



Customer information sharing among rival firms

Qihong Liu^{a,*}, Konstantinos Serfes^b

^a*Department of Resource Economics, University of Massachusetts, 300B Stockbridge Hall,
80 Campus Center Way, Amherst, MA 01003-9246, USA*

^b*Department of Economics and International Business, Bennett S. LeBow College of Business,
Drexel University, Matheson Hall, 32nd and Market Streets, Philadelphia, PA 19104, USA*

Received 12 May 2004; accepted 7 March 2005

Available online 3 May 2005

Abstract

The recent rapid growth of the Internet as a medium of communication and commerce, combined with the development of sophisticated software tools, are to a large extent responsible for producing a new kind of information: Databases with detailed records about consumers' preferences. These databases have become part of a firm's assets, and as such they can be sold to third parties. This possibility has raised numerous concerns from consumer privacy advocates and regulators, who have entered into a heated debate with business groups and industry associations about whether the practice of customer information sharing should be banned, regulated, or left unchecked. This paper investigates the incentives of rival firms to share their customer-specific information and evaluates the welfare implications if such exchanges are banned, in the context of a perfect price discrimination model.

© 2005 Elsevier B.V. All rights reserved.

JEL classification: D43; L13; O30

Keywords: Customer information sharing; Horizontal and vertical differentiation; Perfect price discrimination

*Corresponding author. Tel.: +1 413 545 6650; fax: +1 413 545 5853.

E-mail addresses: qiliu@resecon.umass.edu (Q. Liu), ks346@drexel.edu (K. Serfes).

“Few consumers could write down even 1% of the amount of data that companies have about them.”

Information Week, August 20, 2001

1. Introduction

Earlier literature on information sharing among rival firms has mainly focused on two types of information exchanges: (i) firms share – directly or indirectly – their private signals about demand conditions, or (ii) firms exchange cost data.¹ The recent rapid growth of the Internet as a medium of communication and commerce, combined with the development of sophisticated software tools, are to a large extent responsible for producing a new kind of information: databases with detailed records about consumers’ preferences. Such data are gleaned from a customer’s transactions with a firm and public records and are used to assemble a detailed picture of consumers. Firms can utilize this information to improve the focus of their marketing campaigns, to design products that better fit the needs of their customers and to tailor their price offers according to each consumer’s brand preferences. These databases have become part of a firm’s assets, and as such they can be sold to third parties.² This possibility has raised numerous concerns from consumer privacy advocates and regulators, who have entered into a heated debate with business groups and industry associations about whether the practice of customer information sharing should be banned, regulated, or left unchecked.³ Nevertheless, there is little theoretical work done on this issue. This paper is a step in this direction. We look at rival firms’ incentives to share their customer-specific information and we evaluate the welfare implications if such exchanges are banned, in the context of a perfect price discrimination model.

¹See, for example, Gal-Or (1985), Shapiro (1986), Vives (1990), Villas-Boas (1994), and Armantier and Richard (2003).

²There are many cases where firms join database co-ops (see, for example, “Database Co-ops,” *Catalog Age*, August 1, 1999, where the pros and cons of joining the Abacus Alliance database are discussed). A requirement is that a prospective member firm must contribute its own database. To join the Abacus B2B alliance, for instance, a firm must contribute at least 5000 names (see, “Who’s is Who among the B-to-B Co-op Databases,” *Catalog Age*, May 1, 2004). In doing so, the firm is fully aware that these names can potentially be exploited by rival firms. These co-ops are not uncommon which means that there are benefits from sharing information. Furthermore, drug retailers – including CVS, Kmart, and Wal-Mart – banded together to pool up-to-the-minute sales data from thousands of stores nationwide and sell that information to marketing companies and drugmakers (“Customer Data Means Money,” *Information Week*, August 20, 2001). Finally, The Direct Marketing Association (www.the-dma.org) makes a large number of customer databases available to its members. These databases have been developed by individual firms who found it advantageous to sell them to the DMA.

³For example see, “Senator takes aim at e-commerce data-sharing effort,” www.computerworld.com, December 7, 2000. Based on the Online Privacy Protection Act consumers should give their consent to firms before they share customer information with a third party, e.g. “A very public battle over privacy,” *Business Week*, May 23, 2002. However, firms make every effort to safeguard valuable consumer information and their option to sell it to third parties. According to the latter article above, “. . .most companies bury the opt-out notices within masses of legal jargon at the bottom of monthly mailings.”

We formulate a dynamic (two-period) location model of horizontal and vertical differentiation with two rival firms. In the first period firms know only the distribution of brand preferences and each charges a uniform price. At the beginning of the second period each firm collects detailed (perfect) information about its own customers (i.e., the ones who purchased its product in period 1). Then, each firm decides whether to sell its customer database to the rival firm. The customer information enables a firm, in the next stage, to price discriminate among consumers with different degrees of brand loyalty.

We show that customer information sharing between rival firms will take place even in the *most* competitive environment, where demand creation and any revenues from selling customer data to non-rival firms are assumed away. A necessary condition for some type of information sharing to be part of a subgame perfect equilibrium is firm asymmetry. More specifically, when firms have equal customer bases (i.e., pure horizontal differentiation), in equilibrium, neither firm finds it profitable to sell its database to the rival firm.⁴ With *enough* firm asymmetry, in the unique subgame perfect equilibrium, the firm with the smaller customer base sells its information to the firm with the larger customer base. The “big” firm never sells, in equilibrium, its information to the “small” firm, regardless of the difference in the customer bases between the two firms.⁵ The intuition is as follows. Firms benefit from trading consumer information because a group of consumers buy a firm’s product, although this is not their favorite brand. These names *optimally* end up in the “wrong” database and subsequent trading leads to a Pareto (excluding consumers) improvement. This may very well happen because prices are not equal. A firm with a *large* loyal franchise may choose to exploit its consumers’ strength of preferences for its product and set a high price, in anticipation of the information trade that will follow next.

First period uniform prices are lower than the ones in the corresponding static model, but above marginal cost. Moreover, first period uniform prices are a decreasing function of the small firm’s bargaining power over the gains from trading customer information. If sharing of customer information is banned, then firms become worse off, while consumers become better off (on average). In addition, high firm asymmetry and a high discount factor lead to an increase in social welfare, while low firm asymmetry and a low discount factor result in lower social welfare, when information sharing is banned.

Chen et al. (2001) is a paper most closely related to our work. The authors employ a static model to investigate, among other issues, the incentives of rival firms to sell customer information of imperfect targetability (accuracy). They show that information sharing will take place provided that the size of the two firms’ loyal customers is not too different. This is in contrast with our conclusion, where information sharing occurs if and only if the two firms’ customer bases are

⁴A firm’s customer base is defined as the fraction of consumers that would buy that firm’s product at equal prices.

⁵In Section 5, we show that our model, under some minor modifications, can yield an equilibrium where *also* the big firm sells its customer data to the small firm.

sufficiently different (see Section 5 where we elaborate more on the comparison of our results with those obtained by Chen et al.). Fudenberg and Tirole (2000) use a similar to ours two-period location model with symmetric firms, where in the second period firms can segment the consumers into two groups (own customers and rival firm's customers) depending upon a consumer's purchasing decision in period 1. Firms do not collect any further information about their own customers and consequently the issue of information sharing does not arise. The authors focus on the use of short- and long-term contracts as part of a firm's equilibrium strategy. Chen (2004) develops a dynamic model to study how the nature of competition in a duopoly model of horizontal differentiation affects a firm's incentives for marketing innovation. At the beginning of time a firm can introduce this kind of innovation to facilitate perfect price discrimination in all subsequent periods. A rival firm can imitate the innovation with some lag.

The rest of the paper is organized as follows. In Section 2 we present the model. The two-period game is analyzed in Section 3, where we search for a subgame perfect equilibrium which entails some type of customer information sharing. In Section 4, we solve the game assuming that information sharing is banned and we assess the welfare implications of such a policy. In Section 5, we offer a short discussion on the comparison of our predictions with those derived in Chen et al. and we investigate the robustness of our results to changes in some of our key modeling assumptions. We conclude in Section 6. The appendix contains the proofs of Propositions 2–4.

2. The description of the model

There are two firms A and B who produce competing non-durable goods A and B , respectively, with constant per-unit marginal cost of c . Each consumer buys at most one unit of the good (in each period) and he is willing to pay at most V . We assume that the value, V , is sufficiently high and therefore the market is always covered. Consumers are heterogeneous with respect to the premium they are willing to pay for their most favorite brand. This heterogeneity is captured by a parameter ℓ , which we call it consumer ℓ 's degree of loyalty, and it is uniformly distributed on the interval $I = [-\ell_B, \ell_A]$ with density 1. Consumers with positive loyalty prefer brand A , while consumers with negative loyalty prefer brand B , all else equal. We further assume that $\ell_B \geq 0$. If $\ell_A = \ell_B$, the model is analogous to the standard model of horizontal differentiation. If $\ell_B = 0$, it becomes the standard model of vertical differentiation. If $\ell_A > \ell_B > 0$, the setup has elements of both horizontal and vertical differentiation. There are two periods, $t = 1, 2$, and a common discount factor $\delta \in [0, 1]$. Let $p_A^t(\ell)$ and $p_B^t(\ell)$ denote the price offers to consumer ℓ , from firm A and B , respectively, in period t . We denote by π_A^t and π_B^t firm A 's and B 's profits, respectively, in period t . By Π_A and Π_B we denote the sum of discounted profits over the two periods. The firms act to maximize Π_A and Π_B . Consumer ℓ maximizes her discounted sum of period utilities, using the same discount factor δ as the firms.⁶

⁶Shaffer and Zhang (2002) model the distribution of consumer loyalties in a similar way.

At the beginning of period 1 firms know the distribution of consumer preferences. At the end of period 1 each firm collects detailed (perfect) information only about its own consumers' brand preferences (i.e., the ones who purchased its product). A firm can sell its information directly to a rival firm, or indirectly by first selling it to a market-research company, knowing that the latter will sell it to a rival.⁷ This distinction does not make a difference, in our model, and we will assume that selling is direct. Also, we assume that firms follow a *simple* strategy with regards to information sharing: a firm sells its entire customer database as it is. In other words, we do not search for an optimal selling mechanism. For example, we have excluded strategies on part of the information seller such as: the information seller sells only part of the information, or even damages the information by "throwing in" some noise. This issue is certainly very interesting, but it goes beyond the scope of the present paper. Furthermore, to simplify the analysis, we have assumed that a firm has no information about the brand preferences of the rival firm's customers prior to information sharing (besides, of course, knowing that these customers are not its own). In practice, firms may possess such data, albeit this information is most likely to be more noisy than the rival's corresponding information. Therefore, our implicit assumption in this paper is that this noise is sufficiently high, so that a firm cannot segment the consumers of its rival (before information sharing takes place).

There are two types of customer information sharing that will be considered in this paper:

- Two-way information sharing, where firms exchange their customer databases (the net price may be strictly positive).
- One-way information sharing, where only one firm sells its customer information to its rival.

Firms can price discriminate by (say) sending coupons with different face values to different consumers. There are three distinct types of pricing strategies that a firm can adopt, in our context: (i) *uniform* pricing, where each consumer on the $[-\ell_B, \ell_A]$ interval receives the same price, (ii) *blanket* couponing, where a group of consumers (strictly smaller than the whole $[-\ell_B, \ell_A]$ interval) receives the same price and (iii) *targeted* couponing, where each individual consumer receives a different price. If firms do not share their customer information, then each firm distributes blanket coupons to the customers of the rival firm and targeted coupons to its own customers. If there is a one-way information sharing, then the firm with all the information sends targeted coupons to all consumers, while the other firm sends targeted coupons only to its own customers and blanket coupons to the customers of its rival. Finally, if there is a two-way information sharing, then each firm sends targeted coupons to all consumers.

⁷This is exactly the reason why Wal-Mart decided to stop selling its general sales customer data to market-research companies, since this practice benefits Wal-Mart's competitors more. According to a Wal-Mart spokesman "Our competitors were getting more out of third-party aggregation than we were, so it made more sense for us to stop," "Customer Data Means Money," *Information Week*, August 20, 2001.

The game we analyze unfolds as follows:

Period 1

- Firms, simultaneously and independently, choose their uniform prices and consumers make their purchase decisions.

Period 2

- In stage 1, each firm decides whether to sell its customer information to its rival firm.
- In stage 2, firms, simultaneously and independently, choose their blanket coupons.
- In stage 3, firms, simultaneously and independently, choose their targeted coupons and consumers make their purchase decisions.

We assume that targeted promotions, in period 2, are chosen *after firms* have decided about the value of their blanket coupons. This set up parallels the multistage games that have been examined in the literature (e.g. Banks and Moorthy, 1999; Rao, 1991; Shaffer and Zhang, 1995, 2002; Thisse and Vives, 1988) where firms choose their promotional strategies (targeted coupons) *after* they have chosen their regular (uniform) prices. This assumption serves two purposes. First it is consistent with the common view that a firm's regular price can be adjusted slower than the choice of targeted coupons and second if both decisions are made simultaneously no pure strategy equilibrium exists. Although, blanket coupons in period 2 are not exactly the same as a uniform price, blanket coupons have an element of stickiness, relative to targeted coupons, similar to that of a regular price. Moreover, a pure strategy equilibrium does not exist when firms choose blanket and targeted coupons simultaneously (for the same reason that it does not exist when firms choose regular prices and targeted coupons simultaneously).⁸ Hence, we model these two strategic choices in period 2 sequentially. Furthermore, there is no need to include a regular price in period 2.⁹

Remark 1. We completely ignore other possible utilizations of consumer information by the firms and we focus entirely on its use as a facilitator of price discrimination. Furthermore, we overlook possible non-economic effects (e.g. pure privacy issues) that information sharing may have on consumers.¹⁰ Also, we assume away the likelihood that a firm's customer database can also be shared with a non-rival firm, which is very likely to benefit both parties. Moreover, there is no *demand*

⁸Proof is available upon request.

⁹See the discussion in Liu and Serfes (2004) as to why a regular price does not play a sheltering role in the absence of targeting costs (an assumption that we maintain in this paper).

¹⁰For instance, some consumers feel uneasy when their personal data are put up for sale, regardless of any (reasonable) monetary benefits that they may receive in return. These types of consumers are not present in our model. Recent regulatory efforts to impose an "opt-in" standard, by which firms must obtain permission before a consumer's information is shared with third parties, are attempts to address the privacy concerns (see, Report for Congress, "Internet Privacy: Overview and Pending Legislation," www.epic.org, February 6, 2003).

creation in our model, another positive aspect of having detailed information. Our purpose in this paper is to identify equilibrium strategies regarding sharing of customer information in the most competitive environment, where only the *business stealing* effect is present.

Remark 2. We assume that the information enables the firms to learn the location of each consumer with perfect accuracy (perfect information). In reality, firms can identify each consumer's brand loyalty with some noise, which depends on the quantity and quality of the available information. In Liu and Serfes (2004, 2005), we construct static price discrimination models with imperfect information about consumer brand preferences. The imprecision with which each consumer's loyalty is identified depends on the quality of the available information. As the quality increases the noise is reduced. The limit of this process is the perfect information paradigm. Although that modeling approach seems more realistic, it renders the present model intractable.¹¹ Hence, one can view the results in the present paper as the solution to an interesting limiting case.¹²

In the next section, we search for a subgame perfect equilibrium (SPE). In particular, we are interested in a SPE in pure strategies where some type of information sharing takes place.

3. Analysis

In this section, we proceed as follows. After the first period ends, there are four subgames following the firms' decisions about whether to share information or not: (i) no information exchange (*NE*), (ii) only firm *A* sells its information to *B* ($A \rightarrow B$), (iii) only firm *B* sells to *A* ($B \rightarrow A$) and (iv) two-way sharing ($A \leftrightarrow B$). We analyze each subgame by finding the equilibrium prices and profits. We assume that an information selling transaction will occur if and only if there are gains from trade (*GFT*), i.e., joint firm profits *strictly* increase over the profits prior to that transaction.¹³ Furthermore, firm *A*'s and *B*'s bargaining powers over the surplus from the information sharing are $(1 - \sigma) \geq 0$ and $\sigma \geq 0$, respectively. Then, we move up to period 1, where firms choose their uniform prices to maximize the discounted sum of profits over the two periods. Consumers also act strategically in period 1. In particular, they maximize the discounted sum of their utilities over the two periods

¹¹Nevertheless, in Section 5, we explore the implications of relaxing the perfect price discrimination assumption.

¹²Chen (2004) makes a similar assumption. In his framework if a firm decides to implement a marketing innovation, then it is able to target consumers perfectly.

¹³In this paper, we have assumed that consumers do not care about how information about them is used and whether it is shared or not. The other extreme is to assume that consumers must give their consent before firms share (or sell) their information. Then, consumers (or a party representing them) essentially enter, along with firms, into the bargaining process over the distribution of surplus from sharing information. We reserve this interesting topic for future research.

by correctly anticipating the firms’ information sharing decisions and the period 2 equilibrium prices.¹⁴

3.1. Period 2: Information sharing and pricing decisions

Let ℓ^* denote the marginal consumer in period 1. We assume that if a consumer is indifferent between the two brands, and one firm offers a blanket promotion while the other offers a targeted one, then she buys from the firm who offers the targeted price. On the other hand, if both firms offer to a consumer the same type of a price promotion (i.e., a blanket or a targeted coupon), then she buys the product that she would prefer if the prices were the same. If $\ell^* \geq 0$, then firm A collects information about its own consumers, who are the ones located in $[\ell^*, \ell_A]$, while firm B collects information about the consumers located in $[-\ell_B, \ell^*]$. If $\ell^* < 0$, then the marginal consumer belongs in firm B ’s database. We begin with the case where $\ell^* \geq 0$. Let $I_1 = [\ell^*, \ell_A]$ and $I_2 = [-\ell_B, \ell^*]$.

● **Subgame 1:** No exchange of information (NE).

Each firm first sends blanket coupons to the customers of the rival firm and then distributes targeted price promotions to its own customers.¹⁵ Let us first examine the interval I_1 . Since the cutoff point is in firm A ’s territory, firm B will send the same price offer $p_B^2 = c$ to all consumers. Firm A ’s best response is to offer $p_A^2(\ell) = \ell + c$. Each consumer is indifferent between the two firms and therefore buys from firm A . The profits are

$$\pi_A^2 = \int_{\ell^*}^{\ell_A} (p_A^2(\ell) - c) d\ell = \frac{\ell_A^2 - (\ell^*)^2}{2} \quad \text{and} \quad \pi_B^2 = 0 \quad (\text{in segment } I_1). \tag{1}$$

Therefore, the joint profits in the interval I_1 are

$$\pi^{NE} = \frac{\ell_A^2 - (\ell^*)^2}{2} \quad (\text{in segment } I_1). \tag{2}$$

Now we examine the firms’ strategies and profits in the interval I_2 . Firm A sends blanket coupons, p_A^2 , to the consumers in this interval, while firm B responds by sending targeted price offers. Given p_A^2 , firm B ’s best response is to set $p_B^2(\ell) = p_A^2 - \ell \geq c$. Clearly, the marginal consumer ℓ is located in $(0, \ell^*)$ and is given by $\ell = p_A^2 - c$. Since firm B knows the location of each consumer perfectly it charges a price equal to marginal cost to the marginal consumer. Firm A chooses p_A^2 to

¹⁴This modeling assumption is also made in Fudenberg and Tirole.

¹⁵A firm is allowed to send blanket coupons to its own customers as well, but this possibility is ignored due to the flexibility of charging individualized prices in the next stage. In addition, blanket coupons – like a regular price – serve no sheltering role in the absence of targeting costs. This holds true for all the subgames we analyze.

maximize

$$\pi_A^2 = (p_A^2 - c) \int_{\hat{\ell}=p_A-c}^{\ell^*} d\ell = [\ell^*(p_A^2 - c) - (p_A^2 - c)^2].$$

The first order necessary and sufficient condition is

$$\frac{d\pi_A}{dp_A^2} = \ell^* - 2(p_A^2 - c) = 0 \Rightarrow p_A^2 = \frac{\ell^*}{2} + c. \tag{3}$$

Hence, $\hat{\ell} = p_A^2 - c = \ell^*/2$. Therefore, firm *A*'s profit in the interval I_2 is

$$\pi_A^2 = (p_A^2 - c) \int_{\frac{\ell^*}{2}}^{\ell^*} d\ell = \frac{(\ell^*)^2}{4} \quad (\text{in segment } I_2). \tag{4}$$

Firm *B*'s profit in I_2 is

$$\pi_B^2 = \int_{-\ell_B}^{\frac{\ell^*}{2}} (p_B^2(\ell) - c) d\ell = \int_{-\ell_B}^{\frac{\ell^*}{2}} (p_A^2 - \ell - c) d\ell = \frac{(\ell^* + 2\ell_B)^2}{8} \quad (\text{in segment } I_2). \tag{5}$$

The joint profits in the interval I_2 are

$$\pi^{NE} = (4) + (5) = \frac{3(\ell^*)^2 + 4\ell_B^2 + 4\ell^*\ell_B}{8} \quad (\text{in segment } I_2). \tag{6}$$

The joint profits in $[-\ell_B, \ell_A]$ are

$$\pi^{NE} = (2) + (6) = \frac{4\ell_A^2 - (\ell^*)^2 + 4\ell_B^2 + 4\ell^*\ell_B}{8}. \tag{7}$$

● **Subgame 2:** Firm *A* sells its information to firm *B* ($A \rightarrow B$).

The equilibrium of this subgame is exactly the same with that of subgame 1. Firm *B* cannot benefit from knowing the exact preferences of firm *A*'s customers. Without information (as in subgame 1) firm *B* was offering its product at marginal cost to those customers who, in turn, ended up purchasing firm *A*'s brand. With information firm *B*'s price is still equal to marginal cost.

Therefore, no gains from trading information exist when firm *A* sells its information to firm *B*.

● **Subgame 3:** Firm *B* sells its information to firm *A* ($B \rightarrow A$).

Firm *B* captures all the consumers in $[-\ell_B, 0]$ where firm *A* charges a price equal to $p_A^2 = c$ and firm *B* offers individualized prices $p_B^2(\ell) = c - \ell$. Firm *A* captures all the consumers in $[0, \ell_A]$ where firm *B* charges a uniform price equal to $p_B^2 = c$ and firm *A*

offers individualized prices $p_A^2(\ell) = \ell + c$. The profits are

$$\pi_A^2 = \int_0^{\ell_A} \ell \, d\ell = \frac{\ell_A^2}{2} \quad \text{and} \quad \pi_B^2 = - \int_{-\ell_B}^0 \ell \, d\ell = \frac{\ell_B^2}{2}. \tag{8}$$

Hence, the joint profits are

$$\pi^{B \rightarrow A} = \pi_A^2 + \pi_B^2 = \frac{\ell_A^2 + \ell_B^2}{2}. \tag{9}$$

Firm B will sell its information to firm A if and only if $\pi^{B \rightarrow A} > \pi^{NE}$. In other words, if and only if

$$\begin{aligned} \frac{\ell_A^2 + \ell_B^2}{2} > \frac{(4\ell_A^2 - (\ell^*)^2 + 4\ell_B^2 + 4\ell^*\ell_B)}{8} &\Leftrightarrow \\ GFT = \frac{\ell^*(\ell^* - 4\ell_B)}{8} > 0 &\Leftrightarrow \ell^* > 4\ell_B. \end{aligned} \tag{10}$$

● **Subgame 4:** Firms exchange their information ($A \leftrightarrow B$).

The joint profits are the same as in subgame 3. Joint profits remain unchanged when firm A sells its information to firm B (see subgame 2). Hence, no such transaction will take place.

Next, assume that $\ell^* < 0$. It can be easily seen that firm A has no incentive to acquire firm B 's information, for the same reason that firm B has no incentive to acquire firm A 's information when $\ell^* \geq 0$ (see subgame 2). The gains from trade when firm B acquires firm A 's information are¹⁶

$$GFT = \frac{\ell^*(\ell^* + 4\ell_B)}{8} > 0 \Leftrightarrow \ell^* < -4\ell_B.$$

Since ℓ^* cannot be less than $-\ell_B$, gains from trading information are negative when $\ell^* < 0$.

The next proposition summarizes the results regarding information exchanges.

Proposition 1 (*Information sharing in period 2*). *When firms have equal customer bases (i.e., $\ell_A = \ell_B$), then no exchange of consumer information takes place at the beginning of period 2. When firm A 's customer base is higher (i.e., $\ell_A > \ell_B$), then: (i) firm A never sells its customer information to firm B , and (ii) firm B sells its information to firm A if and only if $\ell^* > 4\ell_B$.*

Proof. The proof is based on the results from the analysis of the four subgames. Note that only in subgame 3 gains from trading information may be positive. Therefore, we focus on that subgame. When $\ell_A > \ell_B$ and more precisely $\ell_A > 4\ell_B$, information sharing (where B is selling to A) is possible, provided that the first period marginal consumer ℓ^* is located at a point greater than $4\ell_B$ (see (10)). If, on the other hand, $\ell_A = \ell_B$ the highest possible ℓ^* is ℓ_A which is less than $4\ell_B$. Hence, there are no gains from trading information. □

¹⁶The derivations are similar to the ones when $\ell^* \geq 0$ and are omitted.

The intuition behind the above result goes as follows. When $\ell^* > 0$ some of firm A 's loyal customers purchase in period 1 from firm B . Consequently, firm A does not have these consumers in its database. This forces firm A to treat these consumers the same as the consumers who are loyal to firm B . Now suppose that firm A obtains information from firm B . This gives firm A the flexibility to charge customized prices to all consumers which creates two opposing effects that govern market interaction: first, competition intensifies since firm A follows a more aggressive pricing strategy in firm B 's territory (negative effect) and second, profits for firm A from its more loyal customers increase due to the surplus extraction effect (positive effect). Next, we look at these two opposing effects more closely in each one of the four distinct market segments (see also Fig. 1). We compare the difference in joint profits between sharing and no sharing of information.

- Interval $[-\ell_B, 0]$. *Joint profits decrease* (only the negative effect is present). Firm A , without firm B 's information, finds it in its best interest to *focus* on its own loyal customers. This in turn helps firm B to raise its price to its own loyal customers and therefore firm B 's profits increase compared to the outcome when B sells its information to A . Firm A makes no sales in this interval, with or without information.
- Interval $[0, \frac{\ell^*}{2}]$. *No change in joint profits* (both effects are present, but cancel each other out). When B sells its information to A , these consumers buy from firm A , otherwise they buy from B . When both firms possess information about these consumers, the competition is very intense for those located close to zero, but for

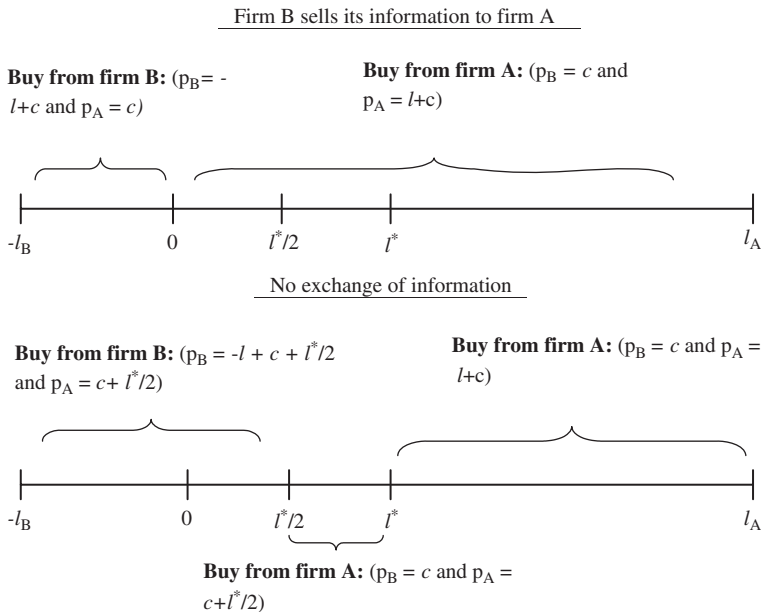


Fig. 1. Second period prices and market shares.

the ones closer to $\frac{\ell^*}{2}$ firm A extracts more surplus, compared to the outcome where only firm B has information. It turns out that there is a reduction in joint profits in the interval $[0, \frac{\ell^*}{4}]$ (due to intensified competition) and an increase in joint profits in the interval $[\frac{\ell^*}{4}, \frac{\ell^*}{2}]$ (due to surplus extraction), when both firms possess information. Moreover, these two opposing effects cancel each other out (due to the uniform distribution assumption) and the net effect on joint profits in the interval $[0, \frac{\ell^*}{2}]$ is zero.

3. Interval $[\frac{\ell^*}{2}, \ell^*]$ *Joint profits increase* (only the positive effect is present). Firm B loses nothing since in any case it charges a price equal to marginal cost and its profits are zero, but firm A gains since it can tailor its prices to each individual consumer.
4. Interval $[\ell^*, \ell_A]$. *No change in joint profits* (neither effect is present). These consumers buy from firm A and firm B prices at marginal cost, under any type of information structure that we have allowed for.

When the interval $[\frac{\ell^*}{2}, \ell^*]$ is sufficiently greater than $[-\ell_B, 0]$, the positive effect dominates the negative. Practically, this means that firm A 's customer base is sufficiently greater than firm B 's and moreover when firm A is forced to charge a uniform price, in period 1, it does not find it profitable to serve all of its loyal customers. Rather, it charges a relatively high price to extract more rents from its relatively more loyal customers. As a result, some of the customers who, all else equal, prefer firm A 's product to firm B 's, end up buying from B in the first period.¹⁷ But once firms have the flexibility of charging discriminatory prices, firm A finds it profitable to reclaim these consumers. If the size of this franchise is relatively big, then the gain in profits that firm A experiences outweighs firm B 's losses. This finding echoes the result in Shaffer and Zhang (2002), who show that the firm with the larger loyal following may become better off when firms move from uniform to discriminatory pricing, i.e., the game need not be a prisoners' dilemma. The idea in that paper is that the *market share effect* – which benefits the firm with the larger customer base – may dominate the intensified competition effect. This market share effect clearly plays a critical role in our framework as well. Moreover, we take it a step further by comparing the gains of the larger firm with the losses of its smaller rival.

It remains to be shown that the first period uniform pricing strategy that we described in the above paragraph is indeed part of a SPE. This is what we do next.

3.2. Period 1: Uniform pricing

In this section, we mainly search for a SPE where sharing of information takes place. As we proved in the previous subsection, the only possibility is for firm B to sell its information to firm A . Thus, in period 2 subgame 3 is played. Consumers have rational expectations. They know how their purchasing decisions in period 1 will affect the information each firm has about them and consequently the price offers

¹⁷This pricing strategy, on part of the firm with the larger loyal following, has been shown to be an equilibrium strategy by Shaffer and Zhang (2002) in a static model.

they will receive from each firm in period 2. The marginal consumer ℓ^* (with $\ell^* > 0$, since otherwise sharing of information is not profitable) in period 1 must be indifferent between buying from firm A today at price p_A^1 (and entering firm A 's database) and then buying again in period 2 from firm A at price $\ell^* + c$, or buying from firm B in period 1 (and entering firm B 's database) at price p_B^1 and then buying from A in period 2 (due to information sharing) at price $\ell^* + c$. Thus, the indifferent consumer must satisfy

$$(p_A^1 - p_B^1) + \delta[(\ell^* + c) - (\ell^* + c)] = \ell^* + \delta \cdot 0 \Rightarrow \ell^* = p_A^1 - p_B^1.$$

Each consumer located to the right of ℓ^* purchases firm A 's product in both periods. Consumers located in $[0, \ell^*)$ purchase from firm B in period 1 and then switch to firm A in period 2 (firm B sells information about these customers to firm A and since they are loyal to firm A , firm B cannot make any sale to them). Finally, consumers in $[-\ell_B, 0)$ buy from firm B in both periods.

The information price (IP) firm A pays to firm B for acquiring firm B 's database is defined as

$$IP = (\pi_B^{NE} - \pi_B^{B \rightarrow A}) + \sigma GFT,$$

where $\pi_B^{NE} = \frac{(\ell^* + 2\ell_B)^2}{8}$ is firm B 's second period profits when it does not sell its information (see Eqs. (1) and (5)), $\pi_B^{B \rightarrow A} = \frac{\ell_B^2}{2}$ is firm B 's second period profits when information is shared (see Eq. (8)), σ is firm B 's bargaining power and $GFT = \frac{\ell^*(\ell^* - 4\ell_B)}{8}$ represents the gains from trade (see Eq. (10)).¹⁸ Firm A 's and B 's discounted sum of profits are

$$\Pi_A = (p_A^1 - c)(\ell_A - \ell^*) + \delta[\pi_A^{B \rightarrow A} - IP], \tag{11}$$

$$\Pi_B = (p_B^1 - c)(\ell^* + \ell_B) + \delta[\pi_A^{B \rightarrow A} + IP], \tag{12}$$

where $\pi_A^{B \rightarrow A} = \frac{\ell_A^2}{2}$ is firm A 's profits in period 2 when firm B sells its information (see Eq. (8)). Firms in period 1 choose their uniform prices, p_A^1 and p_B^1 , to maximize (11) and (12). The first period price is chosen by a firm to strike an optimal balance in the trade-off between: (i) losing (gaining) marginal consumers in period 1 and having a smaller (larger) customer database in period 2 and (ii) gaining (losing) inframarginal rents in period 1. A SPE where firm B sells its information to firm A is summarized in the proposition below.

Proposition 2 (SPE with information sharing). *When $\ell_A > \bar{\ell} = 13\ell_B + \frac{12\sqrt{5\delta}\ell_B}{\sqrt{8-\delta(1+\sigma)}}$ the unique SPE can be described as follows:*

- *Period 1: The firms' uniform prices are*

$$p_A^1 = \frac{\ell_A[8 - \delta(1 + \sigma)]}{12} + \frac{\ell_B[4 - \delta(5 - 7\sigma)]}{12} + c$$

¹⁸Note that $(\pi_B^{NE} - \pi_B^{B \rightarrow A}) > 0$ is in the IP to ensure that firm B is at least as well off by selling its information as when this transaction does not take place.

and

$$p_B^1 = \frac{\ell_A[4 - \delta(1 + \sigma)]}{12} + \frac{\ell_B[8 - \delta(5 - 7\sigma)]}{12} + c.$$

The marginal consumer is located at

$$\ell^* = \frac{(\ell_A - \ell_B)}{3}. \tag{13}$$

- *Period 2: Firm B sells its customer information to firm A. The prices that each firm charges to each consumer are the same as in subgame 3.*
- *Both periods: The sum of discounted equilibrium profits are*

$$\begin{aligned} \Pi_A = & \frac{4}{9} \ell_A^2 + \frac{1}{9} \ell_B^2 + \frac{31}{72} \delta \ell_A^2 + \frac{5}{9} \delta \sigma \ell_A \ell_B + \frac{4(1 - \delta)}{9} \ell_A \ell_B \\ & - \frac{5}{72} \delta \sigma \ell_A^2 + \frac{(1 + \sigma)}{72} \delta \ell_B^2 \end{aligned} \tag{14}$$

and

$$\begin{aligned} \Pi_B = & \frac{4}{9} \ell_B^2 + \frac{1}{9} \ell_A^2 + \frac{5}{72} \delta \ell_B^2 - \frac{(1 + \sigma)}{18} \delta \ell_A \ell_B \\ & + \frac{4}{9} \ell_A \ell_B - \frac{(1 + \sigma)}{72} \delta \ell_A^2 + \frac{41}{72} \delta \sigma \ell_B^2. \end{aligned} \tag{15}$$

Proof. See appendix. □

Firm *A* finds it profitable to set a relatively high price in the first period, so that some of its loyal consumers buy from firm *B* [i.e., the ones in the interval $[0, \ell^*)$]. Firm *B* collects perfect information about the consumers who purchased its product in period 1 and are in the segment $[-\ell_B, \ell^*)$. Firm *A* collects perfect information for those in $[\ell^*, \ell_A]$. Then firm *B* sells its information to firm *A*. In the second period, each consumer buys from the firm she likes most.

The first period uniform prices are lower than in the corresponding static model (i.e., when $\delta = 0$).¹⁹ In particular, equilibrium prices are a decreasing function of δ . Moreover, equilibrium prices decrease as firm *B*'s bargaining power, σ , increases. The intuition with regards to the bargaining power goes as follows. Firm *A* buys firm *B*'s customer database in period 2. By lowering its price in period 1 firm *A*'s customer database increases and consequently it pays a lower information acquisition price to firm *B*, since now firm *B*'s database contains fewer names. As firm *B*'s bargaining power increases, firm *A*'s incentive to lower its first period price increases as well. Firm *B* on the other hand, has an incentive to lower its first period price in order to acquire more names and enhance the value of its database. The incentive to lower the price increases with its bargaining power. A similar intuition applies to changes in the discount factor.

¹⁹This result is to a large extent consistent with the first period pricing patterns in models with switching costs (e.g. Chen, 1997), with the difference that in our model prices exceed marginal cost. In models with poaching (e.g. Fudenberg and Tirole, 2000) first period prices increase relative to their static counterparts.

We know, from Propositions 1 and 2, that when $\ell_A \leq \bar{\ell}$ then information sharing is not part of a SPE. We do not pursue the solution of the game under the assumption that $\ell_A \leq \bar{\ell}$, as this goes beyond the purpose of this paper.

4. Information sharing is banned

In this section, we assess the welfare implications when a regulator does not allow firms to share their information. Since when $\ell_A \leq \bar{\ell}$, information sharing is not an equilibrium, we assume that $\ell_A > \bar{\ell}$. Further, we assume that firms at the beginning of period 2, do not share information and we compare this equilibrium outcome to the one where information sharing is unregulated (see Proposition 2). The profit functions (and the logic behind their derivation) are the same as the ones given by Eqs. (A.13) and (A.14), when $\ell^* \geq 0$, or the ones given by Eqs. (A.15) and (A.16), when $\ell^* \leq 0$ (see appendix). The next proposition summarizes the SPE.

Proposition 3 (SPE when information sharing is banned). *When $\ell_A > \bar{\ell}$ and information sharing is banned, the unique SPE can be described as follows:*

- *Period 1: The firms’ uniform prices are*

$$p_A^1 = \frac{5\ell_A\delta^2 - 8\ell_B\delta - 18\ell_A\delta + 16\ell_A + 8\ell_B}{2(12 - 5\delta)} + c$$

and

$$p_B^1 = \frac{3\ell_A\delta^2 - 20\ell_B\delta - 10\ell_A\delta + 8\ell_A + 16\ell_B + 4\ell_B\delta^2}{2(12 - 5\delta)} + c.$$

The marginal consumer is located at

$$\ell^{**} = \frac{2[\ell_A(2 - \delta) - 2\ell_B(1 - \delta)]}{12 - 5\delta}. \tag{16}$$

- *Period 2: The prices that each firm charges to each consumer are the same as in subgame 1 (with ℓ^{**} in place of ℓ^*), where no exchange of information takes place.*
- *Both periods: The sum of discounted equilibrium profits are*

$$\begin{aligned} \Pi_A = & (4\ell_A^2\delta^3 - 6\ell_A\ell_B\delta^3 - 4\ell_B^2\delta^3 + 46\ell_A\ell_B\delta^2 - 9\ell_A^2\delta^2 + 24\ell_B^2\delta^2 \\ & - 28\ell_A^2\delta - 36\ell_B^2\delta - 104\ell_A\ell_B\delta + 64\ell_A\ell_B \\ & + 64\ell_A^2 + 16\ell_B^2)/(12 - 5\delta)^2 \end{aligned} \tag{17}$$

and

$$\begin{aligned} \Pi_B = & -(5\ell_A^2\delta^3 + 5\ell_A\ell_B\delta^3 - 5\ell_B^2\delta^3 - 58\ell_A\ell_B\delta^2 - 28\ell_A^2\delta^2 + 8\ell_B^2\delta^2 \\ & + 52\ell_A^2\delta + 76\ell_B^2\delta + 160\ell_A\ell_B\delta - 128\ell_A\ell_B \\ & - 32\ell_A^2 - 128\ell_B^2)/[2(12 - 5\delta)^2]. \end{aligned} \tag{18}$$

Proof. See appendix. \square

The market share of firm A in period 1 is larger when information sharing is banned than when it is not (i.e., $\ell^* \geq \ell^{**}$, provided that $\ell_A \geq 7\ell_B$, a condition that is satisfied given our assumptions). Moreover as the discount factor increases, ℓ^{**} decreases. When information sharing is banned, firm A lowers its price in an attempt to gain a larger share and consequently to increase the number of consumers in its database, given that in period 2 the possibility of buying these names from its rival firm is non-existent. In response, firm B lowers its price as well, but not as aggressively as firm A .

4.1. Social welfare

With unit demands and a covered market, only the disutility from not buying the most preferred brand matters. Therefore, the reader should bear in mind that the welfare predictions we obtain are restricted by the fact that aggregate demand is inelastic.²⁰ The possibility of sharing customer databases with the rival firm distributes the dead-weight loss differently across the two periods than when this possibility is absent. In the former case, firms price less aggressively in the first period, which allows the small firm to capture some of its rival's customers, resulting in an inefficient outcome. In the second period, though, this inefficiency disappears, since each consumer buys her most preferred brand. In the latter case, the big firm fights more for market share, surrendering fewer consumers to the rival, which reduces the first period inefficiency. On the other hand, the second period inefficiency does not vanish (see Figs. 2 and 3). These opposing effects create an interesting trade-off for a regulatory authority who wishes to regulate customer information sharing. This trade-off we have identified is likely to be present in a context more general than ours. Next, we compute the social welfare over the two periods.

In period 1, the social welfare when information sharing is banned is greater than that when sharing is allowed by

$$\int_{\ell^{**}}^{\ell^*} \ell \, d\ell = \frac{(\ell^*)^2 - (\ell^{**})^2}{2}.$$

In this case, the extra inefficiency when information sharing is allowed arises because the group of consumers in the interval $[\ell^{**}, \ell^*]$ do not buy their most preferred brand, whereas when information sharing is banned they do (see Fig. 2).

In period 2, the social welfare when information sharing is allowed is greater than that when sharing is banned by

$$\int_0^{\frac{\ell^{**}}{2}} \ell \, d\ell = \frac{(\ell^{**})^2}{8}.$$

When information sharing is allowed, the second period outcome is efficient. Hence, the inefficiency when sharing is banned comes from the group of

²⁰In Section 5, we conjecture how the main predictions will be affected if we allow demand to be elastic.

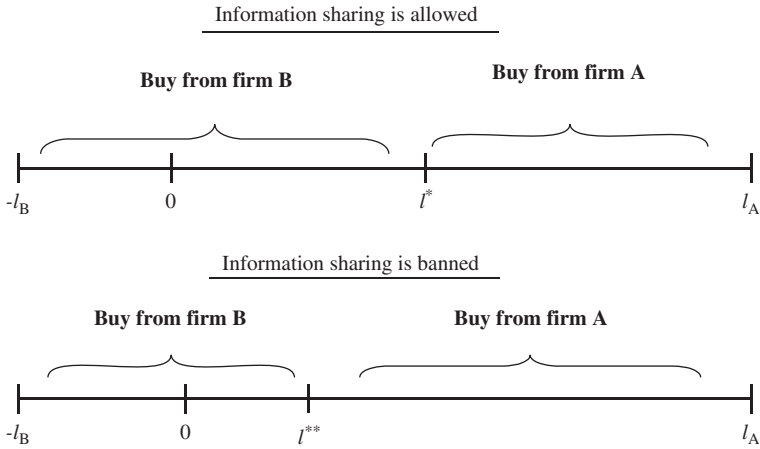


Fig. 2. First period market shares.

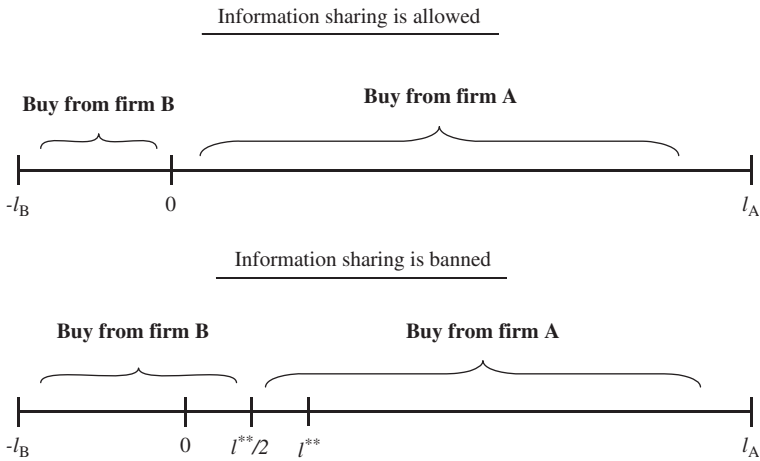


Fig. 3. Second period market shares.

consumers in the interval $[0, \ell^{**}/2]$ who buy from firm *B*, while their favored firm is *A* (see Fig. 3).

Therefore, the discounted social welfare change when information sharing is banned is

$$\frac{[(\ell^*)^2 - (\ell^{**})^2]}{2} - \delta \frac{(\ell^{**})^2}{8}. \tag{19}$$

If (19) is positive, then the outcome when information sharing is banned is more efficient than when it is not. The next proposition presents the social welfare comparison.

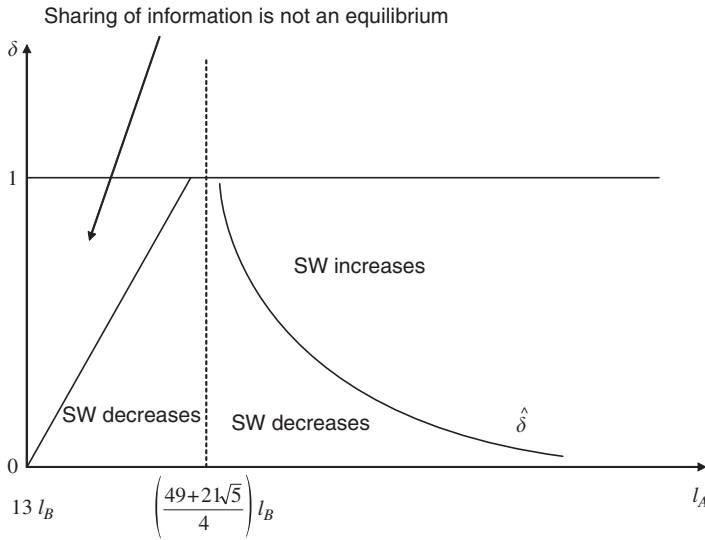


Fig. 4. The effects of banning information sharing on social welfare, $\sigma = 1/2$.

Proposition 4 (Social welfare comparison). *Banning of information sharing decreases social welfare if*

(1) $\bar{\ell} < \ell_A < \left(\frac{49+21\sqrt{5}}{4}\right)\ell_B$,

or

(2) or, $\ell_A > \left(\frac{49+21\sqrt{5}}{4}\right)\ell_B$ and $\delta < \hat{\delta} < 1$.

*Banning of information sharing increases social welfare if $\delta > \hat{\delta} > 0$.*²¹

Proof. See appendix. □

It follows, that high firm asymmetry and a high discount factor lead to an increase in social welfare, while low firm asymmetry and a low discount factor result in lower social welfare, when information sharing is banned (see Fig. 4). The intuition is that when firms place a high value on future profits and information sharing is allowed, firm A does not have a strong incentive to price very aggressively in order to increase its market share by capturing a large fraction of its loyal customers, since it knows that in the next period it will buy these names from firm B. This creates a large inefficiency in the first period because a large group of the consumers who purchase from firm B really prefer firm A’s brand, but buy from firm B due to the difference in

²¹Where $\hat{\delta} = \frac{25\ell_A^2 - 14\ell_A\ell_B - 47\ell_B^2 - \sqrt{(433\ell_B^2 - 590\ell_A\ell_B + 193\ell_A^2)(\ell_A - 7\ell_B)^2}}{18(\ell_A^2 - 4\ell_A\ell_B + 4\ell_B^2)}$.

prices. Therefore, when the discount factor is high, banning information sharing will increase firm *A*'s incentives to lower its first period price and reduce the first period market inefficiency significantly. This reduction will outweigh the second period loss in efficiency, associated with the prohibition of information exchanges.

Profits: Both firms become worse off when information sharing is banned [i.e., (14) > (17) and (15) > 18].²²

4.2. Consumer welfare

The change in consumer welfare is simply the difference between the change in social welfare and the change in profits. We have shown that consumer welfare always decreases when information sharing is allowed.²³ When information sharing is banned firms lower their first period prices (relative to the case where sharing is allowed) in an attempt to increase their market share and hence their consumer databases. This benefits consumers. On the other hand, in the second period, prices are higher when information sharing is not allowed. Firms can sustain higher prices when each knows less about the other's customers. In our framework the first period positive effect (for consumers) is stronger than the second period negative effect and therefore consumer welfare overall increases when exchanges of consumer information are prohibited.

5. Discussion and extensions

In this section, first we offer a discussion which tries to shed some light into the differences between the predictions we derive in this paper and those obtained by Chen et al. and second, we explore a number of extensions to our basic modeling set-up.²⁴

5.1. Comparison with Chen et al.

There are two modeling differences between our model and the one developed in Chen et al. which, in our opinion, are mainly responsible for the different predictions we obtain. First, in our model, consumer information is assumed to be perfect, while in Chen et al. information accuracy varies in a continuous way. Second, and more importantly, we have a continuum of consumers (or consumer loyalties), whereas in Chen et al. there are three distinct groups of consumers, loyal to each firm and switchers (of a positive measure).

In our model, as long as there is a group of loyal consumers to a firm, say firm *A*, who nevertheless buy in period 1 from firm *B*, and this group of consumers is large, trading of information will take place at the beginning of period 2 (firm *B* will sell these names to firm *A*). Consumer information generates two effects: (i) a surplus

²²The proof is very straightforward and it is omitted. It is available upon request.

²³The proof is very straightforward and it is omitted. It is available upon request.

²⁴We thank two anonymous referees for urging us to think along these lines.

extraction effect and (ii) an intensified competition effect. When firm *A* receives information about the above-mentioned group of customers, the first effect outweighs the second. Therefore, firm *A* gains more than what firm *B* loses and surplus is created. The next question is: Why would some loyal consumers to firm *A* buy from *B*, in period 1, to begin with? If firm *A* has a significantly larger loyal franchise overall than its rival, then it finds optimal to set a high (uniform) price in period 1 and surrender a large fraction of its relatively less loyal customers to the rival firm. This is a subgame perfect equilibrium only when firms are “asymmetric enough.”

On the other hand, in the Chen et al. paper a win–win situation (where joint profits increase) arises only when firms are not too asymmetric and the level of targetability is low. Under these assumptions, firms exchange their customer information (two-way sharing). Now let us assume that firms are too asymmetric. In other words, one firm has a sufficiently larger loyal group of consumers than the rival firm. In this case, the switchers are relatively more important for the “small” firm than for the “big” firm. Therefore, the small firm will be reluctant to increase the big firm’s ability to target the switchers more effectively, by sharing its information with that firm. Thus, the small firm will not sell its information to the large firm, a prediction that is opposite from the one we derive in our paper. The big firm, however, can sell its information to the small firm. This will improve the small firm’s targetability and profits without hurting much the big firm (who places relatively low importance on the switchers).

5.2. Extensions

To check the robustness of our results, we extend our model in the following five directions:

1. *Imperfect price discrimination*: Perfect price discrimination is a limiting case which facilitates the analysis greatly and has been used in the literature extensively. One way to model imperfect price discrimination is to assume that customer information allows firms to segment the consumers into groups. A firm is able to distinguish consumers across groups but not within groups (see Liu and Serfes, 2004, 2005). For simplicity, let us assume pure vertical differentiation, i.e., $\ell_B = 0$. Following Liu and Serfes (2005), the $[0, \ell^*]$ interval (where all the “action” takes place) can be divided, in the second period, into $N = 2^k$ segments where k measures the quality of information. Higher k leads to a refinement of the partition. A firm who possesses such information can price discriminate across groups, but the price within each segment is constant. When k goes to infinity we obtain the perfect discrimination paradigm. (The $[\ell^*, \ell_A]$ interval, where firm *A* has perfect information about its own customers, can be analyzed separately and does not affect our argument.) It can be shown that information trading creates surplus in the second period, if and only if $k \geq 3$ (independent of ℓ^*).²⁵ In other words, consumer

²⁵This result can be derived by comparing the joint profits when both firms have consumer information (using Eq. (2) in Liu and Serfes (2005)), i.e., information sharing takes place, with those when only firm *B* (or firm 2 if we use the notation of Liu and Serfes (2005)) has information (using Eq. (4) in Liu and Serfes (2005)), i.e., information sharing does not materialize.

information must allow firms to segment the consumers who are located in the $[0, \ell^*]$ interval into at least 8 segments, in order for information sharing to take place. Intuitively, this says that if consumer information is not of a relatively high quality, then the intensified competition effect dominates the surplus extraction effect and there is no room for trade. We conjecture that firm B 's market share in the first period will be strictly positive, i.e., $\ell^* > 0$ (zero market share for firm B cannot be an equilibrium since it can always charge a zero price and in this case firm A , if it wants to force firm B completely out of the market in period 1, has to charge a zero (uniform) price, which should not be optimal). Moreover, we conjecture that the above predictions will hold even when ℓ_B is sufficiently close to zero. Therefore, perfect price discrimination is not so restrictive since our predictions continue to hold in a rather big neighborhood of perfect discrimination.

2. *Imperfect transferability of consumer information:* One can argue that firm B cannot collect as good information about how consumers value firm A 's product as firm A itself. In our model consumer loyalty is one dimensional (as in the standard Hotelling model). This results in a perfectly negative correlation between a consumer's willingness to pay for the two products (i.e., higher willingness to pay for firm A 's brand automatically implies lower willingness to pay for firm B 's brand). Therefore, perfect transferability of information does not appear to be an issue in our framework. Even if we assume that a firm learns only a consumer's strength of preference for its own product this will immediately yield the consumer's preference for the rival product and vice versa. Imperfect transferability of information, however, remains, in general, a real issue. To incorporate such an assumption we would have to modify our model significantly. Nevertheless, we can try to obtain some, perhaps "rough," insights into this problem by attempting to fit such an assumption into our modeling framework. To this end, suppose that the small firm has information about the large firm's loyal customers, but this information is imperfect (because of the small firm's inability to collect very detailed information about the customers who prefer the rival product). Then, we are back to the model we outlined in the previous paragraph and our conjecture is that the predictions of our model will hold, provided that consumer information transferability is not too imperfect, i.e., $k \geq 3$.

3. *Two-way information exchange:* The main point of this extension is to demonstrate that our model, under some minor modifications, can generate a two-way information exchange. Following Shaffer and Zhang (2000), there are two groups of consumers: A group α of measure $\theta \in [\frac{1}{2}, 1]$ with the premium that consumers in this group are willing to pay for firm A 's product being uniformly distributed on $[0, \ell_A]$ and a group β of measure $1 - \theta$ with the premium that consumers in this group are willing to pay for firm B 's product being uniformly distributed on $[0, \ell_B]$. As in Shaffer and Zhang (2000), we can further assume that in period 1 firms can price discriminate between group α and β , but neither firm knows the degree of brand loyalty of each individual consumer.²⁶ At the beginning of

²⁶If firms are forced to charge only one price in period 1, because they cannot separate the two groups, then a two-way information exchange is not possible and moreover the larger firm (i.e., firm A) does not sell its customer information to the smaller firm, independent of the strength of preferences ℓ_A and ℓ_B .

period 2 firms learn about the exact position of each consumer on an interval. Each group can be analyzed separately and therefore our model can be readily adopted to demonstrate that information sharing will take place. The implication of this modeling approach is that *both* firms sell their customer data. This is the case because each firm is *large* in its *own* market (firm *A* among consumers in group α and firm *B* among consumers in group β).

4. *Elastic demands*: One way to extend our model is to allow for elastic demands. This could be done within our framework by endowing consumers with a linear demand function, although the analysis will be greatly complicated (e.g. Rath and Zhao, 2001). Our conjecture is that the equilibrium will not change qualitatively. The large firm will buy customer information from the small firm as long as the firms are sufficiently asymmetric. Moreover, the two opposing social welfare effects that we identified in Section 4 will also be present. We expect Proposition 4 to continue to hold qualitatively in the case of elastic demands. That is, if the discount factor is high and firms are asymmetric enough, banning information selling will result in lower social welfare. A final conjecture is that if we allow the market size to expand, then we add one more element in favor of trading information and consequently our equilibrium and welfare predictions will only strengthen, i.e., the threshold above which information sharing occurs will decrease and the size of the region of parameters where social welfare decreases (see Fig. 4) if sharing is banned will increase.²⁷

6. Concluding remarks

We develop a parsimonious two-period model with two rival firms who produce horizontally and vertically differentiated products. Our main purpose in this paper is to identify the necessary and sufficient conditions under which firms will share, in some way, their customer-specific information. The information is about the consumers' locations (brand preferences) and enables the firms who possess it to engage in perfect price discrimination. In the first period, firms know only the distribution of preferences and consequently charge uniform prices. At the beginning of the second period they collect perfect information about their own customers (i.e., the ones who purchased their product in period 1) and decide whether to sell this information to the rival firm. We show that a necessary and sufficient condition for information sharing to be part of the unique subgame perfect equilibrium is

²⁷We also examined the robustness of our results to departures from the uniform distribution. We solved the model numerically assuming a triangular distribution. The results do not change qualitatively. For example, with a triangular distribution we need less firm asymmetry to sustain information sharing in equilibrium than under the uniform distribution assumption. The result is intuitive. Recall that the negative effect when firms share information comes from the left tail of the distribution, i.e. from $[-\ell_B, 0]$, and the positive effect comes from the middle, i.e. from $[0, \ell^*]$. The triangular distribution places more weight in the middle of the support relative to the uniform distribution and not surprisingly it is now much easier for information sharing to generate surplus and to be a SPE.

sufficient firm asymmetry. In this case, the firm with the smaller customer base finds it in its best interest to sell its customer data to the firm with the larger customer base (Proposition 2). On the other hand, the big firm never sells its information to its small rival. If information sharing is banned, the social welfare decreases when the degree of firm asymmetry is below a certain threshold. When this threshold is exceeded social welfare decreases only when the discount factor is below a threshold, while it increases when the discount factor is above that threshold. Finally, when sharing is banned, profits decrease, while consumers surplus increases (Proposition 4).

In this paper, we have assumed that detailed customer data allow firms to offer individualized prices to consumers. This is clearly not the only service that firms can get out of a consumer database. Firms, for instance, would also be able to target individual consumers through customized products and services. We intend to tackle this issue in future research.

Acknowledgements

We would like to thank editor Esther Gal-Or, an anonymous associate editor, two anonymous referees, Rajneesh Suri, Srinivasan Swaminathan and seminar participants at the 14th International Conference on Game Theory at Stony Brook 2003, 2004 International Industrial Organization Conference at Northwestern University, at the University of Massachusetts-Amherst (Department of Resource Economics) and at the University of Oklahoma (Department of Economics) for very helpful comments and suggestions. The usual caveat applies.

Appendix A. Proofs of Propositions 2–4

Proof of Proposition 2. The proof consists of three parts: (1) first, we solve the system of reaction functions, (2) then, we check all possible deviations and finally (3) we prove uniqueness of SPE.

(1) Firm *A*'s and *B*'s first order conditions (foc) are:

$$\frac{\partial \Pi_A}{\partial p_A^1} = 0 \Rightarrow \ell_A - 2p_A^1 + p_B^1 - \frac{\delta(1 + \sigma)p_A^1}{4} + \frac{\delta(1 + \sigma)p_B^1}{4} - \frac{\delta(1 - \sigma)\ell_B}{2} + c = 0, \tag{A.1}$$

$$\frac{\partial \Pi_B}{\partial p_B^1} = 0 \Rightarrow \ell_B - 2p_B^1 + p_A^1 - \frac{\delta(1 + \sigma)p_A^1}{4} + \frac{\delta(1 + \sigma)p_B^1}{4} - \frac{\delta(1 - \sigma)\ell_B}{2} + c = 0. \tag{A.2}$$

Note that the second-order condition is satisfied. By solving (A.1) and (A.2) with respect to p_A^1 and p_B^1 , we obtain the first period equilibrium (uniform)

prices:

$$p_A^1 = \frac{\ell_A[8 - \delta(1 + \sigma)]}{12} + \frac{\ell_B[4 - \delta(5 - 7\sigma)]}{12} + c, \tag{A.3}$$

$$p_B^1 = \frac{\ell_A[4 - \delta(1 + \sigma)]}{12} + \frac{\ell_B[8 - \delta(5 - 7\sigma)]}{12} + c. \tag{A.4}$$

By substituting (A.3) and (A.4) back into the objective functions, we obtain the sum of discounted equilibrium profits:

$$\begin{aligned} \Pi_A = & \frac{4}{9} \ell_A^2 + \frac{1}{9} \ell_B^2 + \frac{31}{72} \delta \ell_A^2 + \frac{5}{9} \delta \sigma \ell_A \ell_B + \frac{4(1 - \delta)}{9} \ell_A \ell_B \\ & - \frac{5}{72} \delta \sigma \ell_A^2 + \frac{(1 + \sigma)}{72} \delta \ell_B^2, \end{aligned} \tag{A.5}$$

$$\Pi_B = \frac{4}{9} \ell_B^2 + \frac{1}{9} \ell_A^2 + \frac{5}{72} \delta \ell_B^2 - \frac{(1 + \sigma)}{18} \delta \ell_A \ell_B + \frac{4}{9} \ell_A \ell_B - \frac{(1 + \sigma)}{72} \delta \ell_A^2 + \frac{41}{72} \delta \sigma \ell_B^2. \tag{A.6}$$

Based on the first period equilibrium prices, the marginal consumer is located at

$$\ell^* = p_A^1 - p_B^1 = \frac{(\ell_A - \ell_B)}{3}. \tag{A.7}$$

By substituting (A.7) into $IP = (\pi_B^{NE} - \pi_B^{B \rightarrow A}) + \sigma GFT$ we obtain the equilibrium information price, which is

$$IP = \frac{(\ell_A - \ell_B)[\ell_A(1 + \sigma) + \ell_B(11 - 13\sigma)]}{72}.$$

Recall from Proposition 1, that for information sharing to be part of a SPE (where firm *B* sells its information to *A*) it must be the case that $\ell^* > 4\ell_B$. Using (A.7), it follows that $\ell^* > 4\ell_B$ if and only if $\ell_A > 13\ell_B$.

(2) To conclude that the above pair of prices constitutes a SPE, we must demonstrate that unilateral deviations are unprofitable. There are two types of deviations in our model: (i) a firm changes its first period price but firm *B* still finds it profitable in period 2 to sell its information to firm *A* (i.e., the assumed structure remains unchanged) and (ii) a price change leads to a no sharing of information in period 2 (i.e., the assumed structure changes). The first type of deviation has already been proved that it is not profitable, since the price pair is a solution to the system of best response functions.

Next, we find conditions under which the second type of deviation is not profitable either. We first look at firm *A*'s incentives to deviate and then at firm *B*'s.

Firm A's deviation in period 1: For the structure to change it must be the case that firm *A* lowers its price to the point that $\ell^* \leq 4\ell_B$ and therefore information sharing in period 2 is not profitable. There are two distinct cases: (i) $4\ell_B \geq \ell^* \geq 0$ and (ii) $-\ell_B \leq \ell^* \leq 0$. We start with the first case.

This deviation on part of firm *A* leads the game play to subgame 1 in period 2. The marginal consumer ℓ^* in period 1 must be indifferent between buying from firm *A*

today at price p_A^1 (in which case she is in firm A 's database) and then buying again in period 2 from firm A at price $\ell^* + c$, or buying from firm B in period 1 at price p_B^1 (in which case she is in firm B 's database) and then buying from A in period 2 at price $\frac{\ell^*}{2} + c$. Observe that consumers pay a lower second period price if they buy from firm B in period 1 than from firm A . This feature will play a critical role next in determining the form of the demand function.

The indifferent consumer must satisfy

$$(p_A^1 - p_B^1) + \delta \left[(\ell^* + c) - \left(\frac{\ell^*}{2} + c \right) \right] = \ell^* + \delta \cdot 0 \Rightarrow \ell^* = \frac{2(p_A^1 - p_B^1)}{(2 - \delta)}. \quad (\text{A.8})$$

At $p_A^1 = 4\ell_B + p_B^1$, the marginal consumer before deviation, $\ell^* = p_A^1 - p_B^1$, is equal to $4\ell_B$. The marginal consumer after firm A 's deviation, $\ell^* = \frac{2(p_A^1 - p_B^1)}{(2 - \delta)}$, however, becomes equal to $4\ell_B$ at $p_A^1 = 4\ell_B - 2\delta\ell_B + p_B^1$. For a range of firm A 's prices, i.e., $p_A^1 \in [4\ell_B + p_B^1 - 2\delta\ell_B, 4\ell_B + p_B^1]$, demand is independent of price (vertical), i.e., ℓ^* is fixed at $4\ell_B$ when p_A^1 is in the above range.²⁸

The idea behind this vertical part is as follows. If the consumer at the margin buys from firm B today, then she will end up in firm B 's database, in which case tomorrow she will pay $\frac{\ell^*}{2} + c$. If, on the other hand, she buys from firm A today, then she will end up in firm A 's database, in which case tomorrow she will pay $\ell^* + c$. Hence, the consumer at the margin pays a lower price tomorrow if she ends up in firm B 's database today than if she ends up in firm A 's database today, i.e., $\frac{\ell^*}{2} + c < \ell^* + c$ (given also that $\ell^* > 0$). Therefore, firm A 's price today, p_A^1 , must decrease in a *discrete* way to induce consumers at the margin to switch to firm A .

Hence, firm A 's sum of discounted deviation profits are

$$\Pi_A^d = \begin{cases} (p_A^1 - c)(\ell_A - 4\ell_B) + \delta \left[\frac{\ell_A^2}{2} - \frac{(4\ell_B)^2}{4} \right] & \text{if } 4\ell_B - 2\delta\ell_B + p_B^1 \leq p_A^1 \leq 4\ell_B + p_B^1, \\ (p_A^1 - c)(\ell_A - \ell^*) + \delta \left[\frac{\ell_A^2}{2} - \frac{(\ell^*)^2}{4} \right] & \text{if } p_A^1 \leq 4\ell_B - 2\delta\ell_B + p_B^1, \end{cases} \quad (\text{A.9})$$

where the second period profits come from subgame 1 and in particular (1) and (4), ℓ^* is given by (A.8) and p_B^1 is fixed at the level given by (A.4). The deviating firm chooses p_A^1 to maximize (A.9). We show that as long as $\ell_A > 13\ell_B$ such deviation is not profitable. In particular, the maximized profits as given by (A.5) are greater than the maximum deviation profits $\max_{p_A^1} \Pi_A^d$. To keep the paper within acceptable limits, in the remaining of this proof, we do not present the calculations regarding the comparison of firm profits before and after a deviation. These calculations are straightforward, but somewhat lengthy, and are available upon request.

We continue with the second type of deviation, i.e., $-\ell_B \leq \ell^* \leq 0$. No information sharing takes place in period 2. This case leads to a subgame similar to subgame 1.

²⁸This vertical part in the demand function appears only when $\delta > 0$, $\ell_B > 0$, $\ell^* = 4\ell_B > 0$ and information sharing is allowed.

Firm *B*'s price is fixed at the level given by (A.4). Following the same steps as in that subgame, we can show that firm *B*, in period 2, charges a price of $c - \frac{\ell^*}{2}$ to the consumers in segment $(\ell^*, \ell_A]$ and individualized prices $c - \ell$ to the consumers in $[-\ell_B, \ell^*]$. Firm *A*'s profits in period 2 are analogous to those given by Eq. (5), i.e.,

$$\pi_A^2 = \frac{(\ell^* - 2\ell_A)^2}{8}. \tag{A.10}$$

The marginal consumer ℓ^* in period 1 must be indifferent between buying from firm *A* today at price p_A^1 and then buying in period 2 from firm *B* at price $c - \frac{\ell^*}{2}$, or buying from firm *B* in period 1 at price p_B^1 and then buying again from *B* in period 2 at price $c - \ell^*$. The indifferent consumer must satisfy

$$(p_A^1 - p_B^1) + \delta \left[\left(c - \frac{\ell^*}{2} \right) - (c - \ell^*) \right] = \ell^* + \delta \cdot 0 \Rightarrow \ell^* = \frac{2(p_A^1 - p_B^1)}{(2 - \delta)}. \tag{A.11}$$

Using (A.10), firm *A*'s sum of discounted deviation profits are

$$\Pi_A^d = (p_A^1 - c)(\ell_A - \ell^*) + \delta \frac{(\ell^* - 2\ell_A)^2}{8}. \tag{A.12}$$

We substitute (A.11) into (A.12), differentiate it with respect to p_A^1 and we solve the (foc). The function is strictly concave. We show that firm *A* will charge a price such that $\ell^* = 0$. But from the previous deviation, and observing that firm *A*'s profit function is continuous, we know that firm *A* can do better than that. Therefore a deviation to $\ell^* \leq 0$ is not profitable.

Firm B's deviation in period 1: For the structure to change it must be the case that firm *B* increases its price to the point that $\ell^* \leq 4\ell_B$ and therefore information sharing in period 2 is not profitable. Similarly to the deviation of firm *A*, there are two distinct types of deviations. We begin with $4\ell_B \geq \ell^* \geq 0$. The marginal consumer is the same as in (A.8). The profit function also consists of two parts as (A.9). The first period price of firm *A* is fixed at its level given by (A.3). The sum of discounted deviation profits are calculated in a similar manner as those of firm *A* in the same type of deviation, using also the equilibrium profits from subgame 1. We show that this deviation is not profitable, provided that $\ell_A > 13\ell_B + \frac{12\sqrt{5\delta}\ell_B}{\sqrt{8-\delta(1+\delta)}} \geq 13\ell_B$. Thus, we need a tighter threshold than the $\ell_A > 13\ell_B$ to ensure that firm *B*'s deviation is unprofitable.

Then we turn to $-\ell_B \leq \ell^* \leq 0$. The marginal consumer is the same as in (A.11). The first period price of firm *A* is fixed at its level given by (A.3). The sum of discounted deviation profits are calculated in a similar manner as those of firm *A* in the same type of deviation. We find that this type of deviation is not profitable either.

(3) So far, we have proved that when $\ell_A > 13\ell_B + \frac{12\sqrt{5\delta}\ell_B}{\sqrt{8-\delta(1+\delta)}}$, the strategies that are described in the statement of Proposition 2 constitute a SPE. Now we will show that this SPE is unique. Given that information will be shared in period 2, the pricing strategies, as we have demonstrated above, are indeed unique. But is information

sharing the only outcome when $\ell_A > 13\ell_B + \frac{12\sqrt{5\delta}\ell_B}{\sqrt{8-\delta(1+\sigma)}}$? To be more precise, we will prove that no sharing of information is not a SPE under the assumptions of Proposition 2.

Let $\ell_A > 13\ell_B + \frac{12\sqrt{5\delta}\ell_B}{\sqrt{8-\delta(1+\sigma)}}$, but nevertheless no sharing of information takes place in period 2. For this to be the case, it must be that $\ell^* \leq 4\ell_B$ (otherwise firm *B* will sell its information to *A*). There are two cases: (i) $4\ell_B \geq \ell^* \geq 0$ and (ii) $-\ell_B \leq \ell^* \leq 0$. In the first case the marginal consumer is the same as in (A.8), while in the second she is the same as in (A.11). When $4\ell_B \geq \ell^* \geq 0$, the profit functions are (using the results from subgame 1)

$$\Pi_A = \begin{cases} (p_A^1 - c)(\ell_A - 4\ell_B) + \delta \left[\frac{\ell_A^2}{2} - \frac{(4\ell_B)^2}{4} \right] & \text{if } 4\ell_B - 2\delta\ell_B \leq p_A^1 - p_B^1 \leq 4\ell_B, \\ (p_A^1 - c)(\ell_A - \ell^*) + \delta \left[\frac{\ell_A^2}{2} - \frac{(\ell^*)^2}{4} \right] & \text{if } p_A^1 - p_B^1 \leq 4\ell_B - 2\delta\ell_B, \end{cases} \tag{A.13}$$

and

$$\Pi_B = \begin{cases} (p_B^1 - c)(5\ell_B) + \delta \frac{(6\ell_B)^2}{8} & \text{if } 4\ell_B - 2\delta\ell_B \leq p_A^1 - p_B^1 \leq 4\ell_B, \\ (p_B^1 - c)(\ell^* + \ell_B) + \delta \frac{(\ell^* + 2\ell_B)^2}{8} & \text{if } p_A^1 - p_B^1 \leq 4\ell_B - 2\delta\ell_B. \end{cases} \tag{A.14}$$

The logic behind the construction of (A.13) and (A.14) is the same with that of (A.9) above. First, focus on the first part of the profit functions. An equilibrium in this interval does not exist, since firms wish to end up on the opposite ends of the $[4\ell_B - 2\delta\ell_B, 4\ell_B]$ interval. The second parts of the profit functions are strictly concave in p_A^1 and p_B^1 , respectively. We derive the two reaction functions and we find the unique intersection point, but at that point $\ell^* > 4\ell_B$, a contradiction.

When $\ell^* \leq 0$, the profit functions are:

$$\Pi_A = (p_A^1 - c)(\ell_A - \ell^*) + \delta \left[\frac{(\ell^* - 2\ell_A)^2}{8} \right], \tag{A.15}$$

$$\Pi_B = (p_B^1 - c)(\ell^* + \ell_B) + \delta \left[\frac{\ell_B^2}{2} - \frac{(\ell^*)^2}{4} \right]. \tag{A.16}$$

The second period profits have been derived the same way as the second period profits in (A.13) and (A.14), but with ℓ^* negative instead of positive. The above profit functions are strictly concave in p_A^1 and p_B^1 , respectively. We derive the two reaction functions and we find the unique intersection point. However, either the resulting ℓ^* is positive which leads to a contradiction, or

firm A has an incentive to deviate. Hence, the SPE stated in Proposition 2 is unique. \square

Proof of Proposition 3. We begin our search for a SPE when information sharing is banned, assuming that $\ell^{**} \geq 0$. Differentiate the second parts of (A.13) and (A.14) with respect to p_A^1 and p_B^1 .²⁹ The second-order conditions are satisfied. The unique solution to the system of the two reaction functions is:

$$p_A^1 = \frac{5\ell_A\delta^2 - 8\ell_B\delta - 18\ell_A\delta + 24c - 10c\delta + 16\ell_A + 8\ell_B}{2(12 - 5\delta)}, \tag{A.17}$$

$$p_B^1 = \frac{3\ell_A\delta^2 - 20\ell_B\delta - 10\ell_A\delta + 24c - 10c\delta + 8\ell_A + 16\ell_B + 4\ell_B\delta^2}{2(12 - 5\delta)}. \tag{A.18}$$

The first period marginal consumer, based on the above prices, is located at

$$\ell^{**} = \frac{2[\ell_A(2 - \delta) - 2\ell_B(1 - \delta)]}{12 - 5\delta}.$$

To conclude that the above pair of prices constitutes a SPE, we must demonstrate that unilateral deviations are unprofitable. There are two types of deviations in our model: (i) a firm changes its first period price, but still $\ell^{**} \geq 0$ and (ii) a price change leads to $\ell^{**} \leq 0$. The first type of deviation has already been proved that it is not profitable, since the price pair is a solution to the system of best response functions.

Next, we show that the second type of deviation is not profitable either. We first look at firm A 's incentives to deviate and then at firm B 's.³⁰

Firm A's deviation in period 1: Firm B 's price is fixed at the level given by (A.18). Firm A 's profit function is the same as the one given by (A.15), since now $\ell^* \leq 0$. We show that this type of deviation is not profitable.

Firm B's deviation in period 1: Firm A 's price is fixed at the level given by (A.17). Firm B 's profit function is the same as the one given by (A.16), again since $\ell^* \leq 0$. We show that this deviation is not profitable either.

Next, we search for an equilibrium when $\ell^{**} \leq 0$. The firms' profit functions are the same as the ones given by (A.15) and (A.16). We derive the two reaction functions and we solve them to obtain a pair of prices. We then show that firm A has always an incentive to deviate. Hence, there does not exist such an equilibrium. \square

²⁹We use only the second parts of (A.13) and (A.14) because the possibility of information sharing is non-existent and therefore the vertical part in the demand function does not appear.

³⁰As in the proof of Proposition 2, the details pertaining to the comparison of profits before and after a deviation are straightforward, but lengthy, and therefore are omitted. They are, however, available upon request.

Proof of Proposition 4. From (19), and after we use (13) and (16), we obtain

$$\begin{aligned} & \frac{[(\ell^*)^2 - (\ell^{**})^2]}{2} - \delta \frac{(\ell^{**})^2}{8} \\ &= \frac{\delta[12(11\ell_B^2 - \ell_A^2 - 10\ell_A\ell_B) + \delta(25\ell_4^2 - 14\ell_A\ell_B - 47\ell_B^2) - 9\delta^2(\ell_A - 2\ell_B)^2]}{18(12 - 5\delta)^2}. \end{aligned} \tag{A.19}$$

If (A.19) is positive, the social welfare when information sharing is banned increases. We set (A.19) = 0 and we solve with respect to δ . This yields the following two non-zero solutions:

$$\begin{aligned} \delta_1 &= \frac{25\ell_A^2 - 14\ell_A\ell_B - 47\ell_B^2 - \sqrt{(433\ell_B^2 - 590\ell_A\ell_B + 193\ell_A^2)(\ell_A - 7\ell_B)^2}}{18(\ell_A^2 - 4\ell_A\ell_B + 4\ell_B^2)}, \\ \delta_2 &= \frac{25\ell_A^2 - 14\ell_A\ell_B - 47\ell_B^2 + \sqrt{(433\ell_B^2 - 590\ell_A\ell_B + 193\ell_A^2)(\ell_A - 7\ell_B)^2}}{18(\ell_A^2 - 4\ell_A\ell_B + 4\ell_B^2)}. \end{aligned}$$

First note that $\delta_1 < \delta_2$. (A.19) is negative for any $\delta < \delta_1$ and any $\delta > \delta_2$ (note that the term in the bracket in the numerator of (A.19) exhibits an inverse U-shape with respect to δ). It is positive for $\delta \in (\delta_1, \delta_2)$. It can be checked that if $\ell_A > (\frac{49+21\sqrt{5}}{4})\ell_B$, then $\delta_1 < 1$. Also, for $\ell_A \in (13\ell_B + \frac{12\sqrt{5}\delta\ell_B}{\sqrt{8-\delta(1+\sigma)}}, (\frac{49+21\sqrt{5}}{4})\ell_B)$, $\delta_1 > 1$. Moreover, when $\ell_A > 13\ell_B + \frac{12\sqrt{5}\delta\ell_B}{\sqrt{8-\delta(1+\sigma)}}$ then $\delta_2 > 1$.

Hence, if $\ell_A < (\frac{49+21\sqrt{5}}{4})\ell_B$, for any δ , (A.19) is negative which implies that welfare will decrease if information sharing is banned. On the other hand, if $\ell_A > (\frac{49+21\sqrt{5}}{4})\ell_B$, then $\delta_1 < 1$ and consequently for any $\delta > \delta_1 = \hat{\delta}$, (A.19) is positive which implies that welfare if information sharing is banned increases, while when $\delta < \delta_1 = \hat{\delta}$ it decreases. \square

References

Armantier, O., Richard, O., 2003. Entry and exchanges of cost information. *RAND Journal of Economics* 34, 461–477.
 Banks, J., Moorthy, S., 1999. A model of price promotions with consumer search. *International Journal of Industrial Organization* 17, 371–398.
 Chen, Y., 1997. Paying customers to switch. *Journal of Economics & Management Strategy* 6, 877–897.
 Chen, Y., 2004. Marketing innovation. *Journal of Economics & Management Strategy*, forthcoming.
 Chen, Y., Narasimhan, C., Zhang, Z.J., 2001. Individual marketing with imperfect targetability. *Marketing Science* 20, 23–41.
 Fudenberg, D., Tirole, J., 2000. Customer poaching and brand switching. *RAND Journal of Economics* 31, 634–657.
 Gal-Or, E., 1985. Information sharing in oligopoly. *Econometrica* 53, 329–344.
 Liu, Q., Serfes, K., 2004. Quality of information and oligopolistic price discrimination. *Journal of Economics & Management Strategy* 13, 671–702.

- Liu, Q., Serfes, K., 2005. Imperfect price discrimination in a vertical differentiation model. *International Journal of Industrial Organization*, forthcoming.
- Rao, R., 1991. Pricing and promotions in asymmetric duopolies. *Marketing Science* 10, 131–144.
- Rath, K.P., Zhao, G., 2001. Two stage equilibrium and product choice with elastic demand. *International Journal of Industrial Organization* 19, 1441–1455.
- Shaffer, G., Zhang, Z.J., 1995. Competitive coupon targeting. *Marketing Science* 14, 395–415.
- Shaffer, G., Zhang, Z.J., 2000. Pay to switch or pay to stay: Preference-based price discrimination in markets with switching costs. *Journal of Economics & Management Strategy* 9, 397–424.
- Shaffer, G., Zhang, Z.J., 2002. Competitive one-to-one promotions. *Management Science* 48, 1143–1160.
- Shapiro, C., 1986. Exchange of cost information in oligopoly. *The Review of Economic Studies* 53, 433–446.
- Thisse, J.F., Vives, X., 1988. On the strategic choice of spatial price policy. *American Economic Review* 78, 122–137.
- Villas-Boas, J.M., 1994. Sleeping with the enemy: Should competitors share the same advertising agency? *Marketing Science* 13, 190–202.
- Vives, X., 1990. Trade association disclosure rules, incentives to share information, and welfare. *RAND Journal of Economics* 21, 409–430.