelli (1993), Padilla and Pagano (1997), and Gehrig and Stenbacka (2007) separately establish, banks typically have an incentive to exchange information regarding borrower types as a mechanism to reduce credit losses, that is, as a mechanism to avoid granting finance to consumers who are not creditworthy. In our model, information exchange provides no such benefit. Instead information exchange leads to more-aggressive, type-specific poaching offers targeted at all consumer types. This explains why information exchange intensifies competition, and therefore why it reduces industry profits.

5.2 Comparisons of consumer surplus

We now compare the effects of different types of customer recognition on consumers. From (21) and (32) we can conclude that

$$CS^A - CS^S = \frac{5n\Delta^2}{18\sigma} > 0. \tag{36}$$

Therefore, consumers become worse off under symmetric preference recognition (information exchange) relative to asymmetric preference recognition. The loss to consumers from the transition to symmetric recognition decreases with the switching cost parameter σ, whereas it increases as a function of the loss from a mismatch, Δ. From (10) and (21) we can conclude that

$$CS^I - CS^A = \frac{3n\Delta^2}{2\sigma} > 0. \tag{37}$$

Therefore, consumers become worse off when firms learn the preferences of their own customers.

We now summarize our findings of how consumer surplus is influenced by the three types of customer recognition.

Result 2. *Compared with identity recognition, consumers are worse off when firms can price discriminate based on asymmetric preference recognition. Transitioning to symmetric preference recognition (information exchange regarding consumer preferences) hurts consumers even further. Formally,* $CS^S < CS^A < CS^I$.

Result 2 can be explained by examining the effects of customer recognition on the price variation faced by different consumers, and hence on consumer surplus. More precisely, price discrimination based on recognition of consumer preferences introduces type-contingent price differences for loyal customers compared with pricing based on identity recognition only. Thus, price discrimination based on asymmetric, preference-based recognition makes it possible for the firms to extract more surplus from the consumers. Switching costs restrict the power of the rival firm to compete for this surplus extraction. The ability to extract more surplus by fitting type-contingent prices to different consumers explains why $CS^A < CS^I$.

By comparing (28) with (17) we can conclude that symmetric preference recognition (information exchange of consumer preferences) generates differential poaching prices across consumer types, but it also lowers the price differences charged to loyal customers. Furthermore, by comparing the switching cost thresholds in these two regimes we find that the *total* number of switching consumers is the same. However, symmetric preference recognition increases the variation in poaching prices more than it lowers the variation in incumbency prices, leading to an enhanced ability to extract consumer surplus when evaluated from an aggregate perspective. For this reason, consumer surplus is lower with symmetric than with asymmetric customer recognition, which explains why symmetric preference recognition (information exchange) reduces consumer surplus relative to asymmetric preference recognition.

Result 2 implies that consumers would benefit from a policy that would ban firms from exchanging information about their customers' individual preferences. This result is far from self-evident. A priori, one could argue that information exchange could weaken the lock-in effects associated with an inherited mismatch of consumers who initially purchased the "wrong" brand. Such a line of reasoning would be analogous to the arguments developed by Padilla and Pagano (1997, 2000) in favor of information exchange as a mechanism to reduce the lock-in effects of asymmetric information in lending markets, where incumbent lenders have an informational advantage compared with their rivals regarding the customers' risk characteristics. However, in our model, information exchange, in addition to inducing more aggressive prices targeted to consumers with a low preference for a certain brand, also generates less aggressive prices targeted to consumers with a high preference for the brand. At a fundamental level, information exchange reduces consumer surplus because it increases price variation across consumer types, thereby promoting the ability to extract consumer surplus.

As far as the implications for competition policy are concerned, our policy conclusion raises warnings against information exchange regarding individual customers in markets with asymmetric information about the preferences of individual customers. This recommendation against the exchange of information at a very disaggregate level is in line with competition policy objecting to the dissemination of individualized sales data, illustrated by the famous U.K. Agricultural Tractor Exchange case, see European Commission (1992). These implications for competition policy are discussed extensively by Kühn (2001). Kühn (2001) emphasizes information exchange as a mechanism to facilitate (tacit) collusion. Our model highlights another harmful antitrust effect associated with information exchange, namely the potential for information exchange to serve as a device to better facilitate the extraction of consumer surplus.

5.3 Total welfare comparisons

From Results 1 and 2 we can draw the conclusion that price discrimination based on asymmetric preference recognition introduces a distributional conflict between firms and consumers. Firms gain from asymmetric preference recognition compared with identity recognition, whereas consumers lose. Furthermore, we can also directly conclude that a transition from asymmetric to symmetric customer recognition generates an unambiguous change in total welfare. That is, a market configuration with symmetric preference recognition (information exchange) reduces consumer welfare as wells as firms' profits.

Formally, comparing (11), (22), and (33) yields

$$W^A - W^S = \frac{7n\Delta^2}{18\sigma} > 0 \quad \text{and} \quad W^I - W^A = \frac{n\Delta^2}{2\sigma} > 0. \tag{38}$$

Result 3. *Pricing based on asymmetric preference recognition reduces total welfare compared with only identity recognition. Symmetric preference recognition (information exchange between firms) further increases this social loss. Formally,* $W^I > W^A > W^S$.

Result 3 implies that the loss to consumers from price discrimination based on asymmetric preference recognition exceeds the associated profit gains to firms. The total social loss from pricing based on asymmetric preference recognition decreases with the switching cost parameter, σ, whereas it increases as a function of the loss from a mismatch, Δ. The magnitude of the loss from transitioning to symmetric preference recognition (information exchange) depends on exactly the same factors.

6. Uniform Pricing (no recognition)

It is instructive to compare the effects of the various types of customer recognition analyzed in the previous sections to a benchmark where firms cannot price discriminate at all. This is the case of *uniform* pricing. Uniform pricing can emerge in several scenarios. One example is when firms are unable to collect the information needed to facilitate price discrimination because of an inability to recognize and maintain databases with information on their own customers. Uniforming pricing could also emerge as a result of a regulatory ban on all forms of price discrimination, forcing firms to set one price for all customers.

Despite the formal simplicity associated with the maximization of profit with respect to a single price [recall firms set two prices under regime (I), three prices under (A), and four prices under (S)], the equilibrium with uniform pricing involves a corner solution with the feature that customers who are properly matched with their ideal brand do not switch to the competing brand.

We first demonstrate the nonexistence of a fully interior equilibrium. Suppose that such an equilibrium exists. When firm A is restricted to set p_A only and firm B to p_B only, (2) and (3) become

$$s_A^H = \frac{p_A - p_B - \Delta}{\sigma} \quad \text{and} \quad s_A^L = \frac{p_A - p_B + \Delta}{\sigma}, \tag{39}$$

$$s_B^H = \frac{p_B - p_A - \Delta}{\sigma} \quad \text{and} \quad s_B^L = \frac{p_B - p_A + \Delta}{\sigma}. \tag{40}$$

Even without going into the precise derivation of the equilibrium prices, a close look at (39) and (40) reveals that $s_A^H < 0$ and $s_B^H < 0$ when $p_A \approx p_B$. In fact, allowing for negative values of switching cost thresholds would yield the "false equilibrium" prices $p_A = p_B = \sigma/2$.

Setting $s_A^H = s_B^H = 0$ implies that customers who are "correctly" matched with their ideal brands do not switch under uniform pricing. In this case, the profit maximization problems (4) and (5) become

$$\max_{p_A} \pi_A = p_A(1 - 0 + 1 - s_A^L + 0 + s_B^L)n \tag{41}$$
$$\max_{p_B} \pi_B = p_B(1 - 0 + 1 - s_B^L + 0 + s_A^L)n,$$

where s_A^L and s_B^L are defined in (39) and (40). The equilibrium prices and profit levels are then given by

$$p_A^U = p_B^U = \sigma \quad \text{and} \quad \pi_A^U = \pi_B^U = 2n\sigma, \tag{42}$$

where superscript U indicates equilibrium values under uniform pricing. To prove that the prices (42) indeed constitute a Nash-Bertrand equilibrium, we must establish that no firm, say firm A for the sake of demonstration, would find it profitable to undercut its price and grab some of the customers oriented towards the competing brand. Formally, if firm A undercuts, it chooses p_A to maximize $p_A(1 - 0 + 1 - s_A^L + s_B^H + s_B^L)n$, yielding $\tilde{p}_A^U = (5\sigma - \Delta)/6$ and $\tilde{\pi}_A^U = n(5\sigma - \Delta)^2/(12\sigma)$. Now, firm A will not deviate from the equilibrium price (42) if the profit from deviation $n(5\sigma - \Delta)^2/(12\sigma) < 2n\sigma$. This inequality is satisfied if $\Delta < (2\sqrt{6} + 5)\sigma$, which is assumed throughout, as indicated in Table 1.

The consumer surplus of buyers initially matched with firm i is

$$CS_i^U = n\int_0^1 (v_H - p_i^U)ds + n\int_{s_i^{U,L}}^1 (v_L - p_i^U)ds + n\int_0^{s_i^{U,L}} (v_H - p_j^U - \sigma s)ds. \quad (43)$$

The first term captures the surplus of the n correctly matched i-oriented consumers, where we have already shown that none of them switches under uniform pricing. The second term applies to the n incorrectly matched j-oriented consumers who, because of high switching costs, do not switch. The last term applies to consumers who switch from i to j (their preferred brand). Substituting the equilibrium prices (42) into (39) and (40) for s_A^L and s_B^L, and then into (43) we obtain

$$CS^U = CS_A^U + CS_B^U = \frac{n}{\sigma}\left[\Delta^2 + 2\sigma(v_H + v_L) - 4\sigma^2\right]. \quad (44)$$

Finally, (42) and (44) yield total welfare

$$W^U = CS^U + \pi_A^U + \pi_B^U = \frac{n}{\sigma}\left[\Delta^2 + 2\sigma(v_H + v_L)\right]. \quad (45)$$

Subtracting the profit level (19) when firms recognize their customers' preferences from (42) yields

$$(\pi_A^U + \pi_B^U) - (\pi_A^A + \pi_B^A) = \frac{n}{9\sigma}(16\sigma^2 - 9\Delta^2) > 0. \quad (46)$$

Next, from (32) and (44),

$$CS^U - CS^S = \frac{7n}{9\sigma}(\Delta^2 - 2\sigma^2) < 0. \quad (47)$$

Finally, from (11) and (45)

$$W^U - W^I = \frac{n}{9\sigma}(2\sigma^2 - 9\Delta^2) > 0. \quad (48)$$

Comparing (46), (47), and (48) with Results 1, 2, and 3 yields the following conclusion.

Result 4. *(a) Uniform pricing generates higher profits than any of the discriminatory pricing schemes based on customer recognition analyzed in this study.*

(b) The consumer surplus under all types of price discrimination based on customer recognition is higher than the consumer surplus under uniform pricing.

(c) Total welfare is higher under uniform pricing than under any of the discriminatory pricing schemes based on customer recognition.

From Result 4 we can draw the following conclusion. Relative to competition with uniform pricing, competition is more intense when firms compete strategically using discriminatory pricing schemes based on customer recognition. This conclusion holds true for all the different types of customer recognition we have analyzed. Thisse and Vives (1988) demonstrated a qualitatively similar feature under circumstances where firms compete with completely individualized prices (perfect price discrimination). Discriminatory pricing essentially enlarges the set of strategic pricing options available to competing firms. Different discriminatory pricing schemes make it possible for firms to fine-tune their prices with respect to buyers' specific characteristics. When competitors are restricted to uniform prices, deviating to discriminatory pricing rules typically generates a strategic advantage to a given competitor. However, when all competitors realize the strategic potential of price discrimination and apply discriminatory pricing, competition is intensified. Consequently, under price discrimination all firms in the industry earn lower margins, whereas the consumers benefit from more intense competition. Thus, with oligopolistic competition, the availability of discriminatory pricing schemes catches firms in a classical "prisoner's dilemma" trap. A commitment not to price discriminate would benefit all the firms collectively, but each individual firm would have a strategic incentive to deviate and introduce a discriminatory pricing scheme based on all available information on consumer characteristics. Chen (1997) established an analogous result in his analysis of behavior-based pricing in which consumers differentiated according to their switching costs.

The configuration of identity recognition in our paper captures qualitatively the features of history-based pricing originally analyzed by Chen (1997). Likewise, despite significant differences concerning the details of the model, our configuration with symmetric preference recognition essentially matches perfect price discrimination analyzed by Thisse and Vives (1988) in the sense that competition takes place subject to having firms process all their knowledge regarding the characteristics of their own as well as their rivals' customers. Contrary to this configuration, the case with asymmetric preference recognition captures the feature that an established customer relationship gives the firm an informational advantage over its rivals regarding the characteristics of its customers. As Shin and Sudhir (2010) argue, such an informational advantage generates an incentive for firms to invest in building customer relationship management systems. Shin and Sudhir (2010) show that behavior-based pricing may actually enhance profits compared with uniform prices under circumstances of information asymmetries regarding customer characteristics combined with stochastic preferences.[2] Our classification of preference differentiation generates different conclusions regarding the profitability of discriminatory pricing based on preference recognition from those of Shin and Sudhir (2010).

Result 4 reports a robust conclusion that the gains to firms from uniform pricing dominate the associated loss to consumers regardless of which regime of customer recognition is used as the basis for comparison. In qualitative terms this result coincides with the welfare conclusion reported in Gehrig, Shy, and Stenbacka (2011). However, Gehrig, Shy, and Stenbacka (2011) is restricted to a model of entry with identity recognition, whereas Result 4 applies to a much broader spectrum of mechanisms for customer recognition.

According to Result 4, total welfare is higher under uniform pricing than under any of the discriminatory pricing schemes with customer recognition. In order to understand the intuition behind this result we now compare total welfare associated with identity recognition with total welfare associated with uniform pricing. The sources behind this result can be explained as follows. In Hotelling competition with full market coverage, price changes generate only a redistribution of surplus between consumers and producers, whereas the aggregate

[2]In Shin and Sudhir (2010) customers are differentiated based on their demand.

costs associated with switching and brand mismatch constitute *real* deadweight losses to the economy. Under customer identity recognition the number of switching consumers is $n(1/3 - \Delta/\sigma) + n(1/3 + \Delta/\sigma) = 2n/3$, where the switching consumers include not only those who are initially mismatched, but also those who are initially correctly matched with their preferred brand. Furthermore, the equilibrium with identity recognition was restricted, $\Delta < \sigma/3$. With uniform pricing, the number of switching consumers will be significantly lower. Actually, with uniform pricing only mismatched consumers do switch brands. The total number of switching consumers with uniform pricing is $n\Delta/\sigma < n/3$. Consequently, price discrimination based on identity recognition generates higher aggregate switching costs than uniform pricing. At the same time, uniform pricing reduces the amount of preference mismatch. Overall, our total welfare comparison establishes analytically that uniform pricing induces lower aggregate costs of switching and mismatch than pricing based on any discriminatory scheme based on customer recognition analyzed in this paper.

7. Concluding Comments

This paper introduces three different types of consumer recognition: identity recognition, asymmetric preference recognition, and symmetric preference recognition. We compare the corresponding price equilibria and evaluate the effects on industry profits, consumer surplus, and total welfare. Firms benefit from recognizing the preferences of their customers regardless of whether they share this information or not. Information exchange among firms (symmetric preference recognition) reduces the gains from customer recognition. Our welfare analysis demonstrates that consumers are worse off under pricing based on asymmetric recognition of consumer preferences than with identity recognition. In addition, information exchange regarding consumer preferences hurts consumers even further. Overall, we find that consumers would benefit from a policy that bans information exchange regarding individual consumer preferences (symmetric preference recognition). Our welfare analysis shows that the gains to firms from uniform pricing (no recognition) are larger than the associated loss to consumers, regardless of which regime of customer recognition serves as the basis for comparison.

In terms of its implications for competition policy our model highlights how information exchange may serve as a device to better facilitate the extraction of consumer surplus. Together with alternative mechanisms emphasizing how information exchange may facilitate (tacit) collusion (see, Kühn (2001)), our model gives strong support for policy conclusions raising warnings against the exchange of information regarding individual customers or deals. At the same time, our study points to the limitations of the arguments presented by Padilla and Pagano (1997, 2000) in favor of information exchange as a mechanism to reduce the lock-in effects of asymmetric information in lending markets. In these studies of the credit market, information sharing has the advantage of making it possible to avoid granting funding to borrowers who belong to the rival's customer segment and who are not creditworthy. In view of our study, this argument cannot be extended to industries that do not satisfy the stylized assumptions associated with the credit market model of Padilla and Pagano (1997, 2000). In our model, information exchange achieves the double effect of inducing more aggressive prices targeted to consumers with a low preference for a certain brand and less aggressive prices targeted to consumers with a high preference for the brand. Overall, information exchange reduces consumer surplus because it increases price variation across consumer types, thereby promoting the ability to extract consumer surplus. Lastly, with respect to the implications for competition policy, Section 5.2 raises warnings against information exchange regarding individual customers in markets with asymmetric information about the preferences of individual customers.

Our study is conducted within the framework of a fairly general, but nevertheless highly stylized model. The analysis could be extended by adding structure to the model in a number of directions. The framework of this paper is a symmetric model where the inherited proportions of correctly matched and mismatched consumers are equal. It would be interesting to explore the implications of inherited asymmetries in this respect. Likewise, and relatedly, our perspective has been restricted to a static analysis. It would be of obvious interest to explore potential dynamic implications of competition based on customer recognition. For a dynamic analysis it would be particularly interesting to trace the evolution over time of inherited asymmetries. Finally, our conclusions regarding the consequences of information exchange are drawn following the standard assumption that the information is revealed to rivals in a truthful manner. It would be interesting to explore the implications of information exchange under circumstances where firms use their knowledge of their customer base to strategically manipulate the information revealed to their rivals.

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