Behaviour-Based Price Discrimination in "Switching Markets"*

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Abstract

This paper studies discriminatory and non-discriminatory pricing when firms' customers have heterogeneous switching costs and market shares are asymmetric. This setting encompasses many markets in which established firms are challenged by disruptive entrants and have yet come under regulatory scrutiny. We identify circumstances under which regulatory interventions to protect "back-book" customers from exploitation are counterproductive. And we show how most-favoured customer clauses can be discriminatory and would benefit firms, but firms do not have an incentive to implement them unilaterally.

JEL classification: L11, L13, D4

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1 Introduction

The presence of sticky, or "unengaged", consumers who find it costly to choose to switch from their current service provider is arguably one of the most intractable issues faced by competition authorities [Authority for Consumers and Markets, 2014, Canadian Radio-television and Telecommunications Commission, 2017, European Commission, 2016, Financial Conduct Authority, 2015, Hortaçsu et al., 2017, OECD, 2017]. Such loyal customers, often labelled a provider's "back-book", are said to convey unfair competitive advantages to

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large oligopolistic incumbents because they are typically more profitable than "front-book" customers who are more active, regularly shop around in search for a better deal and find it less costly to switch [Productivity Commission, 2018].

In this paper, in a duopoly with asymmetric market shares we study discriminatory pricing schemes that target customers with heterogeneous switching costs. We compare the resulting outcomes with those under non-discriminatory prices. We thereby investigate how market shares and the distribution of switching costs interact when firms consider which pricing scheme they wish to adopt.

The kind of markets that form the backdrop to our analysis involve utilities such as retail energy, basic telecom services and retail financial services such as current accounts. They provide essential services that every consumer must purchase to satisfy basic needs. So potential lock-in of consumers who find it costly to choose to switch and their exploitation are significant policy concerns.

These markets are dynamic and have recently experienced entry by "challenger" firms. Yet "challenger" firms typically face barriers to entry and expansion due to higher customer acquisition costs and the risk that the make-up of their customer base is overexposed towards customers with low switching costs and hence high propensity to switch [Authority for Consumers and Markets, 2014, Financial Conduct Authority, 2015]. This gives rise to asymmetric market shares, at least initially. The combined effect of potential lock-in of a large portion of consumers and the initial asymmetry of market shares suggests potentially very large consumer detriment [Competition and Markets Authority, 2016a,b, Hortaçsu et al., 2017].

Compounding the issue of consumer inertia creating entry and expansion barriers, incumbents can also recur to the use of behavioural-based price discrimination (BBPD) in order to stifle the growth of "challenger" firms. One obvious form of BBPD is history-base price discrimination (HBPD) whereby firms offer separate poaching prices to rivals' customers, typically at a discount off the price paid by existing customers, and possibly to the detriment of the retained customers [Financial Conduct Authority, 2017].[1]

A second, more subtle, form of BBPD is to exploit consumer inertia by launching a new tariff that is available to both rivals' and own customers, in the knowledge that only the most active among the latter group will be able to take advantage of it.[2] Therefore, this second form of BBPD is akin to a retention strategy based on the use of most-favoured-nation

[1]For example, Competition and Markets Authority [2016a], para 8.232ff, finds evidence of price discrimination between new start-ups and established businesses with respect to business current accounts.

[2]This configuration can be thought of as the result of consumers becoming unengaged due to confusion and ensuing difficulty in choosing the best tariff from a vast number of complex alternatives, whereas active consumers with low switching costs do better at identifying the cheapest tariff when shopping around.

(MFN) or most-favoured-customer (MFC) clauses where existing customers face heterogeneous "hassle costs" to enforce their right by asking their current service provider to match the lower price offered to other (potentially new) customers. Incidentally, this configuration can also arise as a result of regulatory intervention aimed at not only neutralising the use of HBPD by the incumbent (i.e., by imposing a profit sacrifice when poaching rivals' customers), but also protecting existing "back-book" customers by facilitating "internal switching" (i.e., upgrading to a better tariff). We label this configuration HBPD with "leakage"[Financial Conduct Authority, 2016, OECD, 2016].

This paper studies pricing models with random heterogeneous switching costs that differ across duopolistic firms with asymmetric market shares. In doing so, the paper generalizes and extends the analysis of "mature markets" with common uniformly distributed switching costs in Chen [1997]. As pointed out by Chen [1997], markets with asymmetric, history-based market shares may be of interest in their own right, e.g. to study new commercial strategies that were not anticipated at the inception of the market. This setting is also of interest because the kind of "switching markets" we are interested in, at least at the point of entry of a challenger, exhibit asymmetries, not only in terms of market shares, but also with respect to average switching costs as they relate to "back-book" and "front-book" customers. Hence, they are often subject to policy interventions such as mandated removals of arbitrage restrictions that aim at overcoming the risk of such asymmetries becoming entrenched [Financial Conduct Authority, 2015, 2016].

In general, though, regulatory intervention aimed at protecting "back-book" customers is fraught with difficulties to the extent that active customers benefit from lower prices thanks to firms poaching.[3] We characterise the conditions under which "locked-in" prices charged to "back-book" customers under BBPD are lower than those they would face under uniform pricing as result of policy interventions aimed at protecting unengaged customers from exploitation.

Our analysis provides other novel insights. We show that, with heterogeneous switching costs across firms with asymmetric market shares, there are circumstances in which a challenger firm with small market share and a customer base with relatively low switching costs will prefer non-discriminatory pricing, even if faced with a larger incumbent with a customer base with relatively high switching costs. Hence, there is no prisonners' dilemma, in contrast to the Hotelling-based model of Thisse and Vives [1988].

Furthermore, our model of HBPD with leakage adds a new perspective on MFCs. Unlike

[3]For example, OECD [2016], para. 136, report that the UK energy regulator imposed a non-discrimination requirement on energy firms. However, after receiving criticism the CMA identified this as softening competition and has therefore recommended its removal.

in Besanko and Lyon [1993], where MFCs apply to all customers indiscriminately and thus act as a non-discrimination commitment device, in our setting the use of MFCs amounts to a form of third-degree price discrimination. Here we find a different type of prisoners' dilemma, whereby both firms would be better off under the common use of MFCs but none of them has a unilateral incentive to adopt MFCs. In particular, an incumbent with high market shares and relatively high switching costs can anticipate that the smaller rival has strong incentives not to reciprocate but stick to the use of vanilla HBPD. Therefore, an asymmetric regulatory intervention aimed at imposing leakage only on the large incumbent would tend to favour the challenger firm.

Our framework is related to Gehrig et al. [2012] who study the welfare implications of HBPD under asymmetric market shares. The authors find that even when firms can price discriminate between new and current customers, poaching might not take place if switching costs are sufficiently high. Moreover, where market shares are particularly skewed, the erosion of the larger firm's customer base is larger than under uniform pricing. Indeed, for very asymmetric inherited market shares the larger firm may not offer a poaching offer given that it would be too costly to attract marginal customers that are close to the previous cut-off point, but very far from the opposite extreme where the dominant firm is located. This is because, similar to Thisse and Vives [1988], the authors also include brand preferences under a linear Hotelling model so that it is too expensive for the larger firm to pre-empt poaching of its least loyal customers.

We believe that the inclusion of heterogeneous brand preferences to model competition in "switching markets" is problematic, however. In the Hotelling linear duopoly model of product differentiation and horizontal brand preferences, loyal customers are the ones paying the lowest 'delivered' price, inclusive of the 'transport' cost due to distance in product space; marginal consumers that firms compete over are located farther away from either firm and end-up paying a higher 'delivered' price. In contrast to this, the main competition concern raised in the context of consumer disengagement is that loyal "back-book" customers - those less likely to switch - arguably are the ones being exploited by their current provider and pay higher prices, compared to marginal, "front-book" customers. Indeed, a corollary of customer inertia due to the lack of engagement is, at least anecdotally, that customers fail to see that there are benefits from switching because they are under the impression that competing firms are undifferentiated.

Another feature of the Hotelling model of horizontal differentiation that does not fit the stylised facts is that a firm with the smaller market share is protected from the risk of further customer "poaching" thanks to the fact that the make-up of its customer base is dominated by very loyal customers who face very high "transport" costs. This is in contrast to the view that "challenger" firms, which start by definition with very small market shares, might be over-exposed to incumbents' "front-book" customers with low switching costs.

Accordingly, our approach is to directly models heterogeneous switching costs, rather than brand preferences, in a spatial linear model. Moreover, in addition to Gehrig et al. [2012] we also analyse unilateral incentives to adopt BBPD. Our framework is closest to Shaffer and Zhang [2000] who allow for heterogenous switching costs, distributed according to a uniform distribution with common minima equal to zero, and asymmetric baseline market shares. However, we do not impose restrictions on the type of distribution and minima and also study a third pricing regime, MFCs, besides HBPD and UP.

The paper proceeds as follows. Section 2 details our assumptions and discusses HBPD. Section 3 contrasts our results on HBPD with uniform pricing. Section 4 discusses MFCs and HBPD with leakage. And Section 5 concludes.

2 History-Based Price Discrimination

Suppose customers are spread uniformly on the unit interval, and two firms, A and B, are located at x_0, so that A's market share is $x_0 \in (0,1)$ and B's market share is $1-x_0$. Market shares are taken as predetermined, but – as in Chen [1997] – it turns out that they do not matter when prices are not uniform, except in cases when the heterogeneity of customer switching costs itself is tied to market shares.

Suppose customers of firm A have switching costs s_A that are distributed with CDF $\Phi_A(s)$ for $s \in \mathcal{S}_A \subseteq \mathbb{R}_+$, and customers of firm B have switching costs s_B with CDF $\Phi_B(s)$, $s \in \mathcal{S}_B \subseteq \mathbb{R}_+$. This allows for heterogeneity of the distribution of switching costs of the two firms' customer bases, except when $\mathcal{S} = \mathcal{S}_A = \mathcal{S}_B$ and $\Phi_A(s) = \Phi_B(s)$ for all $s \in \mathcal{S}$. Suppose also that both CDFs are continuously differentiable so that their pdfs $\phi_A(s)$ and $\phi_B(s)$ exist.

As in Chen [1997], let q_{ij} denote the levels of historic demand at firm j that currently accrues at firm i, with $i, j \in \{A, B\}$. So when $i \neq j$, this is the demand firm j loses when firm i poaches firm j's customers. Let p_i denote firm i's locked-in price, and p_{ip} firm i's poaching price, which can be thought of as p_i net of an inducement m_i that i offers to j's customers who switch to i. We assume throughout that consumers' valuations exceed prices.

Then, given (p_A, p_B, m_a, m_B), firm A's marginal customer has switching costs $\sigma_A = p_A -$

$p_B + m_B$, and firm B's marginal customer has $\sigma_B = p_B - p_A + m_A$. Therefore,

$$\begin{aligned} q_{AA} &= x_0 \Pr(s_A \geq \sigma_a) = x_0 (1 - \Phi_A(\sigma_A)) \\ q_{BA} &= x_0 \Phi_A(\sigma_A) \\ q_{BB} &= (1 - x_0)(1 - \Phi_B(\sigma_B)) \\ q_{AB} &= (1 - x_0)\Phi_B(\sigma_B). \end{aligned}$$

Assume firms have the same marginal cost c. Then, the firms' profits are given by

$$\begin{aligned} \pi_A(p_A, m_A; p_B, m_B) &= (p_A - c)x_0 (1 - \Phi_A(\sigma_A)) + (p_A - c - m_A)(1 - x_0)\Phi_B(\sigma_B) \\ \pi_B(p_B, m_B; p_A, m_A) &= (p_B - c)(1 - x_0)(1 - \Phi_B(\sigma_B)) + (p_B - c - m_B)x_o\Phi_A(\sigma_A). \end{aligned}$$

The firms' profit maximization problems yield the following first-order conditions,[4]

$$\begin{aligned} p_A^* - c &= \frac{1 - \Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)} \\ p_B^* - c &= \frac{1 - \Phi_B(\sigma_B^*)}{\phi_B(\sigma_B^*)} \\ p_A^* - c - m_A^* &= \frac{\Phi_B(\sigma_B^*)}{\phi_B(\sigma_B^*)} \\ p_B^* - c - m_B^* &= \frac{\Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)}, \end{aligned}$$

where p_i^* and m_i^* denote firm i's optimal price and discount, and $\sigma_i^* = p_i^* - p_j^* + m_j^*$, $i, j \in \{A, B\}$ and $i \neq j$. As in Chen [1997], the initial market shares x_0 and $1 - x_0$ do not matter for the firms' optimal strategy – unless the distributions of the customers' switching costs themselves are functions of the initial market shares.[5]

The first-order conditions permit some initial insights into per-unit margins. They show that a firm's per-unit margin on retained customers is larger (smaller) than the per-unit margin of its rival on its poached customers if the marginal customer's switching cost is below (above) the median switching costs of its customer base. By the definition of σ_A and

[4]The derivation uses the fact that the first-order conditions with respect to m_A and m_B eliminate the derivative of the second summand in π_A and π_B with respect to p_A and p_B, respectively.

[5]This could arise, for example, as a consequence of network effects. See, for example, the discussion in Farrell and Klemperer [2007].

σ_B however, the first-order conditions imply

$$\begin{aligned}\sigma_A^* &= \frac{1-2\Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)}\\ \sigma_B^* &= \frac{1-2\Phi_B(\sigma_B^*)}{\phi_B(\sigma_B^*)},\end{aligned}$$

and so in order for $\sigma_A^* \geq 0$ and $\sigma_B^* \geq 0$, it needs to be the case that both are no larger than the median of the respective switching cost distributions. Hence, the per-unit margin earned on retained customers exceeds the one earned by the rival on the firm's poached customers.

Defining the elasticity of firm j's demand q_{ij} accruing to firm i with respect to firm i's price charged to firm j's customers by $\epsilon_{q_{ij},p_{ji}}(\sigma_j)$, the first-order conditions imply

$$\begin{aligned}\frac{p_A^*-c}{p_A^*} &= -\frac{1}{\epsilon_{q_{AA},p_A}(\sigma_A^*)}\\ \frac{p_B^*-c}{p_B^*} &= -\frac{1}{\epsilon_{q_{BB},p_B}(\sigma_B^*)}\\ \frac{p_A^*-c-m_A^*}{p_A^*-m_A^*} &= \frac{1}{\epsilon_{q_{AB},p_A-m_A}(\sigma_B^*)}\\ \frac{p_B^*-c-m_B^*}{p_B^*-m_B^*} &= \frac{1}{\epsilon_{q_{BA},p_B-m_B}(\sigma_A^*)}.\end{aligned}$$

So the relative profit margins are seen to be inversely proportional to the own and cross price elasticities of the respective firm level demands for the marginal customers. This is noteworthy because it shows that any discount offered to specific groups of customers depends on the magnitude of the firm's own price elasticity of demand relative to the cross price elasticity of its rival's lost demand, for the respective marginal customers in equilibrium.

In order to characterize the solution further, we make the following

Assumption 1: (*Monotone Likelihood Ratio, MLR*)

$$\frac{\phi_A(s)}{\phi_B(s)} \geq \frac{\phi_A(t)}{\phi_B(t)} \quad \forall s \geq t; s \in \mathcal{S}_A, t \in \mathcal{S}_B.$$

The MLR assumption has been discussed and used widely in microeconomic theory [Athey, 2002, Lebrun, 1998, Maskin and Riley, 2000].

The MLR assumption implies that the distribution of firm A's customers' switching costs Φ_A first-order stochastically dominates that of firm B's customers' switching costs, i.e. $\Phi_A(s) \leq \Phi_B(s)$ for all $s \in \mathcal{S}_A \cup \mathcal{S}_B$.[6] It also implies that $\mathbb{E}[s_A] \geq \mathbb{E}[s_B]$.[7] So firm A's customers are more likely to have higher switching costs than firm B's, and their average switching costs are also higher. That suggests that firm A's customers are more likely to be locked-in than firm B's.

Furthermore, the MLR assumption implies the hazard rate (H) inequality:[8]

$$\frac{\phi_B(s)}{1-\Phi_B(s)} \geq \frac{\phi_A(s)}{1-\Phi_A(s)} \quad \forall s \in \mathcal{S}_A \cup \mathcal{S}_B.$$

This inequality implies that, for any s, firm A's demand exhibits a lower own-price elasticity than firm B's demand.

Similarly, the MLR assumption implies the reverse hazard rate (RH) inequality:

$$\frac{\phi_A(s)}{\Phi_A(s)} \geq \frac{\phi_B(s)}{\Phi_B(s)} \quad \forall s \in \mathcal{S}_A \cup \mathcal{S}_B.$$

This inequality, in turn, implies that, for any s, firm A's demand lost to firm B exhibits a higher cross-price elasticity than firm B's demand lost to firm A.

Consider two further assumptions.

Assumption 2: The hazard rates are weakly increasing, i.e.

$$\frac{\phi_i(s)}{1-\Phi_i(s)} \leq \frac{\phi_i(t)}{1-\Phi_i(t)} \quad \forall s \leq t; s,t \in \mathcal{S}_i, i = A, B.$$

This assumptions holds for the uniform distribution and the Weibull distribution with shape parameter greater than or equal to unity.[9] It implies that the firms' own-price elasticities are weakly increasing.

Assumption 3: The reverse hazard rates are weakly decreasing, i.e.

$$\frac{\phi_i(s)}{\Phi_i(s)} \geq \frac{\phi_i(t)}{\Phi_i(t)} \quad \forall s \leq t; s,t \in \mathcal{S}_i, i = A, B.$$

This assumption holds whenever the pdf is bounded. This assumption does not imply that the cross-price elasticities of the firm's lost demand are monotonic, however.

Using these assumptions, we can obtain the following results.

[6] This follows from rearranging, integrating w.r.t. t over $\mathcal{S}_A \cup \mathcal{S}_B$ and then integrating up to s. It is obvious if $\sup \mathcal{S}_B \leq \inf \mathcal{S}_A$.

[7] This follows from $\phi_B(t)s\phi_A(s) \geq \phi_A(t)s\phi_B(s)$, integrating w.r.t. s and t over $\mathcal{S}_A \cup \mathcal{S}_B$.

[8] This follows from rearranging and integrating w.r.t. t up from s.

[9] The Weibull CDF is given by $F(s) = 1 - \exp(-\gamma s^\alpha)$, for $s \in \mathbb{R}$ and scale parameter $\gamma > 0$ and shape parameter $\alpha > 0$; $\alpha = 1$ yields the exponential CDF. Its hazard rate is weakly increasing for $\alpha \geq 1$ and decreasing for $\alpha < 1$.

Lemma 2.1: *Under Assumptions 1-3,* $\sigma_A^* \geq \sigma_B^*$.

Proof: Assumption 1 implies H and RH. Suppose the opposite were true, i.e. $\sigma_A < \sigma_B$. Then, by RH and Assumption 3, for $\sigma_A^* < s < \sigma_B^*$,

$$\frac{\Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)} \leq \frac{\Phi_A(s)}{\phi_A(s)} \leq \frac{\Phi_B(s)}{\phi_B(s)} \leq \frac{\Phi_B(\sigma_B^*)}{\phi_B(\sigma_B^*)},$$

and so the last two first-order conditions imply $p_B^* - m_B^* \leq p_A^* - m_A^*$. H and Assumption 2 imply,

$$\frac{1-\Phi_B(\sigma_B^*)}{\phi_B(\sigma_B^*)} \leq \frac{1-\Phi_B(s)}{\phi_B(s)} \leq \frac{1-\Phi_A(s)}{\phi_A(s)} \leq \frac{1-\Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)},$$

and the first two first-order conditions in turn imply $p_B^* \leq p_A^*$. Therefore, the two inequalities imply $\sigma_B^* = p_B^* - p_A^* + m_A^* \leq p_A^* - p_B^* + m_B^* = \sigma_A^*$, a contradiction. □

The Lemma has the interpretation that firm A's marginal customer that firm B induces to switch has a higher switching cost than firm B's marginal customer.

Under the current assumptions, no more can be said about the relationship between σ_A^* and σ_B^*. Suppose, however,

Assumption 4: *The switching costs of firm A's customers,* s_A*, are a linear transformation of the switching costs of firm B's customers, i.e.* $s_A = a s_B$ *for some* $a > 1$.

Then, we have

Lemma 2.2: *Under Assumption 4,* $\sigma_A^* = a\sigma_B^*$*, and* $\Phi_A(\sigma_A^*) = \Phi_B(\sigma_B^*)$.

Proof: Under Assumption 4, for all s in the $\mathcal{S}_A$, $\Phi_A(s) = \Phi_B(\frac{1}{a}s)$ and $\phi_A(s) = \phi_B(\frac{1}{a}s)\frac{1}{a}$. Therefore, the first-order conditions imply

$$\begin{aligned}\sigma_A^* &= \frac{1-2\Phi_A(\sigma_A^*)}{\phi_A(\sigma_A^*)} \\ &= \frac{1-2\Phi_B(\frac{1}{a}\sigma_A^*)}{\phi_B(\frac{1}{a}\sigma_A^*)\frac{1}{a}},\end{aligned}$$

or

$$\frac{1}{a}\sigma_A^* = \frac{1-2\Phi_B(\frac{1}{a}\sigma_A^*)}{\phi_B(\frac{1}{a}\sigma_A^*)},$$

i.e. $\sigma_B^* = \frac{1}{a}\sigma_A^*$. □

Note that Assumption 4 implies first-order stochastic dominance, but not necessarily monotone likelihood ratio.[10]

The preceding Lemmas are useful in order to establish the following

[10] It does imply MLR in the case of the exponential distribution, for example.

Proposition 2.1: *Under Assumption 4, $p_B^* \le p_A^*$, and $m_B^* \le m_A^*$.*

Proof: From $\sigma_A^* \ge \sigma_B^*$ by the preceding Lemma, it follows that $2(p_A^* - p_B^*) \ge m_A^* - m_B^*$. So it is sufficient to prove that $m_A^* \ge m_B^*$. From the first-order conditions,

$$m_A^* - m_B^* = \frac{1}{\phi_A(\sigma_A^*)} - \frac{1}{\phi_B(\sigma_B^*)}.$$

Lemma 2.2 implies from the first-order conditions that $\sigma_A^* \phi_A(\sigma_A^*) = \sigma_B^* \phi_B(\sigma_B^*)$, where $\sigma_A^* > \sigma_B^*$. Hence $\phi_A(\sigma_A^*) \le \phi_B(\sigma_B^*)$. □

The preceding result shows that, with heterogeneous switching costs, the firm with the more locked-in customer base charges a higher price. At the same time, it must offer a larger discount to its price in order to induce its rival's customer to switch because these customers tend to have lower switching costs.

The model by Chen [1997], for the second period in a two-period game with payments for customers to switch, is a special case of this general framework, with $\phi_A(s) = \phi_B(s) = \frac{1}{\theta} 1_{\{s \in [0,\theta]\}}$, $\theta > 0$.

3 Uniform Pricing

It is interesting to compare the history-based price discrimination outcome of Proposition 2.1 with a situation in which the firms charge uniform prices. In this situation, either some of firm A's customer switch – if firm A's uniform price p_A^u exceeds firm B's uniform price p_B^u –, or some of firm B's customers switch, but not both.

Consider the first of these two cases, with firm A's marginal customer's switching cost $\sigma_A^u = p_A^u - p_B^u > 0$. Assume henceforth that $0 = \min\{s : s \in \mathcal{S}_A\} = \min\{s : s \in \mathcal{S}_B\}$. The firms' demands are then

$$\begin{aligned} q_A^u &= x_0 \left(1 - \Phi_A(\sigma_A^u)\right) \\ q_B^u &= 1 - x_0 + x_0 \Phi_A(\sigma_A^u). \end{aligned}$$

Clearly, only the distribution of switching costs of firm A's customers who are at risk of switching matters in this case. The distribution of firm B's customers' switching cost is immaterial.

The firms' profits are

$$\begin{aligned}\pi_A^u(p_A^u, p_B^u) &= (p_A - c)x_0\left(1 - \Phi_A(\sigma_A^u)\right)\\ \pi_B^u(p_A^u, p_B^u) &= (p_B - c)\left(1 - x_0 + x_0\Phi_A(\sigma_A^u)\right),\end{aligned}$$

and the first-order conditions for the firms' profit maximization problems yield

$$\begin{aligned}p_A^{*u} - c &= \frac{1 - \Phi_A(\sigma_A^{*u})}{\phi_A(\sigma_A^{*u})}\\ p_B^{*u} - c &= \frac{1 - x_0 + x_0\Phi_A(\sigma_A^{*u})}{x_0\phi_A(\sigma_A^{*u})}.\end{aligned}$$

Therefore,

$$\begin{aligned}\sigma_A^{*u} &= p_A^{*u} - p_B^{*u}\\ &= \frac{2x_0\left(1 - \Phi_A(\sigma_A^{*u})\right) - 1}{x_0\phi_A(\sigma_A^{*u})}.\end{aligned}$$

The final equation shows that $x_0 \geq \frac{1}{2}$ is a necessary and sufficient condition for an equilibrium with $p_A^{*u} > p_B^{*u}$ to exist.[11]

The expression for σ_A^{*u} also shows that σ_A^{*u} and hence the optimal uniform prices depend on x_0. In particular, if Φ_A has a relatively high probability mass on low values of s_A, then σ_A^{*u} tends to be small, and the more so that the closer x_0 is to $\frac{1}{2}$. This, in turn, means that firm B's price is not much lower than firm A's price - regardless of how skewed the distribution of switching costs of firm B's customers is towards high or low values.[12] While the situation of Φ_A (and / or Φ_B) having high probability mass on sets of low values of switching costs may appear inconsistent with the notion of a mature market, such situations may arise as a consequence of a regulatory intervention that is aimed at lowering the switching costs of larger portions of consumers.

Also, in that case, firm B may be better off employing a price-discrimination strategy because it would allow it to target and segment consumers with different switching costs in its own customer base. It is easy to construct examples that exhibit that feature.

Example: Suppose $\Phi_i(s) = 1 - \exp(-\gamma_i s^\alpha)$, $i = A, B$, with $\gamma_A = 4$, $\gamma_B = 3$, $\alpha = 1$ (i.e. exponential) and $x_0 = 0.55$.[13] Then, $p_A^* = \frac{1}{4}$, $p_B^* = \frac{1}{3}$, $m_A^* = 0.0759$, $m_B^* = 0.2159$, and $\pi_A = 0.1107$ and $\pi_B = 0.1196$; while $p_A^{*u} = \frac{1}{4}$ and $p_B^{*u} = 0.2342$, and $\pi_A^u = 0.1291$ and

[11] Note that $\sigma_A^u = 0$ implies that the righthand side is strictly positive for $x_0 > 0$, so that by continuity $\sigma_A^{*u} > 0$. Again, Chen [1997] provides a special case of this result.

[12] This is not an issue in models like Chen [1997] that assume homogeneous switching costs.

[13] Note that in this example, Φ_B first-order stochastically dominates Φ_A.

$\pi_B^u = 0.1133$. So firm B would be better off if it could price discriminate, while the opposite is true for firm A.

For comparison, if $\gamma_A = 3$ and $\gamma_B = 4$, i.e. Φ_A first-order stochastically dominates Φ_B, then $p_A^{*u} = \frac{1}{3}$ and $p_B^{*u} = 0.3123$, with profits $\pi_A^u = 0.1721$ and $\pi_B^u = 0.1510$; with history-based price discrimination, $p_A^* = \frac{1}{3}, p_B^* = \frac{1}{4}, m_A^* = 0.2077$ and $m_B^* = 0.0896$, and profits $\pi_A = 0.1313$ and $\pi_B = 0.1041$. So in this case, both firms would be better off with uniform pricing.

The first part of the example shows that with heterogeneous switching costs and asymmetric historic market shares, in the terminology of Belleflamme and Peitz [2010] the competition and surplus extraction effects may operate differently for the two firms. And that may lead them to prefer different pricing strategies.

The second part of the example shows that there are circumstances in which both firms' uniform prices exceed those under HBPD, and both firms earn higher profits with uniform prices than with discriminatory prices. This is consistent with the finding that price discrimination under oligopoly can intensify pricing rivalry when competing firms exhibit best-response asymmetry in that they hold opposing views as to which consumers are strong and which are instead weak [Armstrong, 2006]. It also illustrates the following more general result.

Proposition 3.1: *Under Assumptions 1-3, $p_A^{*u} \geq p_A^*$ and $p_B^{*u} \geq p_B^*$.*

Proof: It is sufficient to prove that $\sigma_A^{*u} \leq \sigma_A^*$ which implies, by the first-order conditions for firm A and Assumption 2, that $p_A^{*u} \geq p_A^*$. This, together with $\sigma_A^* > \sigma_B^* > 0$ under HBPD, as shown in Lemma 2.1, by Assumption 2 implies also $p_B^{*u} \geq p_B^*$.[14]

Suppose to the contrary that $\sigma_A^{*u} > \sigma_A^*$. Then, $p_A^{*u} \leq p_A^*$ by the first-order conditions and Assumption 2. This ranking of prices of firm A, together with the supposition, implies also that $p_B^{*u} \leq p_B^* - m_B^*$.[15] Therefore, $p_B^{*u} - c \leq p_B^* - c - m_B^*$, and hence

$$\frac{1 - x_0 + x_0 \Phi_A(\sigma_A^{*u})}{x_0 \phi_A(\sigma_A^{*u})} \leq \frac{\Phi_A(\sigma_A^*)}{\phi_A(\sigma^*)}.$$

Notice that $x_0 = 1$ implies $\sigma_A^{*u} = \sigma_A^*$. Since the lefthand side of the inequality is decreasing in x_0, Assumption A3 implies that $\sigma_A^{*u} < \sigma_A^*$ for $\frac{1}{2} < x_0 < 1$, a contradiction to the supposition. □

[14] The situation of uniform prices is akin to $\sigma_B^* = 0$, i.e. none of firm B's customers switch. Assumption 2 then implies that p_B^* for $\sigma_B^* > 0$ is lower than the corresponding price if σ_B were zero.

[15] This is because, under the supposition, $p_A^* - p_A^{*u} > p_A^{*u} - p_B^{*u} = \sigma_A^{*u} > \sigma_A^* = p_A^* - p_B^* + m_B^*$.

The Proposition shows that, if the large, established firm has a customer base that finds it relatively more costly to switch, compared to the challenger firm, then uniform prices are higher than prices for locked-in customers under HBPD. This result is of policy relevance as it is often argued that non-discriminatory interventions are aimed at protecting unengaged customers from exploitation. Our result shows that there exist circumstances in which such interventions would harm locked-in customers.

Note that our argument implies that, while $\sigma_A^{*u} \leq \sigma_A^*$, for x_0 high enough $\sigma_A^{*u} \geq \sigma_A^* - \sigma_B^*$. So for high initial market share x_0, firm A looses more market share under uniform prices than under HBPD. This result contrasts with Result 2 in Gehrig et al. [2011] that shows that the market share of the dominant firm is larger under uniform pricing than under HBPD, because under the linear structure of their Hotelling framework the dominant firm finds it very costly to poach distant customers of the rival firm, thereby insulating the smaller firm from poaching by its dominant rival.

Discussion: Unilateral Incentives

We next examine whether a firm has an incentive to poach its rival's customers by unilateral price discrimination. We focus on poaching by the smaller "challenger" firm.

Let p_B^L denote firm B's price for locked-in customers, m_B any discount offered to firm A's customers, and p_A^u firm A's uniform price. Notice first that it must be the case that

$$p_B^L - m_b \leq p_A^u \leq p_B^L.$$

The reason is that, if $p_B^L - m_B > p_A^u$, none of firm A's customers would switch. And if $p_B^L < p_A^u$, all of firm A's customers who switch to B would pay the lower poaching price $p_L^B - m_B$ and the remaining customers of firm B could be charged a higher price.

With these prices, the two firms' marginal customers are

$$\begin{aligned} \sigma_A &= p_A^u - p_B^L + m_B \\ \sigma_B &= p_B^L - p_A^U, \end{aligned}$$

and so $m_B = \sigma^B - \sigma_A > 0$.

On the basis of these prices and marginal customers, the firms' profits are

$$\begin{aligned} \pi_A &= (p_A^u - c)\left[x_0(1 - \Phi_A(\sigma_A)) + (1 - x_0)\Phi_B(\sigma_B)\right] \\ \pi_B &= (p_B^L - c)(1 - x_0)(1 - \Phi_B(\sigma_B) + (p_B^L - c - m_B)x_0\Phi_A(\sigma_A). \end{aligned}$$

The first-order conditions of the firms' profit maximization problems yield

$$\begin{aligned} p_A^u - c &= \frac{x_0(1-\Phi_A(\sigma)) + (1-x_0)\Phi_B(\sigma_B)}{x_0\phi_a(\sigma_A) + (1-x_0)\phi_B(\sigma_B)} \\ p_B^L - c &= \frac{1-\Phi_B(\sigma_B)}{\phi_B(\sigma_B)} \\ p_B^L - c - m_B &= \frac{\Phi_A(\sigma_A)}{\phi_A(\sigma_A)}. \end{aligned}$$

Since $\sigma_B > \sigma_A$, assumptions A1 and A2 imply $\frac{1-\Phi_B(\sigma_B)}{\phi_B(\sigma_B)} \leq \frac{1-\Phi_A(\sigma_A)}{\phi_A(\sigma_A)}$. Therefore, the first two first-order conditions imply that, in order to satisfy $p_A^u < p_B^L$, firm A's market share must not be too high.

Recall that in the case of uniform pricing, firm B sets its price with a view towards the marginal customer of firm A, as seen in the previous section. The distribution of of its own customers' switching costs is immaterial.

With unilateral price discrimination, however, because of the wedge between p_B^L and $p_B^L - m_B$ that brackets firm A's price p_A^u, some of firm B's customers switch to firm A, unlike in the case of uniform pricing. Therefore, firm B sets its locked-in price p_B^L with a view to its marginal customer $\sigma_B > 0$. To defend its turf, firm B must lower its price p_B^L below p_B^u; the latter was only optimal when firm B's customers were not at risk of switching.

Under assumption A1 – whereby firm A's customers are more likely to have high switching costs than firm B's –, the gain in market share by firm B from poaching is small, relative to the loss of market share due to some of its customers switching to firm A, because $\sigma_B > \sigma_A$. So firm B's prices are lower than its uniform price p_B^u, and its market share is no larger than with uniform pricing, so its profits must be lower. In conclusion, firm B does not have an incentive to unilaterally price discriminate.

This outcome differs from results like in Thisse and Vives [1988] where price-discrimination is a dominant strategy for both firms and leads to an outcome that is unambiguously dominated by that resulting from uniform pricing.[16]

> *Example:* (continued) For the case $\gamma_A = 3$ and $\gamma_B = 4$, with $x_0 = 0.55$, the prices are given by $p_A^u = 0.1915$, $p_B^L = \frac{1}{4}$ and $m_B = 0.1477$. These yield profits $\pi_A = 0.0986$ and $\pi_B = 0.1022$.

[16] Unlike in Thisse and Vives [1988], consumer heterogeneity is due to different levels of switching costs, which entails that firms cannot prevent arbitrage, in that consumers with low switching costs cannot be prevented from choosing a tariff aimed at marginal consumers with relatively higher switching costs. Whereas, Thisse and Vives [1988] model consumer heterogeneity based on different levels of transport costs (i.e., as being geographically differentiated), thus allowing firms to set different prices for different levels of transport costs.

4 Leakage (MFCs)

By leakage we mean that a firm offers its inducement m_j^L, $j = A, B$, aimed at its rival's customers as in section 2, to its own customers as well. This can be viewed as a most-favoured customer clause (MFC).[17]

Suppose internal switching is only a fraction $\alpha \in (0, 1)$ as costly as external switching. In this setting, both firms offer a poaching price, below their respective regular price. Some customers of both firms switch internally to the sweetened tariff (internal switcher), and some stay (are locked in) at the regular price. External switching is only in one direction, to the firm with the lower poaching price.[18]

Denote the level of switching costs of the marginal internal switcher by σ_j^i, and the switching costs of the marginal external switcher by σ_j^e, $j = A, B$. Then, if p_j^L denotes the price charged to locked-in customers,

$$\begin{aligned} p_j^L &= p_j^L - m_j^L + \alpha\sigma_j^i \\ p_j^L - m_j^L + \alpha\sigma_j^e &= p_k^L - m_k^L + \sigma_j^e, \quad j, k = A, B; j \neq k. \end{aligned}$$

Therefore,

$$\begin{aligned} \sigma_j^i &= \frac{m_j^L}{\alpha} \\ \sigma_j^e &= \begin{cases} \frac{p_j^L - p_k^L - (m_j^L - m_k^L)}{1-\alpha} & \text{if } p_j^L - p_k^L - (m_j^L - m_k^L) > 0 \\ 0 & \text{o.w.} \end{cases}, \quad j, k = A, B; j \neq k. \end{aligned}$$

Lemma 4.1: $\sigma_j^i > \sigma_j^e$, $j = A, B$.

Proof: Suppose, to the contrary, that $\sigma_j^i < \sigma_j^e$. Then, a customer of firm j with s such that $\sigma_j^i < s < \sigma_j^e$, switches externally, but not internally, iff

$$p_k^L - m_k^L + s < pj^L - m_j^L + \alpha s,$$

or iff

$$(1 - \alpha)s < p_j^L - p_k^L - (m_j^L - m_k^L).$$

A customer of firm j with $s' < \sigma_j^i$ switches internally, but not externally, iff

$$p_k^L - m_k^L + s' > pj^L - m_j^L + \alpha s',$$

[17] See Akman and Hviid [2006] for a discussion of MFCs from the perspective of competition law.
[18] This is shown in Lemma 4.2 below.

or iff

$$(1-\alpha)s' > p_j^L - p_k^L - (m_j^L - m_k^L).$$

But then, $s' > s$, a contradiction. □

Lemma 4.2: $\sigma_A^{*e} > 0$ *(and* $\sigma_B^{*e} = 0$*) if, and only if,* $x_0 \geq \frac{1}{2}$.

Proof: Suppose external switching is from A to B and $\sigma_A^e > 0$. Then,

$$\begin{aligned}
\pi_A^L &= x_0(p_A^L - c)\left(1 - \Phi_A(\sigma_A^e)\right) - m_A^L x_0 \left(\Phi_A(\sigma_A^i) - \Phi_A(\sigma_A^e)\right) \\
\pi_B^L &= (1-x_0)(p_B^L - c) - m_B^L(1-x_0)\Phi_B\left(\sigma_B^i\right) + x_0(p_B^L - c - m_B^L)\Phi_A\left(\sigma_A^e\right).
\end{aligned}$$

The first-order conditions for the firms' profit maximization problem yield

$$\begin{aligned}
\sigma_A^{*i} &= \frac{m_A^{*L}}{\alpha} = \frac{1-\Phi_A(\sigma_A^{*i})}{\phi_A(\sigma_A^{*i})} \\
\sigma_B^{*i} &= \frac{m_B^{*L}}{\alpha} = \frac{1-\Phi_B(\sigma_B^{*i})}{\phi_B(\sigma_B^{*i})} \\
\frac{p_A^{*L} - c - m_A^{*L}}{1-\alpha} &= \frac{1-\Phi_A(\sigma_A^{*e})}{\phi_A(\sigma_A^{*e})} \\
\frac{p_B^{*L} - c - m_B^{*L}}{1-\alpha} &= \frac{1 - x_0 + x_0\Phi_A(\sigma_A^{*e})}{x_0\phi_A(\sigma_A^{*e})}.
\end{aligned}$$

Therefore,

$$\begin{aligned}
\sigma_A^{*e} &= \frac{p_A^{*L} - c - m_A^{*L}}{1-\alpha} - \frac{p_B^{*L} - c - m_B^{*L}}{1-\alpha} \\
&= \frac{2x_0\left(1-\Phi_A(\sigma_A^{*e})\right) - 1}{x_0\phi_a(\sigma_A^{*e})},
\end{aligned}$$

which shows that $\sigma_A^e > 0$ if, and only if, $x_0 \geq \frac{1}{2}$. □

Corollary 4.1: $\sigma_A^{*e} = \sigma_A^{*u}$.

This corollary to Lemma 4.2 follows immediately from the last equality in the proof of the preceding lemma. It shows that firm A's marginal customer who is indifferent between staying with A and externally switching to firm B is the same as in the case of uniform pricing.

Proposition 4.1: *Given* $x_0 > \frac{1}{2}$ *and Assumptions 1-3,* $m_A^{*L} \geq m_B^{*L}$ *and* $p_A^{*L} \geq p_B^{*L}$.

Proof: Assumptions 1-3 imply that the first two first-order conditions of the firms' profit maximization problem imply $\sigma_A^{*i} \geq \sigma_B^{*i}$, and hence $m_A^{*L} \geq m_B^{*L}$. Lemma 3 then implies that $p_A^{*L} - p_B^{*L} \geq 0$. □

Example: (continued) Suppose again that $\gamma_A = 4$ and $\gamma_B = 3$, and let $\alpha = 0.4$. Then, $m_A^{*L} = 0.1000$, $m_B^{*L} = 0.1333$, $p_A^{*L} = \frac{1}{4}$ and $p_B^{*L} = 0.2739$. So locked-in prices are no less than uniform prices. However, with $x_0 = 0.55$, this yields profits $\pi_A^L = 0.0977$ and $\pi_B^L = 0.0900$. So, compared to the outcome with uniform pricing and with history-based price discrimination, both firms are worse off.

In the case of $\gamma_A = 4$ and $\gamma_B = 3$, again with $\alpha = 0.4$ and $x_0 = 0.55$, $m_A^{*L} = 0.1333$, $m_B^{*L} = 0.1$, $p_A^* = \frac{1}{3}$ and $p_B^{*L} = 0.2874$, with profits $\pi_A^L = 0.1303$ and $\pi_B^L = 0.1072$. So compared to history-based price discrimination, firm A is less profitable and firm B is more profitable.

If internal switching is less costly, then in this example MFCs become more profitable for both firms: With $\gamma_A = 4$, $\gamma_B = 3$ and $\alpha = 0.05$, $m_A^{*L} = 0.0167$, $m_B^{*L} = 0.0125$, $p_A^{*L} = \frac{1}{3}$ and $p_B^{*L} = 0.3092$, with profits $\pi_A^L = 0.1669$ and $\pi_B^L = 0.1455$. These are still less than those under uniform pricing, however. Leakage neutralises the toughening effect that the use of history-based price discrimination has on pricing rivalry, thanks to the fact that firms can use their poaching price as a defensive tool.

The example shows that, whether or not MFCs are profitable, relative to history-based price discrimination without leakage, depends on the relative distribution of switching costs between the two firms and the level of the cost of internal switching.

Discussion: Unilateral Incentives

Does either firm have an incentive to unilaterally impose an MFC (i.e. to allow leakage), given its rival does not? As the example shows, this question is only really relevant when the costs of internal switching are sufficiently low and when the distribution of switching costs disadvantages the larger firm.

In this case, the larger, established firm's customers are at relatively higher risk of switching, and hence the larger firm would want to consider an MFC as a defense. But that would mean that it will stem some of the outflow of customers to the challenger firm, while at the same time applying its lower poaching price to a large fraction of its remaining customer base. As α decreases, this fraction of the established firm's customer base increases, while the retention of marginal customers is eroded due to lower poaching prices of the challenger firm. So the established firm will earn less on a large fraction of its customer base and hence does not have an incentive to offer an MFC unilaterally.

To the best of our knowledge there is no extant economic literature researching the incentive to use MFCs where customers face heterogeneous 'hassle' costs to claim for compensation, so that it translates into a form of second-degree price discrimination. Besanko and Lyon [1993] analyse firms' incentives to adopt MFCs where consumers are partitioned between "non shoppers", who never consider switching, and "shoppers", who have no brand preference. However, the MFC applies to every customer indiscriminately. Therefore, the use of an MFC amounts to a non-discrimination commitment device. In our model this corresponds to a setting under uniform pricing where α is equal to zero. The authors show that there can be configurations where firms have a unilateral incentive to use contemporaneous MFCs. They also show that the use of contemporaneous MFCs has a "band-wagon effect" whereby the more firms that adopt the practice in question, the more compelling it is for remaining firms to follow suit. Although our results are consistent with that effect, albeit only for a limited set of parameters, we find that the firms lack the incentives to trigger it in the first place.

On the one hand, the comparative analysis presented above suggests that the imposition of measures intended to encourage internal switching by regulators may well be detrimental to consumers, unless market shares are sufficiently skewed and/or the relative inconvenience of external switching is not too high. On the other hand, these results also suggest that firms might strategically react to the imposition of "leakage" by improving the relative convenience of their internal switching.

As a corollary, an asymmetric regulatory intervention whereby the imposition of "leakage" is solely directed at the larger firm can materially increase the smaller rival's profit, in particular for low values of α, primarily at the expense of its locked-in customers.

5 Conclusions

This paper studies discriminatory and uniform pricing in asymmetric oligopolistic markets where firms' customers have heterogeneous switching costs. We identify circumstances under which price-discrimination can be beneficial for consumers, compared to uniform prices. We also show that the imposition of MFCs, or price discrimination with leakage, might dissipate much of these benefits when internal switching is significantly more convenient than external switching to a rival firm. And we show that, the profitability of price discrimination with and without leakage notwithstanding, firms typically lack the incentive to unilaterally impose discriminatory prices.

Our results are policy relevant. We offer a new perspective on MFCs. We explain that MFCs can act as a discriminatory device, even if they are ex ante offered indiscriminately.

Our results are also relevant for regulatory interventions aimed at stemming or neutralizing possible exploitation of relatively “unengaged” back-book customers. Such interventions typically endorse uniform prices. We show that there are circumstances where uniform prices may well be higher for all customers and where, consequently, such interventions are counterproductive.

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